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# SIGNIFIKAN

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# SIGNIFIKAN
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# Climate Stress, Inflation, and Foreign Investment: Do Growth and Corruption Control Shape Inequality?

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## ABSTRACT

**Research Originality:** This study provides a new contribution by examining climate stress, inflation, and foreign investment within a single integrated framework. By uniting environmental, macroeconomic, and governance factors, it offers a clearer understanding of the structural drivers of inequality in ASEAN-4.

**Research Objectives:** The study examines the impacts of climate change, inflation, and foreign investment on inequality and evaluates how economic growth and corruption control moderate these effects.

**Research Methods:** The study uses annual panel data for Indonesia, Malaysia, Thailand, and the Philippines from 2002 to 2023 and applies moderated panel regression analysis to estimate both direct and interaction effects.

**Empirical Results:** Climate pressures and foreign investment increase inequality, while inflation slightly reduces it. The analysis also shows that economic growth lessens the inequality effect of foreign investment, whereas stronger corruption control unexpectedly amplifies it, suggesting that better governance does not automatically ensure fairer investment outcomes.

**Implications:** These findings suggest that ASEAN-4 policymakers must align inclusive growth, inflation stability, environmental action, and improved governance to effectively reduce inequality and support sustainable development.

**Keywords:**

income inequality; climate change; foreign direct investment; economic growth; corruption control

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## INTRODUCTION

Income inequality remains a major challenge in modern economic development (Kuznets, 2019; Vitkovics, 2023; Agustina et al., 2023). Although many countries have succeeded in reducing poverty and improving average living standards, unequal income distribution persists and, in some cases, has even widened (Umair et al., 2024). The effects of inequality go beyond issues of fairness. Large income gaps are closely linked to political instability, weaker social cohesion, and slower long-term economic growth (Paddu et al., 2025). In developing and emerging economies, inequality is often shaped by multiple structural problems, such as climate risks, macroeconomic instability, and weak governance (Sahu & Mahalik, 2024; Tavares et al., 2025). These issues are particularly relevant in the ASEAN region, where rapid economic growth has not always produced equally shared benefits.

Evidence from ASEAN highlights the seriousness of the problem. The International Monetary Fund notes that inequality can influence economic growth and sustainability. When income growth is concentrated among the richest 20 percent, medium-term GDP growth may actually slow because the benefits are not widely shared (Norris et al., 2015). Data from the World Inequality Database (2025) show that the average Gini ratio in ASEAN has remained around 0.46 over the last two decades, which is considered high globally. Indonesia has the highest inequality in the region, with an average Gini ratio of 0.54, followed by Cambodia at 0.51, while Brunei Darussalam records the lowest at 0.36. In the ASEAN-4 countries, inequality also remains high: Thailand reached 0.52 in 2023, the Philippines averages about 0.47, and Malaysia records 0.42. These differences are largely caused by uneven economic development, regional disparities, and differences in labor skills (Fai & Tomlinson, 2023). Although Indonesia, Malaysia, Thailand, and the Philippines are classified by the World Bank as upper-middle-income countries with per capita incomes between USD 4,466 and USD 13,845, their high levels of inequality indicate that economic growth has not been fully inclusive.

Climate change is another important factor that can worsen inequality. Studies show that environmental shocks—such as extreme weather events and rising temperatures—tend to affect low-income groups more severely, which increases income inequality (Cevik & Jalles, 2023; Singer, 2018; Parsons et al., 2025). For example, a one-percent increase in climate vulnerability is associated with a 1.5-percent rise in inequality. This occurs because poorer households and sectors generally have less capacity to adapt to environmental risks. As a result, climate change is now widely seen not only as an environmental problem but also as an issue related to fairness and income distribution (Davidson, 2021). Recent studies reinforce this argument. Barra et al. (2025) show that uncertainty in economic, climate, and energy policies can change the relationship between environmental conditions and economic growth, often increasing inequality. Similarly, Acheampong et al. (2024) find that high inequality can slow the transition to renewable energy and maintain reliance on non-renewable resources, indicating a strong link between energy systems and income inequality.


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Macroeconomic conditions, particularly inflation, also play an important role in shaping income inequality (Memon & Qureshi, 2021). While moderate inflation can support economic activity, high or prolonged inflation tends to reduce the purchasing power of poorer households and increase inequality. Research suggests a threshold effect: when inflation rises above 6%, it generally worsens income disparities (Glawe & Wagner, 2024). However, the evidence is not always consistent. Some studies argue that wealthier groups are better protected from inflation because they own assets, while others find nonlinear or U-shaped relationships between inflation and inequality (Zheng et al., 2020; Walsh & Yu, 2012). Inflation can also increase inequality over time, especially when it occurs alongside unemployment and weak institutions (Abdi et al., 2025). These mixed findings highlight the importance of examining inflation in specific economic contexts, particularly in emerging markets where inflation shocks often occur and affect social groups differently.

Foreign Direct Investment (FDI) is another factor that influences income inequality, though its impact remains debated. On one side, FDI can create jobs, transfer technology, and increase productivity, which may help reduce inequality over the long run (Ravinthirakumaran & Ravinthirakumaran, 2018). On the other side, when FDI is concentrated in capital-intensive industries or specific regions, it may increase inequality by benefiting mainly skilled workers or urban areas (Le et al., 2021; Suanes, 2016). Research also suggests that the effect of FDI may be nonlinear and depend on institutional quality and a country's ability to absorb investment benefits (Figini & Görg, 2011). Supporting this complexity, Abdi et al. (2025) find that FDI reduces inequality only in the short term, while globalization may increase disparities over time. In Indonesia, Handayani et al. (2022) show that FDI can reduce inequality when it is accompanied by strong economic growth. Meanwhile, research on ASEAN+3 by Shaari et al. (2022) indicates that lower corruption attracts more FDI, although environmental degradation can also draw investment, reflecting pollution-haven behavior. Therefore, the effect of FDI on income distribution must be understood within the broader economic and governance context.

The effects of these factors are also shaped by moderating variables such as economic growth and corruption control. Strong economic growth can reduce the inequality effects of FDI by creating more jobs and enabling redistribution through government spending (Gam et al., 2023). In contrast, weak or uneven growth may increase inequality if the gains from foreign investment benefit only a small group. Governance quality, particularly corruption control, is also crucial. Strong institutions and effective anti-corruption policies can ensure that FDI contributes to inclusive development. In contrast, weak governance may lead to elite capture, rent-seeking, and concentration of investment benefits in certain regions, which can increase inequality (Acemoglu & Robinson, 2012; Le et al., 2021). Supporting this argument, Hakimi and Hamdi (2017) find that corruption reduces economic growth and discourages FDI, thereby reinforcing inequality. Other evidence also emphasizes that reducing corruption and inequality is important for achieving inclusive development and supporting cleaner energy transitions (Acheampong et al., 2024).

These issues are particularly relevant for the ASEAN-4 countries—Indonesia, Malaysia, Thailand, and the Philippines. Although these economies have experienced steady economic growth, inequality remains deeply rooted and continues alongside climate vulnerability, inflation instability, and governance challenges. As members of an increasingly integrated regional economy, ASEAN-4 countries are highly exposed to global capital flows. This makes FDI both an important source of economic growth and a potential contributor to inequality. However, only a limited number of studies examine how environmental pressures, macroeconomic conditions, and governance factors together influence inequality in these countries.

Existing empirical research also provides mixed results. Some studies find that FDI can reduce inequality when economic growth is strong (Gam et al., 2023). However, other research shows that in countries with weak institutions, FDI may actually increase inequality (Le et al., 2021). The relationship between inflation and inequality is also debated, with some studies finding no effect, while others report inequality-reducing or inequality-increasing outcomes depending on the context (Wijayanti & Aisyah, 2022; Glawe & Wagner, 2024; Zheng et al., 2020). These differing findings suggest that earlier studies have not fully considered the combined effects of environmental pressures, macroeconomic conditions, and institutional quality, nor how these factors interact to influence inequality in ASEAN-4 countries.

Against this background, this study positions itself by addressing a clear research gap. First, it integrates climate change, inflation, and FDI into a single analytical framework, a rare approach in ASEAN-focused inequality studies. Second, it introduces economic growth and corruption control as moderators to capture how structural and governance conditions shape the effects of macroeconomic and environmental forces on inequality. Third, it provides a region-specific comparative analysis, offering insights that global or single-country studies cannot capture.

Using annual panel data for 2002–2023 and panel regression with moderation analysis, this study contributes to the literature in three key ways. It presents a unified model linking environmental, macroeconomic, and institutional determinants of inequality; delivers comparative evidence tailored to ASEAN-4's shared development challenges; and generates policy-relevant implications for how growth and anti-corruption strategies can reduce inequality under climate and economic pressures. Together, these contributions establish the study's novelty and relevance and underscore why the topic remains compelling for both scholars and policymakers.

## METHODS

This study uses annual panel data that combine cross-sectional observations from four ASEAN countries—Indonesia, Malaysia, Thailand, and the Philippines—with time-series data from 2002 to 2023, resulting in 88 observations. These countries are selected because they represent the core ASEAN-4 group and are consistently classified by the World Bank as upper-middle-income economies with similar structural characteristics. They also have


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more complete data on environmental, macroeconomic, and governance indicators. Other ASEAN countries lack consistent long-term data for key variables such as corruption control, climate indicators, and income inequality, making it difficult to construct a balanced panel for moderation analysis. The period 2002–2023 is chosen because 2002 is the earliest year when all variables—climate indicators, FDI inflows, inflation, and governance measures—are available and consistently reported for the ASEAN-4. The endpoint of 2023 allows the study to capture recent economic developments, including post-Asian Financial Crisis reforms, deeper global integration, and increasing climate-related pressures.

The dataset includes six main variables to examine the interaction between environmental factors, macroeconomic conditions, and institutional quality. The dependent variable is income inequality (IIE), measured by the Gini index from the World Inequality Database. Two moderating variables are economic growth (EGR) and corruption control (CRC). Economic growth is represented by GDP per capita, while corruption control is taken from the Worldwide Governance Indicators and reflects the extent of corruption, state capture, and the effectiveness of institutions.

The independent variables capture the key economic and environmental factors that affect inequality. Climate change (CLC) is measured using $CO_2$ emissions intensity, defined as the amount of carbon dioxide emissions per unit of GDP, which reflects the environmental impact of economic activity. Inflation (INF) is measured as the annual percentage change in the Consumer Price Index (CPI), indicating price instability and its impact on household purchasing power. Foreign direct investment (FDI) is measured as net inflows as a percentage of GDP, representing foreign capital entering the economy and its potential influence on income distribution.

The empirical analysis applies panel regression techniques to estimate the relationships among these variables. The baseline specification tests the effects of climate change, inflation, and FDI on income inequality, followed by extended models incorporating interaction terms to assess the moderating roles of economic growth and corruption control. The baseline model is expressed in Equation (1):

$$IIE_{it} = \alpha + \beta_{11}CLC_{it} + \beta_{12}INF_{it} + \beta_{13}FDI_{it} + \varepsilon_{it} \quad (1)$$

Because the independent variables differ in scale and magnitude, the model is further transformed using natural logarithms, as shown in Equation (2):

$$LogIIEit = \alpha + \beta_{11}LogCLC_{it} + \beta_{12}INF_{it} + \beta_{13}FDI_{it} + \varepsilon_{it} \quad (2)$$

To extend the analysis, this study also incorporates a moderation framework using Moderated Regression Analysis (MRA). Specifically, it evaluates the roles of economic growth and corruption control as moderating variables in the relationship between FDI and income inequality. These are captured in the following models:

$$LogIIE_{it} = \alpha + \beta_{21}FDI_{it} + \beta_{22}LogGRW_{it} + \beta_{23}FDI_{it}*LogGRW_{it} + \varepsilon_{it} \quad (3a)$$

$$LogIIE_{it} = \alpha + \beta_{31}FDI_{it} + \beta_{32}LogCRC_{it} + \beta_{33}FDI_{it}*LogCRC_{it} + \varepsilon_{it} \quad (3b)$$

where Log is the natural logarithm, IIE is income inequality, CLC is climate change, INF is is inflation is is foreign direct investment, $\alpha$ is the constant, $\varepsilon$ is the error term, $i$ denotes the cross-sectional unit (country), and $t$ represents the time period.

For estimation, the study employs three alternative panel regression models: the Common Effect Model (CEM) or Pooled Least Squares (PLS), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The CEM represents the simplest specification, assuming homogeneous behavior across both cross-sections and time periods. By contrast, FEM controls for unobserved country-specific effects that remain constant over time, while REM assumes that unobserved heterogeneity is random and uncorrelated with the regressors. REM is also known as the Error Component Model (ECM), estimated using Generalized Least Squares (GLS) techniques. The general functional form is presented in Equation (4):

$$Y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \quad (4)$$

where $Y_{it}$ denotes the dependent variable for country $i$ at time $t$, $\alpha$ is the intercept term, $X_{it}$ is the vector of independent variables, $\beta$ represents the corresponding regression coefficients that measure the magnitude and direction of the relationships, and $\varepsilon_{it}$ is the stochastic error term capturing unobserved factors not included in the model.

The appropriate specification of the panel regression model was determined through a sequence of model selection tests, namely the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The Chow test is used to discriminate between the Common Effect Model (CEM), also known as Pooled Least Squares (PLS), and the Fixed Effect Model (FEM). It does so by evaluating whether cross-sectional intercepts are homogeneous across entities. The Hausman test is subsequently applied to differentiate between FEM and the Random Effect Model (REM). This test assesses whether the unobserved individual-specific effects are correlated with the regressors. Finally, the Lagrange Multiplier (LM) test, as introduced by Breusch and Pagan (1980), is conducted to decide between REM and CEM.

## RESULTS AND DISCUSSION

The results of this study reveal three key empirical findings. First, climate change significantly increases income inequality in ASEAN-4, indicating that environmental stress disproportionately affects lower-income groups. Second, inflation within the observed range reduces inequality, suggesting a mild equalizing effect when price increases remain manageable. Third, foreign direct investment tends to widen inequality, though its impact varies when economic growth and corruption control are considered moderating


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factors. These main findings are elaborated through descriptive statistics and econometric estimations presented below.

To provide initial context, Table 1 presents the descriptive statistics for the variables used in this study, offering a preliminary picture of the economic, environmental, and institutional characteristics of the ASEAN-4 countries over the period 2002–2023. The results highlight considerable heterogeneity across observations, particularly for inflation and foreign direct investment, which exhibit the widest fluctuations among the variables.

The descriptive statistics for all variables included in this study are reported in Table 1. The results reveal that income inequality (IIE), measured by the Gini index, averages 0.46 across ASEAN-4, ranging from 0.40 to 0.56, confirming the persistence of relatively high inequality during the period of analysis. Economic growth (GRW), proxied by GDP per capita, has a mean of USD 13,473 but ranges from USD 3,580 to USD 36,417, reflecting substantial differences in output levels across countries and years. Corruption control (CRC) scores only 0.13 on the governance index, underscoring limited institutional effectiveness in curbing rent-seeking and uneven enforcement of anti-corruption measures.

**Table 1. Descriptive Statistics**

| | IIE (Index) | GRW (US$) | CRC (Index) | CLC (US$) | INF (Percent) | FDI (Percent) |
|---|---|---|---|---|---|---|
| Mean | 0.4664 | 13473.09 | 0.1394 | 0.6471 | 3.4726 | 2.2879 |
| Median | 0.4600 | 11547.50 | 0.1378 | 0.6750 | 3.0900 | 2.2900 |
| Maximum | 0.5600 | 36417.00 | 0.1603 | 0.9800 | 13.1000 | 5.4200 |
| Minimum | 0.4000 | 3580.000 | 0.1223 | 0.3500 | -1.2300 | -0.8600 |
| Std. Dev | 0.0458 | 7560.582 | 0.0097 | 0.1831 | 2.6387 | 1.2418 |

Source: Processed results from secondary data (2025).

Turning to the independent variables, climate change intensity (CLC), expressed as $CO_2$ emissions per unit of GDP, averages 0.64, ranging from 0.35 to 0.98, highlighting the environmental burden of economic activity in the region. Inflation (INF) shows considerable volatility, ranging from –1.23 percent to 13.1 percent, although its average remains moderate at 3.47 percent. FDI inflows, expressed as a share of GDP, average 2.28 percent but fluctuate sharply between –0.86 and 5.42 percent, indicating uneven patterns of external capital integration. Overall, the descriptive results emphasize three important features: (i) inequality remains structurally entrenched at relatively high levels; (ii) economic growth and external investment are marked by significant variation across space and time; and (iii) governance weaknesses and environmental stress persist as additional constraints on inclusive development. These dynamics provide the rationale for further econometric investigation into how growth and corruption control may moderate the effects of macroeconomic and environmental factors on inequality in ASEAN-4.

Selecting an appropriate panel data model is a critical step to ensure the accuracy and consistency of econometric estimation. In this study, model specification was guided by both theoretical considerations in variable selection and econometric diagnostics to determine whether the Common Effect Model (CEM), Fixed Effect Model (FEM), or Random Effect Model (REM) provides the best fit for the dataset. To this end, three complementary statistical procedures were applied: the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. These tests are designed to evaluate unobserved heterogeneity across cross-sections, the correlation between regressors and individual effects, and the efficiency gains from random effects estimation.

The results presented in Table 2 demonstrate a consistent pattern across all three model specifications. In Model I, which estimates the direct effects of climate change, inflation, and FDI on income inequality, both the Chow and Hausman tests yield highly significant results, rejecting the null hypotheses in favor of FEM. In Model II, where economic growth interacts with FDI as a moderating variable, the Chow and Hausman statistics again confirm FEM as the superior model. Finally, in Model III, which examines the moderating role of corruption control on the FDI–inequality relationship, the same conclusion holds: the FEM is the most appropriate specification. These findings suggest that unobserved country-specific characteristics—such as structural differences in economic development, institutional quality, or social policy regimes—are not only present but also correlated with the explanatory variables. The FEM, by allowing intercepts to vary across countries, captures this heterogeneity more effectively than either the pooled or random specifications. Consequently, all subsequent estimations in this study rely on the Fixed Effect Model, ensuring both statistical consistency and theoretical coherence.

**Table 2. Results of the Chow and Hausman Tests**

| Model | | Effects Test | Statistic | Prob. | Decision |
|---|---|---|---|---|---|
| Model I (IIE) | Uji Chow | Cross-section F | 99.4887*** | 0.0000 | FEM |
| | | Cross-section Chi-square | 135.8998*** | 0.0000 | |
| | Uji Hausman | Cross-section random | 298.4662*** | 0.0000 | FEM |
| Model II (GRW*FDI) | Uji Chow | Cross-section F | 82.9542*** | 0.0000 | FEM |
| | | Cross-section Chi-square | 123.5720*** | 0.0000 | |
| | Uji Hausman | Cross-section random | 248.8627*** | 0.0000 | FEM |
| Model III (CRC*FDI) | Uji Chow | Cross-section F | 96.3841*** | 0.0000 | FEM |
| | | Cross-section Chi-square | 133.7129*** | 0.0000 | |
| | Uji Hausman | Cross-section random | 289.1523*** | 0.0000 | FEM |

Source: Processed results from secondary data (2025).
Note: *** denotes significance at the 1% level.

The first stage of the analysis examines the direct effects of climate change, inflation, and foreign direct investment (FDI) on income inequality in the ASEAN-4


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countries. The results, estimated using a fixed-effect model, are presented in Table 3. The findings show that climate change has a positive and highly significant impact on income inequality. The coefficient of 0.17 suggests that a one-point increase in climate vulnerability is associated with a 17.39% increase in inequality. This result highlights the unequal impact of environmental shocks, which tend to affect poorer households and workers in climate-sensitive sectors more severely. Similar findings are reported by Malpede and Percoco (2021) and Cevik and Jalles (2021), who argue that the negative distributional effects of climate risks are stronger in developing countries due to limited capacity for adaptation and mitigation. More recent research by Méjean et al. (2024) also shows that climate-related disruptions, such as extreme weather events, can increase inequality both directly—through productivity losses in agriculture and informal sectors—and indirectly by reinforcing poverty traps. However, Otrachshenko and Popova (2021) note that extreme temperature exposure does not always increase inequality, as factors such as labor mobility and regional industrial structures may influence the outcome.

For inflation (INF), the estimated coefficient is –0.0056, indicating a negative relationship between inflation and inequality. This means that a 1% increase in inflation is associated with a small reduction in inequality of about 0.004%. This result supports the idea of a nonlinear or U-shaped relationship between inflation and inequality. At lower levels, inflation may reduce inequality by lowering the real value of debt and narrowing wage differences, thereby benefiting lower-income groups. However, when inflation becomes too high, it can harm poorer households by reducing their purchasing power. Similar patterns have been found in studies of OECD countries and the United States (Zheng et al., 2020; Balcilar et al., 2018). In the ASEAN context, Walsh and Yu (2012) argue that food inflation does not always increase inequality because income gains in other sectors may offset the negative effects on poorer households. However, other studies provide different conclusions. Uspri (2023) and Gros & Shamsfakhr (2023) find that inflation can reduce real wages and purchasing power, thereby increasing inequality under certain conditions.

**Table 3. Panel Regression Results (Model I):**
**Direct Effects of Climate Change, Inflation, and FDI on Income Inequality**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | -0.6812*** | 0.0300 | -2.2686 | 0.0000 |
| CLC | 0.1739*** | 0.0490 | 3.5460 | 0.0007 |
| INF | -0.0056*** | 0.0024 | -2.3283 | 0.0224 |
| FDI | 0.0089** | 0.0045 | 1.9721 | 0.0520 |
| R-squared | 0.8041 | | F-statistic | 55.4228 |
| Adjusted R-squared | 0.7896 | | Prob(F-statistic) | 0.0000 |

Source: Processed results from secondary data (2025).
Note: *** and ** denote significance at the 1% and 5% levels, respectively.

Finally, the results reveal that FDI inflows are positively associated with inequality. This result implies that a 1% increase in FDI inflows increases income inequality, reflecting the uneven distribution of investment benefits across regions and industries. In many developing economies, FDI tends to be concentrated in capital-intensive or export-oriented sectors, thereby disproportionately benefiting skilled labor and urban centers while bypassing rural areas. This is consistent with Suanes (2016) in Latin America, Saucedo et al. (2020) in Mexico, and Ma (2025 in China, which collectively argue that FDI often widens wage gaps in developing countries. Nonetheless, the literature also points to nonlinear effects. Figini and Görg (2011) and Le et al. (2021) report that while FDI inflows initially worsen inequality, at higher levels they can reduce inequality by creating broader spillovers, enhancing technology diffusion, and expanding labor demand. Similarly, Chen and Wu (2019) find that FDI can reduce the Gini coefficient by improving productivity, suggesting that the inequality effect of FDI depends heavily on the absorptive capacity and institutional quality of host countries.

**Table 4. Interaction Test Results (Model II):**
**The Moderating Role of Economic Growth in the FDI–Inequality Nexus**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | -0.5279*** | 0.1848 | -2.8566 | 0.0054 |
| FDI | 0.1757*** | 0.0734 | 2.3941 | 0.0190 |
| GRW | -0.0275 | 0.0197 | -1.3965 | 0.1664 |
| GRW*FDI | -0.0174*** | 0.0077 | -2.2641 | 0.0262 |
| R-squared | 0.8105 | | F-statistic | 57.7590 |
| Adjusted R-squared | 0.7965 | | Prob(F-statistic) | 0.0000 |

Source: Processed results from secondary data (2025).
Note: *** and ** denote significance at the 1% and 5% levels, respectively.

The interaction test using economic growth as a moderating variable is reported in Table 4. The results show that FDI maintains a positive and significant effect on income inequality, indicating that, in the absence of moderating influences, capital inflows tend to widen disparities. Economic growth, proxied by GDP per capita, exhibits a negative coefficient, suggesting that, although the effect is statistically insignificant, higher economic growth is associated with reductions in inequality. Substantively, a 1% increase in economic growth is estimated to lower income inequality by 0.02%.

More importantly, the interaction term between FDI and economic growth is negative, implying that economic growth effectively moderates the relationship between FDI and inequality. In practical terms, this means that in countries with higher economic growth, the inequality-widening effect of FDI diminishes, and FDI can even help reduce disparities. Thus, economic expansion enhances the absorptive capacity of host economies, enabling a broader distribution of the benefits from foreign investment. These findings align with


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those of Gam et al. (2023), who show that although FDI tends to widen inequality, strong economic growth can reverse this effect by broadening employment opportunities and boosting productivity. This pattern reflects the Kuznets (1955) hypothesis, which predicts rising inequality during early industrialization followed by declines as economies diversify and labor markets strengthen—a view echoed by Alamanda (2021), who notes that early-stage rural–urban migration and wage stagnation initially heighten disparities before inclusive policies and rising labor demand gradually narrow gaps. Evidence from Abdi et al. (2025) further supports this trajectory, showing that GDP per capita initially increases inequality in Somalia but that this effect weakens over time, while FDI reduces inequality only in the short run. These results underscore the importance of growth conditions and institutional context, consistent with the moderating role of growth observed in the ASEAN-4. Fazaalloh (2019) similarly finds that FDI's inequality-reducing effects emerge only when growth is taken into account, as technology transfer, skill upgrading, and productivity gains materialize more broadly in expanding economies.

Beyond growth, the interaction between climate pressures and inequality in this study reflects broader global evidence. Barra et al. (2025) show that environmental and policy uncertainty can alter the Environmental Kuznets Curve, intensifying distributional vulnerabilities, while Acheampong et al. (2024) demonstrate that inequality itself can reinforce environmental degradation by reducing renewable energy adoption. This mirrors the ASEAN-4 context, where climate stress, low adaptive capacity, and unequal access to environmental protection jointly amplify inequality. Indonesian evidence from Handayani et al. (2022) further confirms that while growth and FDI can reduce inequality, higher $CO_2$ emissions worsen it by disproportionately harming low-income groups through both economic and health channels. These parallels collectively strengthen the positioning of the present study by showing that ASEAN-4 shares common structural constraints, and that the interplay between growth, investment, and environmental pressures is central to understanding inequality dynamics in the region.

The third model introduces corruption control (CRC) as a moderating variable to examine whether stronger governance institutions influence the impact of foreign direct investment (FDI) on inequality. The results, shown in Table 5, indicate that FDI continues to have a positive and significant effect on income inequality, consistent with Model I. This suggests that foreign capital inflows may widen disparities when their benefits are unevenly distributed. The coefficient for corruption control is negative (–0.271), implying that stronger institutions are associated with lower inequality, although the effect is statistically insignificant ($p = 0.117$). A one-unit increase in CRC is estimated to reduce inequality by about 0.27%, indicating that anti-corruption efforts may support more equitable outcomes, even though their direct impact remains limited in this sample.

The interaction between FDI and corruption control (CRC*FDI) is positive. This unexpected result suggests that when corruption is more effectively controlled, the inequality-increasing effect of FDI becomes stronger. One possible explanation is that FDI

in ASEAN-4 tends to be concentrated in certain regions and sectors. As a result, even with better governance, foreign investment mainly benefits skilled workers, urban areas, or well-connected firms. In this situation, reducing corruption does not automatically ensure that investment benefits are distributed widely, especially when FDI remains focused on capital-intensive industries.

**Table 5. Interaction Test (Model III):**
**The Moderating Role of Corruption Control in the FDI–Inequality Nexus**

| Variable | Coefficient | Std. Error | t-Statistic | Prob |
|---|---|---|---|---|
| C | -1.3139*** | 0.3345 | -3.9271 | 0.0002 |
| FDI | 0.3231*** | 0.1334 | 2.4208 | 0.0177 |
| CRC | -0.2710 | 0.1712 | -1.5827 | 0.1174 |
| CRC*FDI | 0.1601*** | 0.0682 | 2.3470 | 0.0214 |
| R-squared | 0.7889 | | F-statistic | 50.4531 |
| Adjusted R-squared | 0.7732 | | Prob(F-statistic) | 0.0000 |

Source: Processed results from secondary data (2025).
Note: *** and *** denote significance at the 1% and 5% levels, respectively.

These findings are consistent with those of Le et al. (2021), who argue that although FDI often increases inequality, its impact depends on institutional quality and the extent of investment distribution. Even strong institutions may not prevent inequality if FDI remains concentrated in urban or capital-intensive sectors, a pattern also seen in ASEAN-4. This supports the argument of Acemoglu and Robinson (2012) that institutional reforms alone cannot reduce inequality without inclusive development and redistribution policies. The result may also reflect the dynamics discussed by Dobson & Ramlogan-Dobson (2012) and Davidescu et al. (2022), who suggest that in economies with large informal sectors, corruption can sometimes act as an informal redistribution mechanism. When corruption is reduced without expanding formal economic opportunities, inequality may increase. In contrast, Hakimi and Hamdi (2017) find that corruption discourages FDI in MENA countries, while in ASEAN-4 foreign investment continues despite governance differences. This means inequality outcomes depend more on sectoral concentration and the ability of economies to absorb investment benefits than on corruption levels alone. Evidence from Shaari et al. (2022) also shows that environmental degradation can attract FDI in ASEAN+3, suggesting that when FDI flows to pollution-intensive industries, economic gains are concentrated while environmental costs fall more heavily on poorer communities, further increasing inequality.

Other studies also highlight complex relationships between corruption and inequality. Davidescu et al. (2022) and Dobson & Ramlogan-Dobson (2012) suggest that higher corruption can sometimes be associated with lower inequality because informal-sector activities may redistribute resources. When the informal sector accounts


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for a large share of GDP, corruption may serve as an alternative allocation mechanism. However, when the informal sector accounts for more than one-fifth of total output, corruption no longer reduces inequality, suggesting that this relationship depends heavily on economic conditions. Overall, Model III's results show the complex role of institutions in the relationship between FDI and inequality. Although stronger corruption control is expected to reduce inequality, in ASEAN-4, it appears to strengthen the inequality-increasing effect of FDI. This suggests that institutional reforms must be supported by policies that more evenly distribute foreign investment. Such policies may include targeted infrastructure development, investment in human capital, and incentives for FDI in labor-intensive sectors so that the benefits of improved governance can lead to more equal outcomes.

More broadly, the study contributes to the literature in several ways. First, it combines environmental, macroeconomic, and institutional factors in a single empirical framework, an approach rarely used in studies of ASEAN economies. Second, the results show that the impact of FDI on inequality depends strongly on structural conditions, especially economic growth and corruption control, extending the findings of Abdi et al. (2025), Le et al. (2021), and Fazaalloh (2019). Third, the study shows that improvements in governance can unintentionally increase inequality when foreign investment remains concentrated in specific sectors or locations. Together, these findings help explain mixed results in previous research and provide new insights into how environmental pressures, macroeconomic conditions, and institutional quality shape inequality in ASEAN-4.

## CONCLUSION

This study provides new evidence on the drivers of income inequality in the ASEAN-4 by examining environmental, macroeconomic, and institutional factors together. The results show that climate change and foreign direct investment (FDI) tend to increase inequality, while inflation slightly reduces inequality within the observed range. The analysis also finds that economic growth weakens the inequality-increasing effect of FDI. In contrast, stronger corruption control appears to intensify the inequality impact of FDI, suggesting that investment benefits are not evenly distributed. Overall, the findings indicate that inequality in ASEAN-4 is shaped not only by external shocks but also by economic growth patterns and institutional conditions.

These findings have several policy implications. First, governments need to ensure that FDI supports inclusive development rather than benefiting only specific sectors or regions. This can be done by encouraging investment in labor-intensive industries, strengthening connections between foreign companies and local suppliers, and promoting balanced regional investment. Second, improving absorptive capacity is essential. Investments in education, skills, and technology can help workers and domestic firms benefit from productivity gains brought by FDI. Third, inflation management should not focus only on price stability. Because moderate inflation may sometimes reduce inequality, monetary

policy should also be supported by social protection programs such as wage support, food price policies, and targeted cash transfers to protect low-income households. Fourth, the strong effect of climate change on inequality highlights the need to integrate climate policies into development strategies. Expanding climate-resilient infrastructure, protecting vulnerable livelihoods, and reducing environmental risks are important to prevent climate shocks from widening income gaps. Finally, the results suggest that governance reforms alone are not enough. Anti-corruption policies should be combined with transparent investment allocation, monitoring of sectoral concentration, and safeguards against elite capture. Measures such as public disclosure of investment flows, participatory local budgeting, and clear requirements for foreign investors can help ensure that investment benefits are distributed more fairly.

Future research can expand this analysis by including additional institutional indicators, such as the rule of law and regulatory quality, to better understand governance differences within ASEAN-4. Examining sectoral differences in FDI—such as manufacturing, services, and extractive industries—could also provide deeper insights into how foreign investment affects inequality. From a methodological perspective, future studies may employ dynamic panel models or nonlinear approaches to better capture long-term and threshold effects. Comparative studies involving other emerging regions would also help broaden understanding of how climate change, macroeconomic conditions, and governance jointly influence income inequality.

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## REFERENCES

Abdi, A. H., Mohamed, A. A., Mohamed, A. A., & Mohamed, A. A. (2025). Do Globalization, Foreign Direct Investment, and Inflation Drive Income Inequality? Evidence from Somalia Within The Kuznets Curve Hypothesis. *Research in Globalization*, *11*, 100301. https://doi.org/10.1016/j.resglo.2025.100301.

Acemoglu, D., & Robinson, J. A. (2012). *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishers.

Acheampong, A. O., Boateng, E., & Annor, C. B. (2024). Do Corruption, Income Inequality and Redistribution Hasten Transition towards (Non)Renewable Energy Economy? *Structural Change and Economic Dynamics, 68*, 329–354. https://doi.org/10.1016/j.strueco.2023.11.006.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46506

Agustina, M., Majid, M. S. A., Faisal, F., & Musnadi, S. (2023). Does Islamic Banking Sector Matter for Income Disparity Reduction? Empirical Evidence from Indonesia. *International Journal of Professional Business Review*, 8(5), 1–17. https://doi.org/10.26668/businessreview/2023.v8i5.1475.

Alamanda, A. (2021). The Effect of Economic Growth on Income Inequality: Panel Data Analysis from Fifty Countries. *Info Artha*, 5(1), 1–10. https://doi.org/10.31092/jia.v5i1.1176.

Balcilar, M., Gupta, R., & Jooste, C. (2017). The Growth-Inflation Nexus for the US from 1801 to 2013: A Semiparametric Approach. *Journal of Applied Economics*, *20*(1), 105-120. https://doi.org/10.1016/S1514-0326(17)30005-3.

Barra, C., Falcone, P. M., & Giganti, P. (2025). Exploring the Impact of Economic, Climate, and Energy Policy Uncertainty on the Environmental Kuznets Curve: International Evidence. *International Economics, 182*, 100592. https://doi.org/10.1016/j.inteco.2025.100592.

Cevik, S., & Jalles, J. T. (2023). For Whom the Bell Tolls: Climate Change and Income Inequality. *Energy Policy*, 174 (1), 1-11. https://doi.org/10.1016/j.enpol.2023.113475.

Chen, C., & Wu, Y. (2019). Interregional Impact of Foreign Direct Investment on China's Inland Urbanization. *The Singapore Economic Review*, 64(04), 997–1017. https://doi.org/10.1142/S0217590817450035.

Davidescu, A. A., Nae, T. M., & Florescu, M. S. (2022). Exploring the Moderation and Mediation Effects in Addressing the Main Determinants of Income Inequalities in Supporting Quality of Life: Insights from CEE Countries. *International Journal of Environmental Research and Public Health, 19*(14), 1–28. https://doi.org/10.3390/ijerph19148555.

Davidson, M. D. (2021). How Fairness Principles in the Climate Debate Relate to Theories of Distributive Justice. *Sustainability*, 13(13), 1–16. https://doi.org/10.3390/su13137302.

Dobson, S., & Ramlogan-Dobson, C. (2012). Inequality, Corruption, and the Informal Sector. *Economics Letters, 115*(1), 104–107. https://doi.org/10.1016/j.econlet.2011.11.034.

Fai, F. M., & Tomlinson, P. R. (2023). Levelling Up or Down? Addressing Regional Inequalities in the UK. *Contemporary Social Science*, 18(3-4), 285–297. https://doi.org/10.1080/21582041.2023.2282161.

Fazaalloh, A. M. (2019). Is Foreign Direct Investment Helpful to Reduce Income Inequality in Indonesia?. *Economics & Sociology, 12*(3), 25–36. http://dx.doi.org/10.14254/2071789X.2019/12-3/2.

Figini, P., & Görg, H. (2011). Does Foreign Direct Investment Affect Wage Inequality? An Empirical Investigation. *The World Economy, 34*(9), 1455–1475. https://doi.org/10.1111/j.1467-9701.2011.01397.x.

Gam, T. T. H., Oanh, D. L. K., & Dang, N. M. B. (2023). The Impact of Foreign Direct Investment on Income Inequality in Developing Countries: The Bayesian approach. *Jurnal Ekonomi & Studi Pembangunan*, 24(1), 127–143. https://doi.org/10.18196/jesp.v24i1.18164.

Glawe, L., & Wagner, H. (2024). Inflation and Inequality: New Evidence from A Dynamic Panel Threshold Analysis. *International Economics and Economic Policy*, *21*(2), 297–309. https://doi.org/10.1007/s10368-023-00580-x.

Gros, D., & Shamsfakhr, F. (2023). *Inflation and Inequality*. European Union: Economic Governance and EMU Scrutiny Unit.

Hakimi, A., & Hamdi, H. (2017). Does Corruption Limit FDI and Economic Growth? Evidence from MENA Countries. *International Journal of Emerging Markets, 12*(3), 550–571. https://doi.org/10.1108/IJoEM-06-2015-0118.

Handayani, B. D., Yanto, H., Pujiati, A., Ridzuan, A. R., Keshminder, J. S., & Shaari, M. S. (2022). The Implication of Energy Consumption, Corruption, and Foreign Investment for Sustainability of Income Distribution in Indonesia. *Sustainability, 14*(23), 15915. https://doi.org/10.3390/su142315915.

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review*, *45*(1), 1–28.

Le, Q. H., Do, Q. A., Pham, H. C., & Nguyen, T. D. (2021). The Impact of Foreign Direct Investment on Income Inequality in Vietnam. *Economies*, 9(1), 27. https://doi.org/10.3390/economies9010027.

Ma, X. (2025). Foreign Direct Investment and the Gender Wage Gap: Evidence from China. *International Economics, 184*, 100642. https://doi.org/10.1016/j.inteco.2025.100642.

Malpede, M., & Percoco, M. (2021). Climate Change and Income Inequalities. *Working Paper Series No. 19,* Bocconi University.

Méjean, A., Collins-Sowah, P., Guivarch, C., Piontek, F., Soergel, B., & Taconet, N. (2024). Climate Change Impacts Increase Economic Inequality: Evidence from A Systematic Literature Review. *Environmental Research Letters, 19*(4), 1–24. https://doi.org/10.1088/1748-9326/Ad376e.

Memon, S., & Qureshi, I. A. (2021). Income Inequality and Macroeconomic Instability. *Review of Development Economics*, 25(2), 758–789. https://doi.org/10.1111/rode.12730.

Norris, E. D., Kochhar, k., Ricka, f., Suphaphiphat, N., & Tsounta, E. (2015). *Causes and Consequences of Income Inequality: A Global Perspective*. Washington: International Monetary Fund.

Otrachshenko, V., & Popova, O. (2022). Does Weather Sharpen Income Inequality in Russia?. *Review of Income and Wealth, 68*(1), 193–223. https://doi.org/10.1111/roiw.12532.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46506

Paddu, A. H., Fattah, S., & Anwar, A. I. (2025). Income Inequality Challenges Economic Stability and Social Cohesion. *International Journal of Environmental Sciences*, 11(7s), 387–394. https://doi.org/10.64252/csvmzx16.

Parsons, E. S., Jowell, A., Veidis, E., Barry, M., & Israni, S. T. (2025). Climate Change and Inequality. *Pediatric Research*, *98,* 1238-1245. https://doi.org/10.1038/s41390-024-03153-z.

Ravinthirakumaran, K., & Ravinthirakumaran, N. (2018). The Impact of Foreign Direct Investment on Income Inequality: A Panel Autoregressive Distributed Lag Approach for the Asia-Pacific Economic Cooperation Developing Economies. *Asia-Pacific Sustainable Development*, 25(1), 57–84.

Sahu, A. K., & Mahalik, M. K. (2024). What Drives More for Macroeconomic Instability-Carbon Inequality or Income Inequality? Panel Evidence from Emerging Economies. *Environment, Development and Sustainability*, 27, 12653–12676. https://doi.org/10.1007/s10668-023-04455-8.

Saucedo, E., Ozuna, T., & Zamora, H. (2020). The Effect of FDI on Low- and High-Skilled Employment and Wages in Mexico: A Study for the Manufacture and Service Sectors. *Journal for Labour Market Research, 54*(1), 9. https://doi.org/10.1186/s12651-020-00273-x.

Shaari, M. S., Esquivias, M. A., Ridzuan, A. R., Zainal, N. F., & Sugiharti, L. (2022). The Impacts of Corruption and Environmental Degradation on Foreign Direct Investment: New Evidence from the ASEAN+3 Countries. *Cogent Economics & Finance, 10*(1), 2124734. https://doi.org/10.1080/23322039.2022.2124734.

Singer, M. (2018). *Climate Change and Social Inequality: The Health and Social Costs of Global Warming*. New Jersey: Routledge.

Suanes, M. (2016). Foreign Direct Investment and Income Inequality in Latin America: A Sectoral Analysis. *Cepal Review*, *118*, 45–61.

Tavares, W. S., Correia, L., Rego, C., & Loiola, T. (2025). Impact of Regional Inequalities on Sustainable Development Strategies in Africa: A Systematic Literature Review Analysis Of Economic, Social, and Environmental Challenges. *European Journal of Sustainable Development Research*, 9(4), 1–11. https://doi.org/10.29333/ejosdr/16772.

Umair, M., Aizhan, A., Teymurova, V., & Chang, L. (2024). Does the Disparity between Rural and Urban Incomes Affect Rural Energy Poverty? *Energy Strategy Reviews*, *56*, 101584. https://doi.org/10.1016/j.esr.2024.101584.

Uspri, B., Karimi, S., Indrawari, I., & Ridwan, E. (2023). The Effect of Inflation on Income Inequality: Evidence from A Non-Linear Dynamic Panel Data Analysis in Indonesia. *Decision Science Letters*, *12*(3), 639–648. http://dx.doi.org/10.5267/j.dsl.2023.4.001.

Vitkovics, R. (2023). Trends in Income Inequality and Its Impact on Economic Growth. *Financial and Economic Review*, *22*(4), 136–159. https://doi.org/10.33893/FER.22.4.136.

Walsh, M. J. P., & Yu, J. (2012). Inflation and Income Inequality: Is Food Inflation Different? *IMF Working Papers* 2012/147, International Monetary Fund.

Zheng, Z., Huang, C. Y., & Wan, X. (2020). Human Capital and Income Inequality in a Monetary Schumpeterian Growth Model. *MPRA Paper* 101912.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Economic Growth and Greenhouse Gas Emissions in Asia: A Dynamic Panel Analysis Across Income Groups

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**ABSTRACT**

**Research Originality**: This study contributes to environmental economics by examining the relationship between economic growth and greenhouse gas emissions across Asian countries, while accounting for differences in income levels. Using a dynamic STIRPAT framework, the analysis also incorporates urbanization, energy intensity, and carbon intensity to understand how emission drivers vary across stages of development.

**Research Objectives**: The study aims to explore the dynamic link between economic growth and greenhouse gas emissions and to identify how demographic and technological factors influence emission patterns in lower-middle-, upper-middle-, and high-income Asian economies.

**Research Methods**: The analysis uses panel data from 41 Asian countries during 1990–2022 and applies a dynamic panel estimation method, the two-step System Generalized Method of Moments (System-GMM).

**Empirical Results**: Economic growth and urbanization generally increase greenhouse gas emissions. However, the main drivers differ by income level. In lower-middle-income countries, emissions are mainly driven by economic growth and carbon intensity. In upper-middle-income countries, urbanization and energy intensity play a larger role, while in high-income countries, the link between growth and emissions becomes weaker.

**Implications**: These findings suggest that environmental policies should be tailored to each stage of economic development.

**Keywords:**

greenhouse gas emissions; economic growth; energy intensity; STIRPAT model; dynamic panel GMM

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## INTRODUCTION

Asia has experienced one of the fastest rates of economic growth globally in recent decades. The region's economic prosperity has been significantly enhanced by rapid industrialization, growing urban populations, and rising income. Simultaneously, this economic growth has intensified environmental pressure, particularly through increased greenhouse gas (GHG) emissions. Asia currently accounts for a significant share of global carbon emissions, mainly due to energy-intensive industrial activities and fossil-fuel-dependent production methods. Therefore, understanding the relationship between economic growth and environmental deterioration has become an increasingly important issue in environmental economics and sustainable development (Adebayo et al., 2023; Ahmad et al., 2023).

Recent empirical studies have emphasized that economic growth remains a key driver of carbon emissions in developing and emerging economies. Rapid economic growth increases energy demand, infrastructure development, and industrial production, all of which contribute to higher emissions. Empirical studies across several regions confirm that increases in GDP per capita are often associated with rising carbon emissions, particularly in economies that still rely heavily on fossil fuels (Khan et al., 2023; You et al., 2022). Nathaniel (2020) and Li et al. (2022) show that energy consumption and economic expansion remain closely linked to rising $CO_2$ emissions in several emerging economies. In many developing regions, the impact of economic growth often outweighs technological improvements, resulting in a tenacious growth–emission linkage. Similarly, recent studies applying the STIRPAT framework find that economic growth, population dynamics, and technological factors jointly influence environmental outcomes across countries (Amer et al., 2024; Kumar, 2023).

Urbanization is usually recognized as a major factor influencing environmental outcomes. The development of new urban areas often leads to higher energy consumption, increased transportation demand, and intensive infrastructure growth. These structural changes often lead to higher carbon emissions in rapidly urbanizing economies. Empirical evidence across Asian countries shows that urban population growth and infrastructure development significantly contribute to rising emissions, particularly in densely populated developing regions (Qian et al., 2024; Wei et al., 2022). Similarly, studies on urban development patterns have shown that large metropolitan areas tend to increase energy demand and carbon footprints due to intensive economic activity and transportation networks (Acheampong et al., 2022; Wang et al., 2018; Li et al., 2022). Other studies also emphasize the role of energy intensity and technological efficiency in shaping environmental outcomes, indicating that economies with inefficient energy structures tend to generate higher emissions per unit of output (Amer et al., 202).

Another important determinant of environmental degradation is energy efficiency, often measured through energy intensity and carbon intensity indicators. Economies with high energy intensity require greater energy input per unit of economic output, increasing emissions. Empirical evidence suggests that energy intensity and carbon intensity remain


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major contributors to environmental degradation in emerging economies, particularly where industrial production still relies heavily on fossil fuels (Adebayo et al., 2023; Khan et al., 2023). Studies focusing on ASEAN and Asian economies also emphasize that energy efficiency improvements play a critical role in mitigating environmental impacts associated with economic growth (Yaseen, 2024).

Despite the growing literature on the growth–emission nexus, several limitations remain in existing empirical studies. First, many studies rely on static panel regression models that do not adequately address endogeneity and reverse causality between economic growth and emissions. Economic growth may increase emissions through higher energy consumption, but environmental degradation can also affect economic performance through environmental regulations or resource constraints. Static models often fail to capture this dynamic relationship, potentially leading to biased estimations (Khan et al., 2023).

Second, previous studies frequently analyze countries as a homogeneous group, ignoring differences in their levels of economic development. However, the determinants of environmental degradation may vary significantly across income groups. Lower-income countries often rely on energy-intensive industrial sectors, while higher-income economies tend to adopt cleaner technologies and stricter environmental regulations. Consequently, the growth–emission relationship may differ significantly across development stages (Qian et al., 2024; Wei et al., 2022).

Third, only a limited number of studies integrate demographic factors, technological efficiency indicators, and economic development within a single dynamic framework. While several studies examine individual determinants of emissions—such as energy consumption, urbanization, or economic growth—few studies simultaneously analyze these factors using a dynamic panel approach that accounts for endogeneity and cross-country heterogeneity (Adebayo et al., 2023; Ahmad et al., 2023). This limitation creates a gap in understanding how economic, demographic, and technological factors jointly influence environmental degradation in Asia.

This study aims to address these empirical gaps by investigating the dynamic relationship between economic growth and greenhouse gas emissions in Asian countries using an extended STIRPAT framework and a dynamic panel estimation approach. Specifically, this research employs the two-step System Generalized Method of Moments (System-GMM) estimator to control for endogeneity, unobserved heterogeneity, and potential reverse causality. In addition, this study stratifies the analysis by income group—namely, lower-middle-income, upper-middle-income, and high-income economies—to capture structural differences in emission dynamics across development stages.

The main novelty of this study lies in three aspects. First, it provides a dynamic empirical investigation of the growth–emission relationship in Asia using System-GMM estimation, which is more appropriate for panel datasets with many countries and relatively short time periods. Second, this study incorporates demographic and technological indicators—urban population, energy intensity, and carbon intensity—within the STIRPAT framework to provide a more comprehensive explanation of emission dynamics. Third,

disaggregating the analysis by income level highlights how environmental determinants vary across development stages, providing more nuanced insights for policy formulation.

Based on these motivations, this study aims to examine the dynamic relationships among economic growth, urbanization, energy intensity, carbon intensity, and greenhouse gas emissions across Asian countries. By applying a System-GMM estimation to panel data covering the period 1990–2022, this study seeks to provide new empirical evidence on the determinants of emissions across different income groups and to contribute to the ongoing debate on sustainable economic development in rapidly growing economies.

## METHODS

This study employs panel data covering 41 Asian countries over the period 1990–2022. The dataset is primarily obtained from the World Development Indicators (WDI) published by the World Bank, which provides internationally comparable macroeconomic and environmental indicators. The selected time span reflects the availability and consistency of environmental and energy-related indicators across Asian economies. Previous empirical studies on environmental sustainability also commonly employ similar time horizons due to limitations in consistent emissions data across countries (Sugiharti et al., 2025).

**Table 1. Operational Variables**

| Variables | Definitions | Measurements | Sources | References |
|---|---|---|---|---|
| ghgex | Total Greenhouse Gas Emissions | Megatons of $CO_2$ equivalent | World Bank | York, Rosa & Dietz (2003); Wang, Li & Fang (2018); Su et al. (2023) |
| gdpcapita | GDP per capita | Constant 2015 US dollars | World Bank | Grossman & Krueger (1995); Azomahou, Laisney & Van Phu (2006); Ito (2017) |
| urban | Total urban population | People | World Bank | Poumanyvong & Kaneko (2010); Lin et al. (2017); Wang et al. (2018) |
| energyintensity | Total energy consumption per unit of economic output | (kg of oil equivalent) per $1,000 GDP (constant 2017 PPP) | World Bank | Fan & Hossain (2018); Acheampong et al. (2022); Adebayo et al. (2023) |
| co2intensity | $CO_2$ emissions per unit of GDP | kilogram $CO_2$ / $GDP (PPP) | World Bank | Wang & Zhao (2015); Khan et al. (2023); Adebayo et al. (2023) |

The dataset includes five key variables that represent the environmental, economic, demographic, and technological dimensions. Greenhouse gas emissions (GHGEX) are used as the dependent variable, measured in megatons of $CO_2$-equivalent. Economic development is proxied by GDP per capita in constant 2015 US dollars. Population dynamics are represented by the urban population, which captures the scale of urban economic activities. Technological and energy-related factors are represented by energy


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intensity and carbon intensity. Energy intensity measures energy consumption per unit of economic output, while carbon intensity measures carbon emissions per unit of GDP.

The selection of these variables follows the extended STIRPAT framework, which emphasizes that environmental degradation is influenced by population dynamics, economic affluence, and technological factors (Sugiharti et al., 2025). Recent empirical studies on environmental economics frequently incorporate energy intensity and urbanization indicators to capture technological efficiency and structural economic transformation (Qian et al., 2024). The urban population is used instead of the total population because urban activities tend to generate higher energy demand and carbon emissions than rural areas (Acheampong et al., 2022; Wang et al., 2022).

The analysis covers the period 1990–2022 for two main reasons. First, the early 1990s represent the beginning of rapid economic transformation in many Asian economies following trade liberalization and industrial expansion. Second, reliable environmental indicators for most Asian countries have been consistently available since the early 1990s. Therefore, this period provides a sufficiently long time horizon to analyze the dynamic relationship between economic growth and environmental outcomes (Sugiharti et al., 2025; Cooray et al., 2024).

The empirical analysis in this study is grounded in the STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) model. The STIRPAT framework extends the IPAT identity, enabling empirical estimation of environmental impacts using stochastic regression models. The model provides a flexible framework for examining how socioeconomic and technological factors influence environmental degradation (Amer et al., 2024). The STIRPAT framework has been widely applied in environmental economics to examine the determinants of carbon emissions and environmental degradation across countries. Recent studies have extended the model by incorporating additional variables such as urbanization, energy efficiency, renewable energy adoption, and technological innovation (Cooray et al., 2024; Sugiharti et al., 2025). These extensions enable researchers to more effectively capture the complex relationship between economic development and environmental sustainability.

In its standard form, the STIRPAT model can be expressed as follows:

$$I = aP^b A^c T^d e \quad (1)$$

Where $I$ represents environmental impact, $P$ denotes population, A represents affluence (economic development), and $T$ represents technological factors. The model is typically transformed into a log-linear form to facilitate econometric estimation.

$$\ln I_i = \alpha + b.\ln P_i + c.\ln A_i + d.\ln T_i + \varepsilon_i \quad (2)$$

Following recent empirical applications, this study extends the STIRPAT model by incorporating urban population, energy intensity, and carbon intensity as proxies for population dynamics and technological conditions. This extension allows the model to capture the effects of urban economic expansion and energy efficiency on greenhouse gas emissions (Qian et al., 2024).

The empirical specification used in this study can therefore be written as:

$$\ln (ghgex_{it}) = \alpha + \beta_1 \ln (gdpcapita_{it}) + \beta_2 \ln (urban_{it}) + \beta_3 \ln (energyintensity_{it}) + \beta_4 \ln (co2intensity_{it}) + \varepsilon_{it} \quad (3)$$

where $i$ represents countries and $t$ denotes time.

To estimate the dynamic relationship between economic growth and greenhouse gas emissions, this study employs a dynamic panel data approach using the System Generalized Method of Moments (System-GMM) estimator. Dynamic panel models are particularly suitable for datasets characterized by a large number of cross-sectional units and relatively short time dimensions, which is typical for macroeconomic panel datasets (Wang et al., 2022). One of the main advantages of the System-GMM estimator is its ability to address endogeneity, a common problem in environmental-economic models. Economic growth may influence emissions through increased production, while environmental degradation may simultaneously affect economic performance through environmental regulations and policy interventions. System-GMM addresses this issue by using lagged variables as internal instruments (Sugiharti et al., 2025).

In addition, System-GMM helps control for unobserved heterogeneity across countries and reduces omitted variable bias. Previous studies have shown that dynamic panel methods yield more reliable estimates than static panel regressions when analyzing environmental sustainability and carbon emissions (Cooray et al., 2024). The dynamic specification of the model can be written as follows:

$$\ln (ghgex_{it}) = \gamma \ln (ghgex_{it-1}) + \beta_1 \ln (gdpcapita_{it}) + \beta_2 \ln (urban_{it}) + \beta_3 \ln (energyintensity_{it}) + \beta_4 \ln (co2intensity_{it}) + \mu_i + \varepsilon_{it} \quad (4)$$

where the lagged dependent variable captures the persistence of emissions over time. $\mu_i$ captures unobserved country-specific effects and $\varepsilon_{it}$ is the error term.

Several diagnostic tests are conducted to ensure the validity and robustness of the System-GMM estimation. First, the Arellano–Bond serial correlation test is used to examine autocorrelation in the residuals of the differenced equation. The presence of first-order correlation is expected, while the absence of second-order correlation indicates a valid model specification. Second, the Hansen test of over-identifying restrictions is employed to assess the validity of the instrumental variables used in the estimation. A statistically insignificant Hansen statistic indicates that the instruments are valid and not correlated with the error term (Wang et al., 2022).

Third, the Sargan test is also conducted to examine the overall validity of the instrument set. These diagnostic procedures are widely applied in dynamic panel data studies examining environmental sustainability and carbon emissions (Sugiharti et al., 2025; Cooray et al., 2024). Finally, robustness checks are performed by comparing results from the Fixed Effects (FE), Difference-GMM, and System-GMM estimators. Such comparisons help verify the stability and reliability of the estimated coefficients across different econometric approaches. Similar robustness strategies have been widely adopted in recent environmental economics research to ensure the consistency of empirical findings (Qian et al., 2024).


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## RESULTS AND DISCUSSION

The empirical results reveal that the relationship between economic growth and greenhouse gas emissions differs across income groups in Asia. The System-GMM estimation indicates that economic growth and urbanization are significant determinants of emissions in the overall sample, though their effects vary by stage of economic development. Three main findings emerge from the empirical analysis. First, economic growth continues to exert a positive influence on greenhouse gas emissions in the full sample, suggesting that the scale effect of economic expansion still dominates technological improvements in many Asian economies. Second, urbanization plays a significant role in increasing emissions, particularly in countries undergoing rapid structural transformation. Third, the roles of energy intensity and carbon intensity vary across income groups, reflecting differences in technological capability and energy structures.

These findings indicate that the environmental consequences of economic growth vary across stages of economic development. It really depends on how economies are built, what level of technology they use, and how they manage the environment. Asian countries do not all face the same challenges, and these results clearly show that. The descriptive statistics indicate substantial heterogeneity among Asian countries in terms of economic development, demographic characteristics, and energy structures. Such variation supports the need for econometric models capable of capturing both cross-country differences and dynamic adjustments over time. As reported in Table 2, greenhouse gas emissions exhibit substantial dispersion across countries and over time. The mean emissions value is 463.18 $MtCO_2e$, while the maximum is 15,175.62 $MtCO_2e$, indicating that a small number of large economies dominate the regional emissions profile.

**Table 2. Descriptive Statistics**

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| ghgex | 1353 | 463.1766 | 1560.236 | 0.135700 | 15175.62 |
| gdpcapita | 1353 | 11362.95 | 15483.25 | 166.7104 | 81608.57 |
| urban | 1353 | 40242866 | 1.09E+08 | 58079.00 | 8.98E+08 |
| energyintensity | 1353 | 5.746575 | 3.346339 | 1.550000 | 30.44000 |
| co2intensity | 1353 | 0.334633 | 0.288875 | 0.022153 | 1.931147 |

GDP per capita in Asia ranges from approximately USD 166 to over USD 81,000, underscoring a substantial development gap among countries. This economic heterogeneity supports stratifying empirical analyses by income group. Urban population levels also vary considerably, reflecting the rapid pace of urbanization in Asia. Urban expansion is typically linked to greater infrastructure development, increased transportation demand, and higher energy consumption, all of which may intensify environmental pressures.

Energy intensity and carbon intensity also differ across countries. Elevated energy intensity indicates greater energy use per unit of output, while high carbon intensity reflects a reliance on fossil fuels. These disparities demonstrate that technology and energy

systems are not uniform among Asian economies. In summary, the descriptive statistics indicate substantial structural differences among countries. Therefore, dynamic panel techniques that account for both temporal changes and country-specific characteristics are appropriate for analysis.

The diagnostic tests provide additional support for the validity of the estimated model. The Arellano-Bond tests indicate no evidence of second-order serial correlation, suggesting that the dynamic specification is appropriate. The Hansen test of over-identifying restrictions also fails to reject the null hypothesis, indicating that the instrument set is valid. Although the Sargan test rejects the null hypothesis in some specifications, this result should be interpreted cautiously, as the Sargan statistic is sensitive to heteroskedasticity and to instrument proliferation in large panels. The Hansen test is generally considered more robust under such conditions. Therefore, following standard practice in dynamic panel estimation, the validity of the instruments is primarily assessed using the Hansen test results (Roodman, 2009; Baltagi, 2021).

**Table 3. Estimation Result**

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | **Full** | | **Lower middle income** | | **Upper middle income** | | **High income** | |
| L.ln_ghgex | 0.340 | [0.099] | 0.918*** | [0.000] | 0.0899 | [0.583] | 0.826*** | [0.000] |
| ln_gdpcapita | 0.242** | [0.005] | 0.0242 | [0.074] | 0.627 | [0.080] | 0.0228 | [0.770] |
| ln_urban | 0.501* | [0.037] | 0.0630 | [0.159] | 0.806*** | [0.000] | 0.0884 | [0.467] |
| ln_energyintensity | 0.122 | [0.506] | -0.00338 | [0.868] | 0.838* | [0.036] | 0.118 | [0.523] |
| ln_co2intensity | 0.0750 | [0.085] | 0.00820 | [0.055] | 0.0297 | [0.509] | -0.00726 | [0.359] |
| Constant | -6.899 | [0.062] | -0.766 | [0.230] | -15.35*** | [0.000] | -0.960 | [0.657] |
| Observations | 889 | | 311 | | 311 | | 245 | |

*p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For the full sample, the lagged dependent variable (ln_ghgex) is positive and marginally significant (β = 0.340, p = 0.099), suggesting moderate persistence in emissions across the panel. Among the explanatory variables, ln_gdpcapita (β = 0.242, p = 0.005) and ln_urban (β = 0.501, p = 0.037) are both positive and statistically significant, indicating that economic growth and urban population are important contributors to greenhouse gas emissions in Asia. Other variables, such as energy intensity and $CO_2$ intensity, are not statistically significant. This dynamic persistence is commonly observed in environmental studies, as emissions trajectories tend to follow long-term structural patterns related to industrial development and energy consumption (Adebayo et al., 2023).


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**Table 4. Diagnostic Tests**

| Group | AR(1) z-stat | AR(1) p-val | AR(2) z-stat | AR(2) p-val | Sargan $\chi^2$ | Sargan p-val | Hansen $\chi^2$ | Hansen p-val |
|---|---|---|---|---|---|---|---|---|
| Full Sample | -1.49 | 0.137 | -0.88 | 0.377 | 470.9 | 0 | 3.68 | 0.452 |
| Lower-Middle Income | -1.83 | 0.068 | -1.09 | 0.274 | 0.68 | 0.953 | 1.05 | 0.902 |
| Upper-Middle Income | -1.07 | 0.285 | -1.02 | 0.306 | 294.67 | 0 | 8.08 | 0.089 |
| High Income | -1.45 | 0.146 | -0.33 | 0.744 | 6.51 | 0.164 | 2.71 | 0.607 |

Diagnostic tests show that the Arellano-Bond test for AR(1) is insignificant (p = 0.137) and AR(2) is also insignificant (p = 0.377), indicating no second-order serial correlation in the first-differenced residuals. The Hansen J-test (p = 0.452) confirms the validity of the instruments, and the difference-in-Hansen tests further support the exogeneity of instrument subsets. Economic growth has a positive effect on emissions. This suggests that the scale effect of economic expansion still outweighs technological and efficiency improvements in many Asian economies. Rapid industrialization and expanding production drive up energy demand, thereby increasing emissions. Recent studies on emerging economies also show that economic growth is closely linked to environmental degradation (Narayan et al., 2016; You et al., 2022; Khan et al., 2023).

Urbanization also positively influences emissions, as rapid urban growth often increases transportation demand, raises energy consumption, and drives infrastructure expansion. As a result, environmental pressure may intensify when urbanization coincides with energy systems reliant on fossil fuels. This finding aligns with recent studies emphasizing that urban expansion significantly contributes to carbon emissions in developing regions (Wang et al., 2021; Acheampong et al., 2022). In contrast, energy intensity and $CO_2$ intensity are not statistically significant in the full-sample estimation. This result may reflect heterogeneous technological conditions across countries. While energy efficiency improvements have been observed across several economies, these gains may not yet be strong enough to offset the environmental impact of economic expansion.

In lower-middle-income countries, the coefficient on the lagged dependent variable is strongly significant and close to unity ($\beta = 0.918$, $p < 0.001$), suggesting high persistence in emissions. GDP per capita is marginally significant ($\beta = 0.0215$, $p = 0.074$), while $CO_2$ intensity is positive and significant at the 10% level ($\beta = 0.00204$, $p = 0.055$), indicating that carbon-intensive activities strongly influence emissions in this group. Other explanatory variables are not statistically significant. The validity of the instruments is confirmed by the Sargan (p = 0.953) and Hansen (p = 0.902) tests. Furthermore, the difference-in-Hansen tests for the instruments for levels and endogenous regressors suggest that the instrument subsets are exogenous, justifying the use of the GMM estimation strategy for this sub-sample.

GDP per capita is weakly but positively linked to emissions. While the coefficient is only marginally significant, its positive sign means economic growth in these countries

still leads to rising emissions. This result aligns with early industrialization, in which production relies on energy-intensive sectors and fossil fuels. $CO_2$ intensity raises emissions, underscoring the impact of energy choices. Lower-middle-income countries rely on carbon-intensive energy sources, such as coal and oil, which drive emissions growth. Recent studies show carbon intensity remains a key cause of environmental degradation (Adebayo et al., 2023; Khan et al., 2023).

One possible explanation for this pattern is that lower-middle-income economies often rely on fossil fuels such as coal and oil to support industrial expansion. These energy systems tend to emit more than cleaner technologies. Similar findings have been reported by Nathaniel (2020) and Adebayo et al. (2023), who show that carbon-intensive energy structures significantly increase emissions in developing economies. From a structural perspective, these results suggest that early-stage industrialization tends to prioritize production growth over environmental efficiency. As a result, environmental degradation becomes a common by-product of economic expansion in lower-income economies. Therefore, improving energy efficiency and reducing carbon intensity should become key policy priorities. Policies encouraging cleaner energy technologies and gradual diversification toward renewable energy sources may help mitigate environmental pressures while maintaining economic growth.

The findings for upper-middle-income nations reveal a distinct trend. Urbanization is the primary driver of emissions in this category. The coefficient associated with the urban population is substantial. Rapid urban expansion exerts significant pressure on the environment. In the upper-middle-income group, the lagged dependent variable becomes statistically insignificant ($\beta = 0.0896$, $p = 0.583$), implying a lower degree of emission persistence. The strongest and most significant predictor is ln_urban ($\beta = 1.165$, $p < 0.001$), indicating that urbanization is the primary driver of increased emissions. Energy intensity is also statistically significant ($\beta = 0.837$, $p = 0.036$), indicating that energy inefficiency drives emissions. $CO_2$ intensity and GDP per capita are statistically insignificant.

Diagnostic statistics suggest that the AR(2) test is passed ($p = 0.306$), and while the Sargan test indicates potential overidentification problems ($p = 0.000$), the Hansen test remains acceptable ($p = 0.089$). Difference-in-Hansen tests further support instrument validity ($p > 0.05$), although the test statistics suggest caution given the possible proliferation of instruments. This result suggests that the environmental pressure in these economies is increasingly driven by urban expansion rather than income growth alone. Rapid urbanization often leads to increased transportation demand, expanded infrastructure, and the concentration of industrial activities in metropolitan areas. Empirical evidence indicates that urbanization can significantly increase emissions when urban development is not accompanied by improvements in energy efficiency and environmental regulation (Wang et al., 2018; Acheampong et al., 2022). Energy intensity also becomes statistically significant in this group, indicating that inefficient energy use remains an important driver of emissions.

These findings indicate that upper-middle-income economies are undergoing structural transformation characterized by rapid urban growth and industrial restructuring.


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During this stage of development, environmental pressures are more closely linked to urban economic activity and energy efficiency than to income growth alone. Therefore, urban planning policies that promote energy-efficient infrastructure, public transportation, and low-carbon urban development strategies are essential to reducing emissions in rapidly urbanizing economies.

For high-income countries, the lagged dependent variable is highly significant ($\beta = 0.826$, $p < 0.001$), indicating a strong dynamic component in emissions. None of the explanatory variables — including GDP per capita, urbanization, energy intensity, or $CO_2$ intensity — is statistically significant, suggesting that other unobserved factors, such as technological innovation, environmental regulations, or structural decarbonization, may explain the variation in emissions. The AR(2) test is satisfied ($p = 0.744$), and both the Sargan ($p = 0.164$) and Hansen ($p = 0.607$) tests do not reject the null of instrument validity. Difference-in-Hansen tests across all instruments and subsets confirm the robustness of the model specification.

This result may indicate that traditional drivers such as income growth and urbanization are no longer the dominant determinants of emissions in advanced economies. Instead, environmental outcomes may increasingly depend on technological innovation, renewable energy adoption, and environmental regulations. Recent empirical studies suggest that technological innovation and institutional quality are increasingly important in reducing emissions in developed economies (Ahmad et al., 2023; Su et al., 2023).

This pattern is consistent with the Environmental Kuznets Curve hypothesis, which suggests that environmental degradation may decline after a certain level of economic development, driven by technological improvements and strengthened environmental governance. Therefore, high-income countries should continue strengthening innovation-driven environmental policies, including investments in renewable energy, carbon-reduction technologies, and stricter environmental regulations.

**Table 5. Robustness Checks**

| | (1) | (2) | (3) |
|---|---|---|---|
| | Fixed Effects | Diff GMM | Sys GMM |
| ln_gdpcapita | 0.488*** | 0.395*** | 0.242*** |
| | (0.064) | (0.036) | (0.082) |
| ln_urban | 0.769*** | 0.639*** | 0.501** |
| | (0.048) | (0.077) | (0.232) |
| ln_energyintensity | 0.318*** | 0.161*** | 0.122 |
| | (0.082) | (0.030) | (0.181) |
| ln_co2intensity | 0.005 | 0.009*** | 0.075* |
| | (0.014) | (0.003) | (0.042) |
| L.ln_ghgex | | 0.084 | 0.340* |
| | | (0.061) | (0.202) |
| Observations | 889 | 849 | 889 |

The robustness analysis compares the results obtained from three alternative estimation methods: Fixed Effects, Difference GMM, and System GMM. The results show that the main relationships remain consistent across estimation techniques. Economic growth consistently exhibits a positive impact on emissions across all estimators. However, the magnitude of the coefficient decreases when dynamic estimators are employed. This suggests that static models may overestimate the environmental impact of economic growth by failing to account for dynamic feedback effects.

Urbanization also maintains a positive, significant relationship with emissions across models. This robustness confirms that urban expansion remains a key structural factor influencing environmental outcomes in Asia. Energy intensity is significant in static models but becomes insignificant in the dynamic System-GMM specification. This pattern indicates that part of the estimated effect in static models may be attributable to unobserved heterogeneity or endogeneity. Overall, the robustness checks support the reliability of the System-GMM estimates and confirm that the dynamic specification provides a more accurate representation of the growth–emission relationship.

## CONCLUSION

This study examines the relationship between economic growth and greenhouse gas emissions in Asian countries using a dynamic panel-data approach based on the STIRPAT framework. By applying the two-step System Generalized Method of Moments (System-GMM) to panel data covering 41 Asian economies from 1990–2022, the analysis provides empirical evidence on how economic, demographic, and technological factors influence emission dynamics across income groups.

The results show that economic growth and urbanization significantly increase greenhouse gas emissions across the overall sample of Asian economies. However, the determinants of emissions differ across stages of economic development. In lower-middle-income countries, emissions are mainly driven by economic expansion and carbon intensity, indicating continued dependence on carbon-intensive energy systems. In upper-middle-income economies, urbanization and energy intensity become more influential factors, reflecting the environmental pressure associated with rapid structural transformation. In contrast, the relationship between economic growth and emissions becomes weaker in high-income countries.

These findings suggest that environmental policy should be designed according to the stage of economic development. For developing economies, improving energy efficiency and reducing carbon intensity remain important priorities to mitigate environmental pressures while maintaining economic growth. In middle-income countries, sustainable urban planning and energy-efficient infrastructure are essential to manage the environmental impact of rapid urbanization. Meanwhile, high-income economies should continue strengthening policies that support technological innovation and low-carbon energy transitions.


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## REFERENCES

Acheampong, A. O., Dzator, J., & Savage, D. A. (2022). Renewable Energy, Economic Growth, and Carbon Emissions: Evidence from Africa. *Energy Policy, 162*, 112783. https://doi.org/10.1016/j.enpol.2022.112783.

Adebayo, T. S., Kirikkaleli, D., & Adeshola, I. (2023). Role of Technological Innovation and Renewable Energy in Achieving Carbon Neutrality: Evidence from Emerging Economies. *Science of the Total Environment, 858*, 159983. https://doi.org/10.1016/j.scitotenv.2022.159983.

Ahmad, M., Jiang, P., Murshed, M., & Shehzad, K. (2023). The Role of Technological Innovation and Renewable Energy in Reducing Environmental Degradation. *Renewable Energy, 202*, 1022–1034.

Amer, M., Shahbaz, M., & Vo, X. V. (2024). Urbanization, Energy Use and Environmental Degradation: Evidence from the STIRPAT Model. *Environmental Science and Pollution Research, 31*, 14290–14305.

Azomahou, T., Laisney, F., & Van Phu, N. (2006). Economic Development and $CO_2$ Emissions: A Nonparametric Panel Approach. *Journal of Public Economics, 90*(6–7), 1347–1363.

Baltagi, B. H. (2021). *Econometric Analysis of Panel Data* (6th ed.). Berlin: Springer.

Cooray, A., Dutta, N., & Mallick, S. (2024). Economic Growth, Energy Consumption and Carbon Emissions: Evidence from Panel Data. *Energy Economics, 125*, 106937.

Fan, Y., & Hossain, M. I. (2018). Technological Innovation, Energy Efficiency and Carbon Emissions: Evidence from Developing Economies. *Energy Policy, 115*, 44–52.

Grossman, G. M., & Krueger, A. B. (1995). Economic Growth and the Environment. *Quarterly Journal of Economics, 110*(2), 353–377.

Ito, K. (2017). $CO_2$ Emissions, Renewable and Non-Renewable Energy Consumption, and Economic Growth: Evidence from Panel Data for Developing Countries. *International Economics, 151*, 1–6. https://doi.org/10.1016/j.inteco.2017.02.001.

Khan, A., Ullah, S., & Pata, U. K. (2023). Environmental Innovation dnd Carbon Emissions Nexus: Evidence from Emerging Economies. *Journal of Environmental Management, 325*, 116504.

Kumar, S. (2023). Population, Economic Growth and Carbon Emissions: An Empirical Application of the STIRPAT Model. *Environmental Science and Pollution Research, 30*, 54721–54733.

Li, K., Fang, L., & He, L. (2022). How Urbanization Affects Carbon Emissions: Evidence from Panel Data of Asian Economies. *Journal of Cleaner Production, 349*, 131330.

Lin, B., & Zhu, J. (2017). Energy and Carbon Intensity in China's Manufacturing Industry. *Energy Policy, 102*, 193–201.

Narayan, P. K., Saboori, B., & Soleymani, A. (2016). Economic Growth and Carbon Emissions. *Economic Modelling, 53,* 388-397. https://doi.org/10.1016/j.econmod.2015.10.027.

Nathaniel, S. P. (2020). Environmental Degradation in ASEAN Economies: The Role of Economic Growth and Energy Consumption. *Environmental Science and Pollution Research, 27*, 15157–15168.

Poumanyvong, P., & Kaneko, S. (2010). Does Urbanization Lead to Less Energy Use and Lower $CO_2$ Emissions? A Cross-Country Analysis. *Ecological Economics, 70*(2), 434–444. https://doi.org/10.1016/j.ecolecon.2010.09.029.

Qian, Y., Chen, Y., & Zhang, H. (2024). Urban Development, Energy Efficiency and Carbon Emissions: Evidence From Asian Countries. *Sustainable Cities and Society, 99*, 104987.

Roodman, D. (2009). A Note on the Theme of Too Many Instruments. *Oxford Bulletin of Economics and Statistics, 71*(1), 135–158. https://doi.org/10.1111/j.1468-0084.2008.00542.x.

Su, C. W., Umar, M., & Khan, Z. (2023). Technological Innovation, Environmental Regulation and Carbon Emissions: Evidence from Panel Economies. *Energy Economics, 117*, 106441.

Sugiharti, L., Akter, S., Das, M. K., Pattak, D. C., Esquivias, M. A., & Akter, S. (2025). Population Dynamics, Economic Growth, Energy Mix, and Environmental Pollution in ASEAN: Exploring the Role of Renewable, Nuclear, and Nonrenewable Energy Using the CCEMG Approach. *Environmental and Sustainability Indicators, 26,* 100598. https://doi.org/10.1016/j.indic.2025.100598.

Wang, S., Li, G., & Fang, C. (2018). Urbanization, Economic Growth, Energy Consumption and $CO_2$ Emissions. *Renewable and Sustainable Energy Reviews, 81*, 2144–2159. https://doi.org/10.1016/j.rser.2017.06.025.

Wang, Y., Zhang, C., & Li, J. (2021). Energy Efficiency, Urbanization and Carbon Emissions: Evidence from Developing Economies. *Energy Policy, 156*, 112421.

Wang, X., & Zhao, Y. (2015). Carbon Intensity and Economic Development: Evidence from Emerging Economies. *Energy Policy, 86*, 665–673.

Wei, Y., Han, R., & Zhang, L. (2022). Urbanization and Environmental Pressure: Evidence from Asian Economies. *Journal of Cleaner Production, 330*, 129787.

York, R., Rosa, E. A., & Dietz, T. (2003). STIRPAT, IPAT and ImPACT: Analytic Tools for Unpacking the Driving Forces of Environmental Impacts. *Ecological Economics, 46*(3), 351–365.

Yaseen, M. (2024). Energy Efficiency and Carbon Emissions in Developing Economies. *Environmental Science and Pollution Research, 31*, 21711–21725.

You, W., Lv, Z., & Xu, Y. (2022). Economic Growth and Carbon Emissions: Evidence from Panel Analysis. *Energy Economics, 109*, 105967.


http://journal.uinjkt.ac.id/index.php/signifikan
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# The Hidden Side of Regional Economic Growth in Bali

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## ABSTRACT

**Research Originality**: This research's novelty lies in its examination of the development of a multidimensional, non-compensatory framework, based on the Adjusted Mazziotta–Pareto Index (AMPI), which integrates regional fiscal priorities and socio-economic outcomes to map patterns of economic growth performance.

**Research Objectives**: This research aims to assess the patterns and dynamics of economic growth performance across regencies and municipalities in Bali Province before, during, and after the COVID-19 pandemic, with particular attention to differences in growth quality, resilience, and recovery.

**Research Methods**: This research employs the Adjusted Mazziotta–Pareto Index (AMPI) analysis from 2016 to 2024, which is constructed using five indicators: government spending on public services, education, health, lowering the poverty rate, and supporting GRDP growth.

**Empirical Results**: The results indicate that economic growth performance across regencies and municipalities in Bali Province is dynamic and heterogeneous, varying by region and period.

**Implications**: Regional development policies should prioritize the quality and resilience of economic growth by balancing public spending across structurally impactful sectors and adopting adaptive fiscal strategies.

**Keywords:**

government spending; poverty; economic resilience; composite index; Covid-19

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## INTRODUCTION

Economic growth measured solely by Gross Domestic Product (GDP) or Gross Regional Domestic Product (GRDP) is often regarded as insufficient to reflect economic development performance. Those aggregate output–based measures tend to overlook structural factors that shape the sustainability of growth, including the composition of fiscal policy and public expenditure priorities that determine how the benefits of growth are distributed over the long term (Shaddady, 2022). Developments in public spending across the ASEAN region also indicated how the health sector has increasingly been positioned as a long-term fiscal priority (Melati & Sihaloho, 2025). Further empirical evidence from Indonesia showed that, in the long run, government spending has a positive and significant effect on economic growth (Nofrianto et al., 2021). Nevertheless, numerous studies emphasized that the structure and quality of government spending served a greater decisive role than the sheer magnitude of aggregate expenditure in promoting sustainable economic growth, particularly when spending is directed toward productive sectors such as education, health, and innovation and research (Antolin-Diaz & Surico, 2025; Emeru, 2023).

These studies on the relationship between government spending and economic growth presented results that were not entirely consistent. On one hand, increased public spending on education and health functions has been widely regarded as an investment in human capital that can enhance productivity and long-term economic capacity (Nuţă et al., 2023; Anwar et al., 2023; Ziberi et al., 2022; Zubir et al., 2023). On the other hand, the effectiveness of government spending is highly contingent upon the efficiency and composition of expenditure, particularly during periods marked by major economic shocks, such as financial crises and the COVID-19 pandemic, when unproductive spending may burden fiscal sustainability instead, without generating meaningful growth (Afonso & Alves, 2025; Antolin-Diaz & Surico, 2025). These divergent findings signaled an ongoing academic debate regarding the extent to which government spending genuinely promotes high-quality economic growth, rather than merely accelerating aggregate growth rates.

Beyond the growth dimension, several studies also highlighted the link between government spending and social outcomes, particularly in poverty. Public spending plays a more consistent role in poverty reduction than economic growth alone, thereby revealing the limitations of GDP- or GRDP-based indicators when used in isolation (Kitole et al., 2024). High economic growth does not necessarily reflect development quality if it is not accompanied by improvements in social indicators and welfare distribution; consequently, increases in aggregate growth rates alone were insufficient to ensure inclusive and sustainable development (Fitriady et al., 2022; Poku et al., 2022; Yulianita et al., 2023). In the vicious cycle of poverty theory, high poverty levels can hinder economic growth through reduced productivity and constrained investment, which emphasizes the correlation between low income, limited access to education and healthcare, as well as weak regional economic capacity (Prameswari et al., 2021;


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Supratiyoningsih & Yuliarmi, 2022; Zhu et al., 2022). The elasticity of economic growth with respect to poverty reduction is relatively low when poverty is perceived as a multidimensional phenomenon; therefore, poverty should be treated as an indicator of the quality of economic growth rather than an end state of growth (Balasubramanian et al., 2023).

Recent studies similar to ours indicated a shift away from reliance on single economic indicators toward multidimensional evaluation frameworks that integrate economic and social dimensions in assessing regional development performance (Lin & Zhou, 2022). The COVID-19 pandemic has further underscored the inadequacy of single growth indicators such as GDP or GRDP for evaluating regional development performance, and highlighted the importance of integrated approaches that link fiscal policy, the composition of public expenditure, and social outcomes (Naseer et al., 2023). Crises such as the COVID-19 pandemic have not only affected aggregate growth but also altered household consumption patterns and suppressed purchasing power, particularly in regions with specific economic structures (Murti et al., 2023). The effectiveness of fiscal intervention was determined not only by the scale of budgetary expansion but also by the composition and quality of public spending, especially in allocations to productive expenditures that enhance long-term economic capacity and productivity (Sardoni, 2024).

In the Indonesian context, local government spending is classified according to governmental affairs and functions, aligned with the national budgeting system. At the regency/municipality level in Bali Province, budget allocations are predominantly concentrated on public service functions, education, and health (DJPK, 2025). Regencies and municipalities in Bali Province exhibit an economic structure highly specialized in the tourism and service sectors, enabling relatively rapid growth during expansionary periods. However, this strong dependence also increases vulnerability to systemic external shocks, such as the COVID-19 pandemic, which had significant impacts on the continuity of accommodation-related businesses and regional economic stability (Dariwardani et al., 2025). These external shocks triggered sharp economic contractions and revealed disparities in adaptive capacity and recovery across regencies and municipalities in Bali Province – making the region a relevant empirical case for examining economic growth performance.

Although research on government spending and economic growth has expanded substantially, most empirical studies continue to rely on causal approaches based on inferential econometric models using single GRDP indicators as proxies for regional economic performance. These approaches have not fully captured the quality, resilience, and social dimensions of regional economic growth, especially amid the systemic shock of the COVID-19 pandemic. Moreover, empirical evidence that integrates the structure of local government spending, particularly spending on public services, education, and health, using a social indicator of poverty within a single multidimensional evaluation framework, remains relatively limited at the regency and municipality level, and from

a cross-crisis perspective. These limitations pointed to a significant research gap in comprehensively mapping and understanding patterns of regional economic growth performance.

Based on this research gap, the novelty of this study lies in extending the measurement of regional economic growth performance beyond single growth indicators, through adopting a multidimensional composite index approach that integrates fiscal, economic, and social dimensions. Furthermore, this study has departed from conventional causal econometric approaches by employing a composite index framework to capture patterns, heterogeneity, and the relative performance of regencies and municipalities across the timespan of pre-, during-, and post-COVID-19 periods. Empirically, this study provides new evidence at the regency and municipality levels in Bali Province, yielding relevant policy implications for prioritizing local government expenditure allocations for public services, education, and health in shaping the quality and resilience of economic growth performance. In line with these contributions, the main objective of this study is to assess the patterns of economic growth performance across regencies and municipalities in Bali Province along the timespan of pre-, during-, and post-COVID-19 periods, using a multidimensional index approach that incorporates government spending allocations to public services, education, health, lowering poverty rate, and supporting GRDP growth rates.

## METHODS

This study employed secondary data that was obtained from the National Statistics Agency (*Badan Pusat Statistik*) and the Directorate General of Fiscal Balance (*Direktorat Jenderal Perimbangan Keuangan*) of the Ministry of Finance of the Republic of Indonesia. The scope of this study covers all regencies and municipalities in Bali Province, namely Denpasar Municipality, Badung, Bangli, Buleleng, Gianyar, Jembrana, Karangasem, Klungkung, and Tabanan Regency. The observation period spanned 9 years, from 2016 to 2024. The 2016–2024 timespan was deliberately selected in accordance with several methodological considerations. First of all, this period comprises three distinct economic phases: the economic shock caused by the pandemic, the COVID-19 period, and the post-pandemic recovery period. Delineation of these economic phases not only mapped regional economic growth performance under normal conditions but also evaluated the resilience and recovery capacity of regional economies in response to systemic external shocks. Furthermore, this period ensured consistency in the classification and reporting of regional fiscal data, particularly the local government spending by function, thereby enabling valid comparisons across regions and over time. Accordingly, the 2016–2024 period is considered relevant and sufficient for constructing a composite index that comprehensively captures the dynamics of regional economic growth performance.

This study employed the Adjusted Mazziotta–Pareto Index (AMPI) as its primary analytical tool. AMPI is a non-compensatory composite index that penalizes imbalance


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among indicators, meaning that units with uneven indicator values cannot offset low performance in one indicator with high performance in another (Mazziotta & Pareto, 2022). AMPI was used in this study to ensure alignment with the research objective, in which local government spending on public services, education, and health functions, together with poverty rates and GRDP growth rates, were treated as complementary and non-substitutable indicators. In this regard, a non-compensatory approach is well-suited to capturing situations in which high economic growth does not necessarily indicate strong economic performance when imbalances in public spending allocation or a persistent high poverty rate accompany it.

Compared with other composite methods, AMPI offered several advantages well aligned with the characteristics of this study. First, AMPI is relatively robust to any changes in indicator structure, thereby allowing consistent comparisons across regencies and municipalities, and over time. Second, AMPI supported both spatial and temporal analyses, which were essential for mapping the dynamics of regional economic growth performance during the periods before, during, and after the COVID-19 pandemic. Third, the stability of index values, even when one or two indicators are excluded, makes AMPI remarkably suitable for analyzing regional performance amid economic fluctuations caused by external shocks (Lazar & Litan, 2022; Scaccabarozzi et al., 2022).

In this study, regional economic growth performance was conceptualized as a multidimensional construct that reflects the interaction between regional fiscal capacity and the socioeconomic conditions of the population. The indicators were grouped into two main dimensions: regional fiscal and socioeconomic. The regional fiscal dimension was represented by local government spending on public services, education, and health. These three indicators reflected the structural priorities of local government spending, which were directly related to government administration, human capital development, and the provision of basic public services. All indicators in the regional fiscal dimension showed a positive polarity, indicating that higher values were interpreted as better conditions for regional economic growth performance. The socioeconomic dimension is represented by the poverty rate and the growth rate of Gross Regional Domestic Product (GRDP). The percentage of the population living in poverty was used as an indicator of the quality of economic growth and was assigned a negative polarity, since an increase in poverty reflects a deterioration in development performance, even when economic growth may still occur. In contrast, the GRDP growth rate showed a positive polarity, reflecting an expansion of economic activity and regional productive capacity.

All indicators in this study were measured in percentage units, as uniform measurement units were intended to facilitate normalization and ensure comparability among indicators in constructing the composite index. Determining polarity direction and measurement units was a critical foundation for the normalization and aggregation stages of the AMPI method, as errors in polarity assignment can lead to biased interpretations of performance. Table 1 presents detailed information on the indicators and polarity of the economic growth performance index.

**Table 1. Indicators and Polarity for the Economic Growth Performance Index**

| Dimension | Indicator | Polarity | Unit |
|---|---|---|---|
| Regional Fiscal | Government Spending by General Public Services Function | Positive | % |
| Regional Fiscal | Government Spending by Education Function | Positive | % |
| Regional Fiscal | Government Spending by Health Function | Positive | % |
| Socioeconomic | Percentage of Population Living in Poverty | Negative | % |
| Socioeconomic | GRDP Growth Rate | Positive | % |

The AMPI method began with data or indicator normalization using the following formula.

$$r_{ij} = \frac{(x_{ij} - Min x_j)}{(\text{Max} x_j - Min x_j)} \text{ x } 60 + 70 \quad (1)$$

Normalization aimed to transform the original indicator values into standardized scores that reflect the relative position of each regency and municipality compared to others with the same indicator. This process enabled a fair and proportional assessment of regional performance across the development dimensions under analysis. Individual indicators were normalized by rescaling to "goalposts," namely, the minimum and maximum values that define the feasible range for each variable across all time periods and analytical units. In this formulation, $X_{ij}$ denotes a matrix with $n$ rows representing the units of analysis and $m$ columns represent the indicators, while $\text{Max}_{xj}$ and $\text{Min}_{xj}$ denote the targets for the indicator $j$. These targets corresponded to the minimum and maximum values of the indicator $j$ across all regencies and municipalities in Bali Province, over all periods considered.

Let $\text{Inf}_{xj}$ and $\text{Sup}_{xj}$ denoted, respectively, were the overall minimum and maximum values of the indicator jacross all units and time periods included in the analysis. By defining $\text{Ref}_{xj}$ ) as the reference value for the indicator j, the target bounds can be determined as follows:

$$\begin{cases} \text{Min } xj = \text{Ref } xj - \Delta \\ \text{Max } xj = \text{Ref } xj + \Delta \end{cases} \quad (2)$$

where $\Delta = \frac{(\text{Sup}_{x_j} - \text{Inf}_{x_j})}{2}$

Through this procedure, the normalized values were broadly constrained within a range of 70 to 130, with a value of 100 representing the reference level (Ariyani & Fauzi, 2024). After all indicator values have been normalized and adjusted, the aggregation process was conducted to obtain the AMPI score for each unit of analysis. Let $M_{ri}$ and $S_{ri}$ denote, respectively, the mean and standard deviation of normalized indicator values for the unit $i$. The general form of AMPI is expressed by the following equation.

$$\text{AMPI } +/- = M_{ri} \pm S_{ri}\, cv_i \quad (3)$$

where $CV_i = S_{ri} / M_{ri}$ represents the coefficient of variation for unit i. The ± sign indicated whether the phenomenon being measured was to be maximized or minimized.


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The AMPI values obtained through this computation process were used as the basis for assessing the relative economic growth performance of regencies and municipalities in Bali Province, both across regions and across analytical periods. AMPI values were interpreted relative to a benchmark of 100, representing the average economic growth performance across all units of analysis in a given year. Respectively, the interpretation of these results is not absolute, but was based on the relative position of each unit with respect to the reference value.

## RESULT AND DISCUSSION

In this study, the economic growth performance of regencies and municipalities in Bali Province was assessed using the Adjusted Mazziotta–Pareto Index (AMPI) across three analytical periods: the pre-COVID-19, pandemic, and post-pandemic periods. Overall, the results revealed clear disparities in economic growth performance across regions and notable shifts in performance patterns over time. During the pre-pandemic period, several regencies exhibited higher economic growth than other areas. During the pandemic, however, performance rankings shifted, with urban areas demonstrating greater economic resilience. During the post-pandemic period, regions that experienced the deepest economic contractions during the crisis tend to display stronger recovery performance. This pattern indicated that economic growth performance across regencies and municipalities in Bali Province was dynamic and could not solely be explained by GRDP growth rates. It is, instead, also shaped by regional economic resilience and the quality of growth.

**Table 2. AMPI Values of Economic Growth Performance of Regencies/Municipality in Bali Province from 2016–2024**

| Local Government | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|
| Badung | 102.01 | 102.70 | 102.69 | 105.74 | 92.77 | 100.68 | 104.06 | 102.37 | 98.24 |
| Bangli | 96.52 | 98.35 | 98.86 | 100.16 | 99.69 | 97.53 | 99.46 | 98.09 | 101.20 |
| Buleleng | 98.33 | 98.82 | 100.19 | 100.98 | 95.58 | 95.45 | 97.32 | 99.55 | 101.61 |
| Gianyar | 99.55 | 100.53 | 101.54 | 102.52 | 94.96 | 91.58 | 98.37 | 99.74 | 99.68 |
| Jembrana | 88.16 | 94.79 | 98.41 | 100.86 | 97.66 | 99.06 | 98.55 | 100.16 | 101.16 |
| Karangasem | 92.72 | 93.60 | 95.32 | 96.19 | 96.48 | 93.86 | 95.41 | 97.31 | 96.66 |
| Klungkung | 94.74 | 95.11 | 97.89 | 98.58 | 96.58 | 96.30 | 97.27 | 97.80 | 101.73 |
| Tabanan | 95.73 | 100.21 | 101.73 | 103.01 | 99.45 | 94.59 | 100.27 | 98.92 | 100.80 |
| Denpasar | 102.43 | 102.00 | 101.34 | 101.40 | 95.81 | 99.61 | 102.47 | 101.54 | 100.66 |

Based on the AMPI values shown in Table 2, Bangli Regency exhibits distinctive characteristics compared to other regencies and municipalities in Bali Province. Bangli Regency consistently falls within the middle-performance group throughout the entire observation period. The AMPI values for Bangli Regency do not display extreme

fluctuations, either in the form of sharp declines or substantial increases; thereby indicating a relatively stable pattern of economic growth performance over time. The economic growth performance of regencies and municipalities in Bali Province was analyzed dynamically by examining year-to-year changes in index values. These annual changes reflected shifts in relative regional economic growth performance, with periods of improvement, contraction, or stability. This dynamic approach enabled the identification not only of performance levels but also of the intensity of change and regional responses to evolving economic conditions over time.

Annual changes in regional economic growth performance are measured using differences in AMPI values (ΔAMPI). A positive ΔAMPI indicated an improvement in relative performance compared to the previous year, whereas a negative value signified a deterioration in performance. The magnitude of ΔAMPI reflected the intensity of performance change: relatively small values indicated performance stability, while larger values suggested significant shocks or substantial performance shifts. Table 3 showed annual dynamics of economic growth performance across regencies and the municipality in Bali Province over the 2016–2024 period.

**Table 3. Annual Dynamics of Economic Growth Performance of Regencies/Municipality in Bali Province from 2016–2024**

| Local Government | 2017-2016 | 2018-2017 | 2019-2018 | 2020-2019 | 2021-2020 | 2022-2021 | 2023-2022 | 2024-2023 |
|---|---|---|---|---|---|---|---|---|
| | Δ1 | Δ2 | Δ3 | Δ4 | Δ5 | Δ6 | Δ7 | Δ8 |
| Badung | 0.69 | -0.01 | 3.05 | -12.96 | 7.91 | 3.38 | -1.68 | -4.13 |
| Bangli | 1.84 | 0.51 | 1.30 | -0.47 | -2.16 | 1.93 | -1.37 | 3.11 |
| Buleleng | 0.49 | 1.36 | 0.79 | -5.40 | -0.13 | 1.87 | 2.23 | 2.07 |
| Gianyar | 0.98 | 1.01 | 0.98 | -7.56 | -3.39 | 6.80 | 1.36 | -0.06 |
| Jembrana | 6.63 | 3.62 | 2.45 | -3.19 | 1.40 | -0.51 | 1.61 | 0.99 |
| Karangasem | 0.88 | 1.72 | 0.87 | 0.29 | -2.62 | 1.55 | 1.90 | -0.65 |
| Klungkung | 0.37 | 2.78 | 0.68 | -1.99 | -0.28 | 0.97 | 0.53 | 3.93 |
| Tabanan | 4.48 | 1.52 | 1.28 | -3.56 | -4.86 | 5.68 | -1.35 | 1.88 |
| Denpasar | -0.43 | -0.66 | 0.06 | -5.60 | 3.80 | 2.86 | -0.94 | -0.87 |

To obtain a better-structured overview of economic growth performance across different phases of the COVID-19 pandemic, the annual performance changes were subsequently aggregated into average performance changes by analytical period: pre-pandemic, pandemic, and post-pandemic. This averaging procedure aimed to filter out short-term fluctuations and to highlight dominant performance patterns characterizing each phase, thereby enabling systematic comparisons of performance across regions and periods. The summary of average changes in economic growth performance for regencies and municipalities in Bali Province by phase is shown in Table 4 below.


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**Table 4. Average Changes in Economic Growth Performance of Regencies/Municipalities in Bali Province**

| Local Government | Pre–Covid-19 Period | During Covid-19 Period | Post–Covid-19 Period |
|---|---|---|---|
| Badung | 1.243 | -2.528 | -0.812 |
| Bangli | 1.215 | -1.315 | 1.224 |
| Buleleng | 0,882 | -2.765 | 2.053 |
| Gianyar | 0,991 | -5.473 | 2.702 |
| Jembrana | 4.233 | -0,897 | 0.698 |
| Karangasem | 1.157 | -1.164 | 0.933 |
| Klungkung | 1.279 | -1.138 | 1.808 |
| Tabanan | 2.428 | -4.209 | 2.070 |
| Denpasar | -0.342 | -0.895 | 0.350 |

The results indicated that, prior to the COVID-19 pandemic, Jembrana Regency recorded the highest average economic growth among regencies and municipalities in Bali Province, as reflected in its relatively higher AMPI scores. This finding suggested that the interaction between local government spending on general public services, education, and health functions, poverty dynamics, and GRDP growth in Jembrana Regency was more effective and coordinated than in other regions. Before the pandemic, Jembrana's economic growth performance was driven not merely by the magnitude of government spending, but more importantly, by the quality of fiscal management and the consistency of expenditure orientation toward basic public service functions. Jembrana Regency was one of the regions that implemented bureaucratic reform and local public financial governance reforms relatively early and consistently. These reforms encompassed organizational streamlining, improvements in spending efficiency, enhancement of civil servant capacity, and a strong emphasis on the provision of basic public services (Ikhwan, 2019). Consistent with this finding, previous studies indicated that public social spending, particularly in education, health, and social protection, positively influences economic growth, especially when supported by a high level of government effectiveness. Within this framework, government effectiveness serves not only a direct role in fostering economic growth, but also as a mediating factor that amplifies the impact of social government spending on economic performance (Cooray & Nam, 2025).

In contrast, during the pre–Covid-19 period, Denpasar Municipality recorded the lowest average economic growth among Bali Province's regencies. This outcome reflected the characteristics of an urban economic structure that has reached maturity. As the provincial center of government, trade, and services, the structure of local government spending in Denpasar Municipality was dominated by operational and maintenance expenditures, which serve to maintain the stability of public services and the urban economy. However, such spending showed lower growth leverage than development-oriented government spending in regions still in an expansionary phase. The impact of

urban agglomeration on economic performance is inherently contextual. In regions with high levels of agglomeration and relatively established economic structures, additional government spending and increased economic activity do not necessarily generate strong short-term growth acceleration (Maket et al., 2024). Similarly, the effects of development institutions on economic growth are context-dependent and strongly influenced by regional structural characteristics. The evidence from a study of 239 cities in China indicated how the contribution of universities to innovation and economic growth was region-specific and more pronounced in areas with particular structural attributes, implying that additional development inputs do not automatically translate into high growth acceleration in economically mature cities (Peng & Xu, 2024).

Therefore, the differences in economic growth performance between Jembrana Regency and Denpasar Municipality during the pre-pandemic period reflected variations in development stages and regional structural characteristics. Jembrana Regency, as a region still undergoing consolidation and expansion, has proven able to utilize public spending more effectively as an effective growth-enhancing instrument. In contrast, Denpasar Municipality, which exhibits a more stable performance pattern but with a relatively lower growth rate, has reflected the characteristics of a mature urban economy. These findings imply that interpreting regional economic growth performance must account for structural context and development stages, and therefore cannot be uniformly applied across regions.

During the COVID-19 pandemic, the economic growth performance of regencies and municipalities in Bali Province generally contracted substantially. AMPI values across all regions recorded negative changes, reflecting a deterioration in economic growth performance driven by a sharp decline in GRDP growth rates and heightened socioeconomic pressures. This finding confirmed that the COVID-19 pandemic constituted a systemic external shock capable of fundamentally altering both the pattern and relative ranking of regional economic growth performance. Although all regions were adversely affected, the magnitude of contraction in economic growth performance varied considerably across regencies and municipalities. Jembrana Regency continued to record a relatively better average economic growth performance than most other regions. The most striking finding during this pandemic period is the shift observed in Denpasar Municipality, which recorded the highest average economic growth performance compared to all regions, in contrast to its position in the pre-pandemic period. This shift indicated that the pandemic has not only suppressed overall economic performance but also reshaped the structure of relative regional advantages.

Denpasar Municipality's economic growth performance during the pandemic was supported by its capacity to maintain relatively higher per capita income levels than other regencies in Bali Province. Based on changes in income per capita over the 2019–2021 period, Denpasar exhibited the most distinct trajectory among the regions. Even though contraction was experienced during the initial phase of the pandemic, Denpasar was still among the fastest ones to register a positive turnaround in income per capita. This evidence was aligned with international regional studies stating that economic crises do not


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merely reduce growth rates, but also reconfigure relative regional positions through shifts in income dynamics per capita (Mendoza-González et al., 2024). Denpasar Municipality possesses a more diversified and adaptive economic base structure, which enabled it to sustain economic performance even under severe pressures imposed by the COVID-19 pandemic (Shara, 2021). The Denpasar Municipal Government introduced the Pandemic Incubation Program (PIP) as a business-based fiscal stimulus initiative aimed at supporting local economic actors (Arsa et al., 2021). Rapid and well-targeted fiscal policy responses were a critical determinant of both the depth of economic contraction and the speed of recovery during pandemic-induced crises. The sudden and asymmetric nature of the COVID-19 recession required responsive fiscal interventions to stabilize economic activity and accelerate the rebound process (Auerbach et al., 2022).

Gianyar Regency was recorded as the region with the lowest average economic growth during the COVID-19 pandemic. This region has experienced a significant economic contraction due to its high dependence on the tourism sector. With tourism contributing nearly 90 percent of local own-source revenue, any disruptions to tourist mobility have directly translated into a sharp deterioration in regional economic performance (Yasintha et al., 2022). Tourism is widely recognized as one of the economic sectors that is most vulnerable to external disruptions, especially by global health crises and mobility restrictions (Aldao et al., 2025). High dependence on tourism renders tourism-based regions extremely susceptible to external shocks (Wickramasinghe & Naranpanawa, 2023)This is clearly reflected in the severe economic contraction experienced by Gianyar Regency during the COVID-19 pandemic.

The AMPI results show that Gianyar Regency had the strongest economic growth during the recovery phase, reflecting a successful rebound after a severe COVID-19 contraction. This suggests that heavily affected regions can recover well if supported by targeted fiscal policies and productive public investment. Gianyar used government spending effectively, especially in public services and health, and benefited from the National Economic Recovery (PEN) program to build hospitals, markets, and public spaces. These investments improved services and boosted local economic activity. Thus, fiscal success depends not only on the size of spending but also on its quality, long-term benefits, and social impact (Langston & Crowley, 2022).

In contrast, Badung Regency recorded the weakest post-pandemic growth, despite having the highest local revenue and serving as a tourism hub. This indicates that strong fiscal capacity does not guarantee better growth. A slowdown in transportation and warehousing—an important non-tourism sector—contributed to this outcome (BPS, 2025; Puspitasari & Sudharma, 2025). Post-pandemic recovery often includes initial growth followed by slowing due to economic adjustments (Efthimiou, 2025), with longer-term impacts emerging over time (Wang et al., 2023). Overall, recovery quality depends not only on fiscal strength or sectoral advantages but also on how well governments shift from stimulus to sustainable growth. This study highlights that AMPI better captures recovery dynamics and sustainability than GRDP alone.

## CONCLUSION

This study finds that economic growth across regencies and municipalities in Bali Province is dynamic and varies by region and time. Before the pandemic, regions with better-managed government spending showed stronger growth. During the COVID-19 pandemic, all regions experienced economic contraction, with shifts in performance rankings reflecting differences in local economic resilience. After the pandemic, areas that suffered the most severe declines tended to recover the fastest. Interestingly, regions with greater fiscal capacity did not always achieve the best recovery outcomes. Overall, the results suggest that regional economic performance cannot be measured solely by GRDP growth. Instead, it should be viewed as a multidimensional concept that balances economic growth, the quality of public spending, and broader socio-economic conditions.

Local governments need to strategically direct public spending toward basic service functions that have improved regional economic resilience and can maintain stable economic growth performance. This objective can also be achieved by promoting diversification of regional economic structures as a primary policy strategy to reduce dependence on sectors highly vulnerable to external shocks, particularly in tourism-based regions. In addition, strengthening coordination between the central and local governments is essential to prevent policy overlap, enhance the synergy of development programs, and maximize the impact of public spending on economic recovery and the sustainability of regional economic growth.

## REFERENCES

Afonso, A., & Alves, J. (2025). Does government spending efficiency improve fiscal sustainability? *European Journal of Political Economy*, *90*. https://doi.org/10.1016/j.ejpoleco.2023.102403

Aldao, C., Blasco, D., & Poch Espallargas, M. (2025). Lessons from COVID-19 for the Future: Destination Crisis Management, Tourist Behaviour and Tourism Industry Trends. *Journal of Tourism Futures*, *11*(3), 406–420. https://doi.org/10.1108/JTF-02-2022-0059.

Antolin-Diaz, J., & Surico, P. (2025). The Long-Run Effects of Government Spending. *American Economic Review*, *115*(7), 2376–2413. https://doi.org/10.1257/aer.20231278.

Anwar, A., Hyder, S., Mohamed Nor, N., & Younis, M. (2023). Government Health Expenditures and Health Outcome Nexus: A Study on OECD Countries. *Frontiers in Public Health*, *11*(18). https://doi.org/10.3389/fpubh.2023.1123759.

Ariyani, N., & Fauzi, A. (2024). Measuring The Resilience of Rural Tourism in Indonesia Using the Adjusted Mazziotta-Pareto Index. *Journal of Infrastructure, Policy and Development*, *8*(4), 1–25. https://doi.org/10.24294/jipd.v8i4.3467.

Arsa, I. K. S., Widiastini, N. M. A., & Koma, F. Y. I. (2021). Strategi Bertahan Masyarakat Denpasar Pada Masa Pandemi Covid-19 (Studi Pada Penerima Program Stimulus PIP 2). *Jurnal Kewirausahaan dan Bisnis*, *26*(2), 137–150. https://doi.org/10.20961/jkb.v26i2.54311.

Auerbach, A., Gorodnichenko, Y., McCrory, P. B., & Murphy, D. (2022). Fiscal Multipliers in the COVID19 Recession. *Journal of International Money and Finance*, *126*, 102669. https://doi.org/10.1016/j.jimonfin.2022.102669.

Balasubramanian, P., Burchi, F., & Malerba, D. (2023). Does Economic Growth Reduce Multidimensional Poverty? Evidence from Low- and Middle-Income Countries. *World Development*, *161*, 106119. https://doi.org/10.1016/j.worlddev.2022.106119.

BPS. (2025). *Produk Domestik Regional Bruto Provinsi Bali Menurut Lapangan Usaha 2020–2024*. Jakarta: BPS.

Coman (Nuţă), A. C., Lupu, D., & Nuţă, F. M. (2023). The Impact of Public Education Spending on Economic Growth in Central And Eastern Europe. An ARDL Approach with Structural Break. *Economic Research-Ekonomska Istraživanja*, *36*(1), 1261–1278. https://doi.org/10.1080/1331677X.2022.2086147.

Cooray, A., & Nam, Y. S. (2025). Public Social Spending, Government Effectiveness, and Economic Growth: An Empirical Investigation. *Applied Economics*, *57*(1), 52–66. https://doi.org/10.1080/00036846.2024.2302933.

Dariwardani, N. M. I., Suardana, I. W., Sunarta, I. N., Mananda, I. G. P. B. S., & Cahyanto, I. (2025). Resilience in Bali's Accommodation Businesses Amidst the COVID-19 Pandemic: A Survival Analysis. *Jurnal Kajian Bali*, *15*(1), 173–203. https://doi.org/10.24843/JKB.2025.v15.i01.p07.

DJPK. (2025). *Realisasi APBD Belanja per Fungsi*. 2025. Retrieved from: https://djpk.kemenkeu.go.id/?p=5412

Efthimiou, S. G. (2025). The Trends of Tourism Sector After Covid-19 Period: A Study of Strategy and Implications. *Corporate and Business Strategy Review*, *6*(1), 119–133. https://doi.org/10.22495/cbsrv6i1art12.

Emeru, G. M. (2023). Effect of Public Expenditure on Economic Growth in the Case of Ethiopia. *Scientific World Journal*, *1,* 9305196. https://doi.org/10.1155/2023/9305196.

Fitriady, A., Silvia, V., & Suriani, S. (2022). Does Economic Growth Mediate Investment, Inflation, and Human Development Investment on Poverty in Indonesia? *Signifikan: Jurnal Ilmu Ekonomi*, *11*(2), 437–456. https://doi.org/10.15408/sjie.v11i2.26145.

Ikhwan, K. (2019). Deskripsi Reformasi Birokrasi Dalam Pelayanan Publik di Kabupaten Jembrana, Provinsi Bali. *Ensiklopedia of Journal*, *2*(1), 26–35. https://doi.org/10.33559/eoj.v1i5.306.

Kitole, F. A., Msoma, L. J., & Sesabo, J. K. (2024). Navigating the Economic Landscape: A Comprehensive Analysis of Government Spending, Economic Growth, and Poverty Reduction Nexus in Tanzania. *Applied Economics Letters*, *32*(9), 1306–1310. https://doi.org/10.1080/13504851.2024.2302902.

Langston, C., & Crowley, C. (2022). Fiscal Success: Creating Quality Infrastructure in a Post-COVID World. *Sustainability*, *14*(3), 1642. https://doi.org/10.3390/su14031642.

Lazar, D., & Litan, C. M. (2022). Regional Well-being in Romania: Assessment After a Decade of EU Accession. *International Journal of Social Economics*, *49*(7), 1009–1028. https://doi.org/10.1108/IJSE-08-2021-0480.

Lin, B., & Zhou, Y. (2022). Measuring the Green Economic Growth in China: Influencing Factors and Policy Perspectives. *Energy*, *241,* 122518. https://doi.org/10.1016/j.energy.2021.122518.

Maket, I., Szakalne Kano, I., & Vas, Z. (2024). Urban Agglomeration and Regional Economic Performance Connectedness: Thin Ice In Developing Regions. *Research in Globalization*, *8*, 100211. https://doi.org/10.1016/j.resglo.2024.100211.

Mazziotta, M., & Pareto, A. (2022). Weighting in Composit Indices Construction: The Case of the Mazziotta-Pareto Index. *Rivista Italiana Di Economia Demografia e Statistica*, *76*(4), 17–26.

Melati, A. P. S., & Sihaloho, E. D. (2025). The Future of Health Expenditure in ASEAN Countries: A Forecasting Analysis with ARIMA. *Signifikan: Jurnal Ilmu Ekonomi*, *14*(2). https://doi.org/10.15408/sjie.v14i2.46420.

Mendoza-González, M. Á., Quintana-Romero, L., & Guerrero-Jiménez, A. (2024). Regional Per Capita Income Inequality and Fiscal Policy in Mexico, 1989–2021. *The Annals of Regional Science*, *73*(4), 1681–1699. https://doi.org/10.1007/s00168-024-01312-y.

Murti, P. P. I., Siregar, H., & Sugema, I. (2023). Impacts of Covid-19 Pandemics and Wealth on Household Consumption in Java Island. *Signifikan: Jurnal Ilmu Ekonomi*, *12*(2), 371–382. https://doi.org/10.15408/sjie.v12i2.32336.

Naseer, S., Khalid, S., Parveen, S., Abbass, K., Song, H., & Achim, M. V. (2023). COVID-19 Outbreak: Impact on the Global Economy. *Front. Public Health*, *5,* 1009393. https://doi.org/10.3389/fpubh.2022.1009393.

Nofrianto, N., Muliana, Y., & Cahyadi, A. (2021). The Impact of Islamic Bank Financing, Government Spending, and Investment on Economic Growth in Indonesia. *Signifikan: Jurnal Ilmu Ekonomi*, *10*(2), 299–310. https://doi.org/10.15408/sjie.v10i2.20469.

Peng, C., & Xu, H. (2024). Universities and Cities: The Impact of Higher Education on Urban Innovation, Entrepreneurship, and Economic Growth. *Asian Economic Papers*, *23*(2), 33–56. https://doi.org/10.1162/asep_a_00890.

Poku, K., Opoku, E., & Agyeiwaa Ennin, P. (2022). The Influence of Government Expenditure on Economic Growth in Ghana: An ARDL Approach. *Cogent Economics & Finance*, *10*(1), 2160036. https://doi.org/10.1080/23322039.2022.2160036.

Prameswari, A., Muljaningsih, S., & Asmara, K. (2021). Analisis Pengaruh Kemiskinan, Indeks Pembangunan Manusia (IPM) dan Tenaga Kerja terhadap Pertumbuhan Ekonomi di Jawa TimuR. *Jurnal Ekonomi Pembangunan STIE Muhammadiyah Palopo*, *7*(2), 75-90. https://doi.org/10.35906/jep.v7i2.909.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50226

Puspitasari, S. I. D., & Sudharma, I. W. P. A. (2025). Pengaruh Sektor Basis Non Pariwisata, Pendidikan dan UMK terhadap Penyerapan Tenaga Kerja di Provinsi Bali. *Ekonomi dan Bisnis Universitas Udayana*, *14*(10), 1475–1492.

Sardoni, C. (2024). Public Spending and Growth: A Simple Model. *Structural Change and Economic Dynamics*, *69*, 56–62. https://doi.org/10.1016/j.strueco.2023.12.002.

Scaccabarozzi, A., Mazziotta, M., & Bianchi, A. (2022). Measuring Competitiveness: A Composite Indicator for Italian Municipalities. *Social Indicators Research*, *173*(1), 53–82. https://doi.org/10.1007/s11205-022-02990-x.

Shaddady, A. (2022). Is Government Spending an Important Factor in Economic Growth ? Nonlinear Cubic Quantile Nexus from Eastern Europe and Central Asia (EECA). *Economies*, *10*(11), 286. https://doi.org/10.3390/economies10110286.

Shara, A. R. I. D. (2021). Analysis of Basic and Non-Basic Sectors in Denpasar City in the Middle of the Covid-19 Pandemic Era. *Sustainability (STPP) Theory, Practice and Policy*, *1*(2), 154–172. https://doi.org/10.30631/sdgs.v1i2.1012.

Supratiyoningsih, L., & Yuliarmi, N. N. (2022). Pengaruh Investasi, Pengeluaran Pemerintah, dan Tenaga Kerja Terhadap Pertumbuhan Ekonomi dan Tingkat Kemiskinan di Provinsi Bali. *E-Jurnal Ekonomi dan Bisnis Universitas Udayana*, *11*(1), 1-10. https://doi.org/10.24843/eeb.2022.v11.i01.p01.

Wang, J., Cui, M., & Chang, L. (2023). Evaluating Economic Recovery by Measuring the COVID-19 Spillover Impact on Business Practices: Evidence from Asian Markets Intermediaries. *Economic Change and Restructuring*, *56*(3), 1629–1650. https://doi.org/10.1007/s10644-023-09482-z.

Wickramasinghe, K., & Naranpanawa, A. (2023). Tourism and COVID-19: An Economy-Wide Assessment. *Journal of Hospitality and Tourism Management*, *55*, 131–138. https://doi.org/10.1016/j.jhtm.2023.03.013.

Yasintha, P. N., Gelgel, N. M. R. A., Sukadi, B. D. N. R., Sari, N. P. M., & Pinatih, D. A. A. I. (2022). Resiliensi Pemerintah Kabupaten Gianyar dalam Mewujudkan Pariwisata Berkelanjutan di Tengah Pandemi Covid-19. *Jurnal Transformative*, *8*(1), 57–80. https://doi.org/10.21776/ub.transformative.2022.008.01.3.

Yulianita, A., Ramadhan, D. R., & Mukhlis, M. (2023). Factors Affecting Economic Growth in Indonesia. *Signifikan: Jurnal Ilmu Ekonomi*, *12*(2), 245–262. https://doi.org/https://doi.org/10.15408/sjie.v12i2.31186.

Zhu, Y., Bashir, S., & Marie, M. (2022). Assessing the Relationship between Poverty and Economic Growth: Does Sustainable Development Goal Can be Achieved? *Environmental Science and Pollution Research*, *29*(19), 27613–27623. https://doi.org/10.1007/s11356-021-18240-5.

Ziberi, B. F., Rexha, D., Ibraimi, X., & Avdiaj, B. (2022). Empirical Analysis of the Impact of Education on Economic Growth. *Economies*, *10*(4), 89. https://doi.org/10.3390/economies10040089.

Zubir, E., Hartono, D., Robiansyah, A., & Kharis, S. A. A. (2023). Pengaruh Realisasi Angaran Kesehatan, Anggaran Pendidikan dan Pariwisata Terhadap Penanggulan Kemiskinan di Provinsi Jawa Barat. *Jurnal Ilmiah Ekonomi Dan Bisnis*, *11*(2), 1397–1404.


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# Credit Composition and Subnational Economic Growth: Long-Run and Short-Run Evidence from East Nusa Tenggara

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## ABSTRACT

**Research Originality.** This study advances the finance–growth nexus literature by providing subnational time-series evidence on credit composition rather than aggregate credit, focusing on a structurally developing province in Eastern Indonesia.

**Research Objectives.** This study examines whether different types of bank credit contribute differently to regional economic growth in East Nusa Tenggara.

**Research Methods.** This study applies the Autoregressive Distributed Lag (ARDL) approach. The ARDL Bounds Test is employed to verify cointegration, followed by Error Correction Model (ECM) estimation and diagnostic stability tests.

**Empirical Results.** The findings confirm a significant long-run relationship between credit composition and regional economic growth. Consumer credit exhibits a positive long-run effect on real GRDP, while investment credit shows a moderate impact. Working capital credit does not demonstrate a significant long-run contribution.

**Implications.** The results suggest that not only the volume but also the credit allocation structure plays a crucial role in shaping regional economic performance. Policy strategies in developing regions should therefore emphasize productive and demand-supporting credit allocation to promote sustainable growth.

**Keywords:**

financial intermediation; finance growth nexus; subnational growth dynamics; credit allocation structure; developing regional economy

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## INTRODUCTION

Economic growth is widely recognized as a multidimensional process shaped by the interaction of human capital accumulation, infrastructure development, institutional quality, fiscal policy, technological progress, and financial sector development. Within this broader framework, financial intermediation—particularly the allocation of bank credit—plays a pivotal role in mobilizing savings and channeling them toward productive investment activities (Azolibe, 2020). However, credit constitutes only one dimension of regional growth dynamics, and its effectiveness largely depends on how financial resources are distributed across economic sectors. The finance–growth nexus has been extensively investigated at both cross-country and national levels. Recent studies indicate that financial deepening promotes economic growth by enhancing access to finance and stimulating investment expansion (Lotto, 2023; Mamun & Ariffin, 2018). Nonetheless, emerging evidence suggests that this relationship is neither linear nor uniform. Its impact varies according to institutional quality, economic structure, and crucially the composition of credit (Uddin et al., 2023).

Most empirical studies rely on aggregate credit indicators, implicitly assuming homogeneous effects on economic growth. Such an approach may oversimplify transmission mechanisms by neglecting the heterogeneity among consumer credit, working capital credit, and investment credit. Theoretically, consumer credit primarily stimulates short-term aggregate demand, whereas working capital and investment credit enhance productive capacity and long-run capital accumulation (Sipahutar, 2024). Empirical findings, however, remain mixed. Several studies emphasize the dominant role of productive and investment credit in promoting regional and national growth (Firmansyah, 2024; Lestari et al., 2021) while others indicate that household and consumer credit expansion can also contribute significantly to economic performance in developing economies (Asllani et al., 2020). These inconsistencies highlight the importance of further investigation, particularly at the subnational level, where variations in credit structure and sectoral composition may yield different growth dynamics.

Most Indonesian studies on credit and growth rely on national or provincial panel data with aggregate credit indicators, providing broad insights but overlooking regional heterogeneity and credit-type effects. Evidence from less developed provinces such as East Nusa Tenggara (NTT) remains limited, even though financial access and banking penetration are known to influence regional growth strongly. This gap underscores the need for province-specific analyses of credit composition (Amaluddin et al., 2024; Anton et al., 2023).

East Nusa Tenggara (NTT) presents a relevant case. Between 2000 and 2024, real GRDP (at constant 2010 prices) rose from approximately IDR 27.5 trillion to IDR 78.0 trillion, indicating sustained long-term growth despite periodic volatility, including a contraction during the COVID-19 pandemic in 2020. Over the same period, bank lending expanded more rapidly than output, with consumer credit emerging as the dominant component, while investment credit remained comparatively limited.


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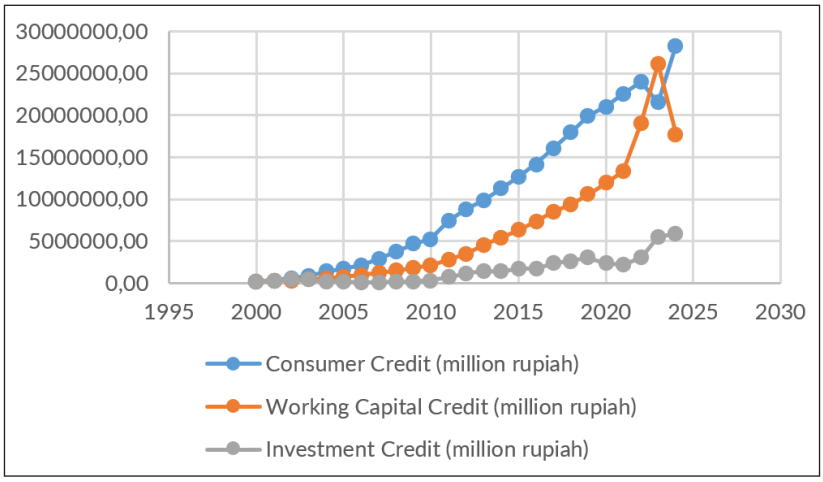
East Nusa Tenggara (NTT) presents a relevant case for examining the relationship between credit composition and regional growth. Between 2000 and 2024, real GRDP at constant 2010 prices increased from approximately IDR 27.5 trillion to IDR 78.0 trillion, reflecting steady long-term expansion despite temporary contraction during the COVID-19 pandemic in 2020. During the same period, total bank lending grew more rapidly than output, led by a substantial rise in consumer credit, which expanded from IDR 223 billion in 2000 to IDR 28.3 trillion in 2024. Working capital credit also increased sharply from IDR 207 billion to IDR 17.8 trillion, while investment credit remained comparatively modest, rising from IDR 218 billion to IDR 5.9 trillion. These trends highlight the dominance of consumption-based financing in NTT's credit structure and suggest potential constraints on long-term productive investment.

**Figure 1. Bank Credit Composition in East Nusa Tenggara, 2000–2024**




Source: Statistics Indonesia (BPS) and Financial Services Authority (OJK)

This study does not posit credit as the sole determinant of economic growth, recognizing that multiple structural and institutional factors shape regional performance. Nonetheless, it focuses specifically on the financial intermediation channel to assess whether different types of credit contribute differently to regional growth dynamics. The research gap lies in the limited time-series evidence at the provincial level on the differentiated effects of consumer credit, working capital, and investment credit on regional economic growth in Indonesia. Previous studies primarily employed national aggregates or panel regressions using total credit indicators, which may obscure heterogeneity across regions (Suhendra & Ronaldo, 2017).

To address this gap, the present study utilizes annual data for 2004–2024. It applies the Autoregressive Distributed Lag (ARDL) framework to capture both short-run dynamics and long-run equilibrium relationships within a single regional economy. This approach follows recent applications in Indonesia that demonstrated the ARDL model's robustness in exploring cointegration between financial intermediation and economic growth (Sumarni, 2019), as well as its effectiveness in analyzing the role of credit and

financial stability during structural shocks such as the COVID-19 pandemic (Sinay & Kembauw, 2023).

Accordingly, this study analyzes the impact of bank credit composition on regional economic growth in East Nusa Tenggara using a time-series approach. Its primary contribution lies in providing subnational empirical evidence that the structure of credit allocation, rather than credit volume alone, plays a crucial role in regional economic development.

## METHODS

This study employs annual secondary time-series data covering the period 2004–2024, yielding 21 observations. The selected period reflects the availability and consistency of provincial-level data on bank credit by use type, ensuring comparability across years. The data are obtained from the official publications of the Central Bureau of Statistics (BPS) of East Nusa Tenggara, the Indonesian Banking Statistics issued by Bank Indonesia, and the Financial Services Authority (OJK). Quarterly provincial data on credit composition are not consistently available for the entire period; therefore, annual data are used to ensure reliability and consistency in the estimation. All variables are transformed into natural logarithms to minimize scale differences, reduce potential heteroskedasticity, and facilitate elasticity-based interpretation.

This study uses Gross Regional Domestic Product (GRDP) data for East Nusa Tenggara (NTT) at constant 2010 prices for the period 2000–2024. However, due to periodic base-year revisions (rebasing) conducted by Statistics Indonesia (BPS), the earlier series is not directly comparable with the 2010-base series, despite both being expressed in constant prices. This inconsistency results from changes in relative price structures and sectoral weights applied in the compilation process. To ensure time-series consistency for econometric analysis, a splicing (linking) method is applied using 2010 as the anchor year, as it is common to both datasets: (i) the pre-2010 constant-price GRDP series (2000–2013) and (ii) the 2010-base GRDP series published by BPS from 2010 onward. All observations prior to 2010 are adjusted to the 2010 base scale, producing a single, homogeneous real GRDP series covering the entire study period.

The splicing procedure serves as a scale adjustment that aligns the level of the earlier series with the 2010-base series without altering the underlying growth trajectory. Consequently, base-year revisions do not introduce artificial level shifts or distort long-term trend interpretation. This technique is widely recognized in macroeconomic time-series research as a standard approach for reconciling base-year or methodological revisions (Mustofa & Faizin, 2025).

This study employs the Autoregressive Distributed Lag (ARDL) approach developed by Nkoro & Uko (2016) and Pesaran et al. (2001). The ARDL model is selected based on several methodological advantages. First, it accommodates regressors with mixed integration orders, I(0) and I(1), without requiring uniform stationarity. Second, it performs reliably in small-sample settings. Third, it enables the simultaneous estimation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of both short-run adjustments and long-run equilibrium within a single reduced-form specification. Finally, compared to Johansen's Vector Error Correction Model (VECM), the ARDL framework minimizes the risk of over-parameterization in limited samples.

Given the relatively small sample size (21 annual observations) and the mixed integration orders identified through unit root testing, the ARDL approach is considered more appropriate than VECM for this study. Its suitability for small-sample, mixed-order cointegration analysis has been demonstrated in recent applications in Indonesia (Sudrajad et al., 2023), as well as in broader econometric modeling literature (Kripfganz & Schneider, 2023). The general error-correction representation of the ARDL model can be expressed as:

$$\Delta lnPDRB^t = \beta_0 + \sum \beta_i \Delta X_{t-i} + \lambda ECT_{t-1} + \varepsilon_t$$

Where ECT denotes the error correction term, which captures the speed of adjustment toward the long-run equilibrium, and λ represents the adjustment coefficient.

The estimation procedure follows several sequential steps. First, unit root tests are conducted to assess the stationarity properties of the variables. The Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are employed to ensure that none of the variables is integrated of order two, I(2), as the ARDL framework becomes invalid in the presence of I(2) variables.

Second, the optimal lag length is determined using the Akaike Information Criterion (AIC) to balance model parsimony with the ability to capture underlying dynamic adjustments. Based on this criterion, the selected specification is ARDL(4,4,4,3). Third, the ARDL model is estimated in levels to incorporate both the autoregressive structure of the dependent variable and the distributed lag effects of the regressors. Fourth, the ARDL Bounds Test for cointegration is applied. A long-run relationship is confirmed when the calculated F-statistic exceeds the upper critical bound value.

Fifth, once cointegration is established, both the long-run coefficients and the short-run dynamics are estimated by reparameterizing the model as an Error Correction Model (ECM), in which the coefficient on the lagged error-correction term ($\mathbf{ECT}_{t-1}$) represents the speed of adjustment toward long-run equilibrium. Finally, diagnostic and stability tests are conducted to evaluate model robustness. These include the Breusch–Godfrey LM test for serial correlation, the IM-test decomposition for heteroskedasticity, the Jarque–Bera test for normality, and the CUSUM and CUSUMSQ tests for structural stability.

All estimations are performed using Stata, following the ARDL implementation procedures developed by (Kripfganz & Schneider, 2023), which provides integrated bounds testing and ECM estimation within a unified framework.

## RESULTS AND DISCUSSION

This study investigates the impact of bank credit composition on regional economic growth in East Nusa Tenggara (NTT) using an ARDL(4,4,4,3) model selected by the Akaike Information Criterion (AIC) with annual data for 2004–2024. The ARDL Bounds

Test confirms a long-run relationship between real GRDP and credit composition: the computed F-statistic (49.056) exceeds the 1% upper critical bound. At the same time, the t-statistic also lies beyond the lower bound, indicating strong evidence of cointegration.

In the long run, consumer credit (lnCC) has a positive effect on regional output. Conversely, working capital credit (lnWCC) shows no significant long-run effect, suggesting that its expansion does not consistently translate into sustained output growth. Investment credit (lnIC) exhibits a positive but weaker long-run influence, implying that its growth impact depends on project efficiency, sectoral allocation, and structural capacity. These findings align with prior studies showing that different types of bank credit affect growth through distinct transmission channels (Anama & Lubis, 2025; Razak et al., 2020)

The Error Correction Term (ECT) is negative, confirming a rapid adjustment toward the long-run equilibrium. Short-run dynamics differ across credit types: lagged changes in consumer and working capital credit significantly influence output, while investment credit shows more volatile short-term responses. Diagnostic and stability tests detect no serial correlation, heteroskedasticity, or non-normal residuals, and both CUSUM and CUSUMSQ tests confirm parameter stability. Overall, these results reinforce the notion that credit composition, not merely credit volume, matters for regional growth, consistent with empirical evidence emphasizing the heterogeneous growth effects of banking intermediation (Naula et al., 2025).

**Table 1. Results of Unit Root Tests (ADF and Phillips–Perron)**

| Variable | ADF | | PPerron | |
|---|---|---|---|---|
| | statistic z(t) | p-value | statistic z(t) | p-value |
| GRDP | -2.156 | 0.2226 | -2.156 | 0.2226 |
| ΔGRDP | -2.973 | 0.0374 | -2.973 | 0.0374 |
| lnCC | -7.225 | 0.0000 | -7.225 | 0.0000 |
| ΔlnCC | -2.979 | 0.0369 | -2.979 | 0.0369 |
| lnWCC | -2.342 | 0.1586 | -2.342 | 0.1586 |
| ΔlnWCC | -4.495 | 0.0002 | -4.495 | 0.0002 |
| lnIC | -0.134 | 0.9460 | -0.134 | 0.9460 |
| ΔlnIC | -3.48 | 0.0085 | -3.48 | 0.0085 |

Source: Author's calculations using Stata.

Stationarity testing was conducted using the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests to ensure that none of the variables were integrated of order two (I(2)), as required under the ARDL framework. The results are presented in Table 1. The findings reveal a mixed order of integration among the variables. Real GRDP (lnGRDP) is non-stationary at levels but becomes stationary after first differencing, indicating integration of order one, I(1). Similarly, working capital credit (lnWCC) and investment credit (lnIC) are non-stationary in level form but stationary after first differencing, and are therefore classified as I(1). In contrast, consumer credit (lnCC) is


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stationary at levels, suggesting integration of order zero, I(0). The consistency between ADF and PP test results reinforces the robustness of these classifications.

Importantly, none of the variables are integrated of order two. The coexistence of both I(0) and I(1) variables satisfies the preconditions for applying the ARDL methodology and confirms that alternative techniques requiring uniform integration order, such as Johansen's Vector Error Correction Model (VECM), would be less appropriate in this context. Optimally selecting the lag length is a critical step in ARDL estimation, ensuring the model adequately captures temporal dynamics while avoiding over-parameterization. Several information criteria were employed, including the Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan–Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC). The results are presented in Table 2.

All criteria consistently identify a lag order of four as optimal. In particular, the AIC attains its minimum value at lag four, supported by the lowest FPE and a statistically significant Likelihood Ratio (LR) test. The consistency across multiple criteria indicates that this lag configuration provides the most appropriate balance between model fit and parameter efficiency. Accordingly, the ARDL (4,4,4,3) specification is selected for subsequent estimation. This specification captures both short-run adjustments and long-run relationships while maintaining model parsimony and empirical robustness.

**Table 2. Lag Length Selection Criteria**

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| 0 | 11.3998 | | | | 5.80E-06 | -0.70474 | -0.66156 | -0.50578 |
| 1 | 117.339 | 211.88 | 16 | 0.0000 | 1.10E-09 | -9.2704 | -9.05451 | -8.27562 |
| 2 | 137.817 | 40.956 | 16 | 0.0010 | 9.20E-10 | -9.69688 | -9.30828 | -7.90627 |
| 3 | 179.298 | 82.961 | 16 | 0.0000 | 1.50E-10 | -12.1236 | -11.5623 | -9.53718 |
| 4 | 290.254 | 221.91* | 16 | 0.0000 | 9.5e-14* | -21.1671* | -20.433* | -17.7848* |

Source: Author's calculations using Stata.

The estimated ARDL (4,4,4,3) model is strongly statistically significant, as confirmed by the joint F-test. The relatively high explanatory power and low Root Mean Square Error (RMSE) indicate that the dynamic specification adequately captures variations in regional output. However, given the time-series nature of the data and the limited sample size, interpretation focuses on the signs, magnitudes, and temporal distribution of the coefficients rather than relying solely on goodness-of-fit metrics. The lagged values of real GRDP reveal pronounced intertemporal dynamics, particularly at intermediate lags, suggesting persistence and gradual adjustment in regional economic growth. This finding confirms that current output is significantly influenced by its past realizations, reflecting structural inertia and path dependence in regional production patterns.

Consumer credit (lnCC) exerts positive effects contemporaneously and at early lags, indicating that household-oriented lending stimulates economic activity through

short-term demand-side channels, such as consumption expansion. The negative coefficient observed at longer lags suggests an adjustment mechanism, implying that initial demand-driven gains may dissipate as temporary consumption effects fade. In contrast, working capital credit (lnWCC) displays a delayed transmission mechanism. The contemporaneous and early lag coefficients tend to be negative, while later lags become positive and statistically significant. This pattern suggests that business-related financing requires time for operational adjustments such as inventory accumulation, production planning, and cash flow stabilization before translating into measurable output gains.

**Table 3. ARDL(4,4,4,3) Estimation Results (Dependent Variable: lnGRDP)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Sample: | 2004 -2024 | | Number of obs | | | 21 |
| | | | F( 18, 2) | | | 8345.45 |
| | | | Prob > F | | | 0.0001 |
| | | | R-squared | | | 1 |
| | | | Adj R-squared | | | 0.9999 |
| Log likelihood | 115.4472 | | Root MSE | | | 0.0032 |
| **Variable** | **Coef.** | **Std. Err.** | **t** | **P>t** | **[95% Conf.** | **Interval]** |
| lnGRDP | | | | | | |
| L1. | -0.30838 | 0.137859 | -2.24 | 0.155 | -0.9015369 | 0.284785 |
| L2. | -0.80149 | 0.178632 | -4.49 | 0.046 | -1.570078 | -0.03289 |
| L3. | -3.43314 | 0.382581 | -8.97 | 0.012 | -5.079248 | -1.78703 |
| L4. | 4.452554 | 0.442739 | 10.06 | 0.01 | 2.547602 | 6.357505 |
| lnCC | | | | | | |
| -. | 0.284772 | 0.039771 | 7.16 | 0.019 | 0.11365 | 0.455894 |
| L1. | 0.457816 | 0.049502 | 9.25 | 0.011 | 0.2448259 | 0.670806 |
| L2. | 0.275753 | 0.045798 | 6.02 | 0.026 | 0.0786988 | 0.472807 |
| L3. | -0.10971 | 0.037987 | -2.89 | 0.102 | -0.2731567 | 0.05373 |
| L4. | -0.48564 | 0.055892 | -8.69 | 0.013 | -0.7261241 | -0.24516 |
| lnWCC | | | | | | |
| -. | -0.27105 | 0.043099 | -6.29 | 0.024 | -0.4564874 | -0.0856 |
| L1. | -0.33102 | 0.058302 | -5.68 | 0.03 | -0.5818736 | -0.08016 |
| L2. | 0.700601 | 0.094266 | 7.43 | 0.018 | 0.2950054 | 1.106196 |
| L3. | 0.153784 | 0.027254 | 5.64 | 0.03 | 0.0365211 | 0.271046 |
| L4. | -0.2642 | 0.043794 | -6.03 | 0.026 | -0.4526274 | -0.07577 |
| lnIC | | | | | | |
| -. | 0.052387 | 0.013524 | 3.87 | 0.061 | -0.005803 | 0.110577 |
| L1. | -0.07782 | 0.012747 | -6.1 | 0.026 | -0.1326616 | -0.02297 |
| L2. | -0.01645 | 0.008354 | -1.97 | 0.188 | -0.052397 | 0.019489 |
| L3. | 0.085999 | 0.009512 | 9.04 | 0.012 | 0.0450747 | 0.126924 |
| _cons | 12.30093 | 2.481031 | 4.96 | 0.038 | 1.625917 | 22.97595 |

Source: Author's calculations using Stata.


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Investment credit (lnIC) exhibits a predominantly lagged impact on regional output. Although its contemporaneous effect is marginal, stronger and statistically significant coefficients emerge at longer lags. This pattern is consistent with the nature of capital formation, where investment projects involve gestation periods before expanding productive capacity and influencing output levels. Overall, the regression results demonstrate that credit composition affects regional economic dynamics in a temporally differentiated manner. The timing, magnitude, and transmission mechanisms vary across credit categories, underscoring that regional growth depends not only on the volume of credit but also on its allocation structure and intertemporal distribution. These findings provide empirical support for the view that financial intermediation shapes subnational economic development through heterogeneous and time-dependent channels (Amaluddin et al., 2024; Bellaa et al., 2022; Razak et al., 2020).

The Error Correction Term (ECT) is negative, confirming convergence toward the long-run equilibrium. Its magnitude indicates that deviations from the equilibrium relationship are corrected rapidly in the subsequent period. An absolute coefficient greater than 1 suggests short-run overshooting before the system stabilizes, implying a relatively strong, potentially volatile adjustment process. This result substantiates the existence of a stable long-run cointegrating relationship between regional output and credit composition. Moreover, it underscores the responsiveness of regional economic growth to disequilibria in financial intermediation, indicating that shocks to credit allocation are not persistent but are instead absorbed through dynamic correction mechanisms.

The long-run estimates reveal heterogeneous effects across credit categories. Consumer credit has a positive impact on regional output, indicating that household-oriented lending contributes meaningfully to sustained economic performance. In regions with limited industrial capacity, such as East Nusa Tenggara (NTT), demand-side channels play a dominant role in supporting long-term growth. In contrast, working capital credit does not exhibit a statistically significant long-run effect. Although theoretically linked to productive activities, the expansion of business financing does not consistently translate into sustained output gains over the study period. This outcome may reflect structural rigidities, limited economies of scale, sectoral concentration, or inefficiencies in the allocation of productive credit.

Investment credit shows a positive long-run coefficient, albeit with weaker statistical significance than consumer credit. This finding suggests that capital formation contributes to economic growth, but its effectiveness depends critically on project implementation, sectoral distribution, institutional quality, and the regional economy's absorptive capacity. Taken together, the long-run results emphasize that the structure of credit allocation plays a decisive role in shaping regional economic performance, yet its effectiveness varies substantially across credit types and depends on the broader structural and institutional context.

**Table 4. Empirical Result of ARDL–ECM (2004–2024)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample: | 2004 -2024 | | Number of obs | | | | 21 |
| | | | R-squared | | | | 0.9949 |
| | | | Adj R-squared | | | | 0.9487 |
| Log likelihood | 115.4472 | | Root MSE | | | | 0.0032 |
| **D.lnGRDP** | | **Coef.** | **Std. Err.** | **t** | **P>t** | **[95% Conf.** | **Interval]** |
| ADJ | | | | | | | |
| | lnGRDP | | | | | | |
| | L1. | -1.09044 | 0.185339 | -5.88 | 0.028 | -1.88789 | -0.293 |
| LR | | | | | | | |
| | lnCC | 0.387902 | 0.081007 | 4.79 | 0.041 | 0.039357 | 0.736448 |
| | lnWCC | -0.01089 | 0.068672 | -0.16 | 0.889 | -0.30637 | 0.28458 |
| | lnIC | 0.040458 | 0.013024 | 3.11 | 0.09 | -0.01558 | 0.096495 |
| SR | | | | | | | |
| | lnGRDP | | | | | | |
| | LD. | -0.21793 | 0.140921 | -1.55 | 0.262 | -0.82426 | 0.3884 |
| | L2D. | -1.01942 | 0.207982 | -4.9 | 0.039 | -1.91429 | -0.12454 |
| | L3D. | -4.45255 | 0.442739 | -10.06 | 0.01 | -6.35751 | -2.5476 |
| | lnCC | | | | | | |
| | D1. | -0.13821 | 0.044508 | -3.11 | 0.09 | -0.32971 | 0.053287 |
| | LD. | 0.319602 | 0.05646 | 5.66 | 0.03 | 0.076674 | 0.56253 |
| | L2D. | 0.595355 | 0.065853 | 9.04 | 0.012 | 0.31201 | 0.878699 |
| | L3D. | 0.485641 | 0.055892 | 8.69 | 0.013 | 0.245159 | 0.726124 |
| | lnWCC | | | | | | |
| | D1. | -0.25917 | 0.048036 | -5.4 | 0.033 | -0.46585 | -0.05248 |
| | LD. | -0.59019 | 0.079314 | -7.44 | 0.018 | -0.93145 | -0.24893 |
| | L2D. | 0.110414 | 0.051002 | 2.16 | 0.163 | -0.10903 | 0.329858 |
| | L3D. | 0.264198 | 0.043794 | 6.03 | 0.026 | 0.075768 | 0.452627 |
| | lnIC | | | | | | |
| | D1. | 0.00827 | 0.007858 | 1.05 | 0.403 | -0.02554 | 0.042081 |
| | LD. | -0.06955 | 0.00825 | -8.43 | 0.014 | -0.10504 | -0.03405 |
| | L2D. | -0.086 | 0.009512 | -9.04 | 0.012 | -0.12692 | -0.04507 |
| | _cons | 12.30093 | 2.481031 | 4.96 | 0.038 | 1.625917 | 22.97595 |

Source: Author's calculations using Stata.

The short-run dynamics reveal heterogeneous adjustment patterns and distinct transmission mechanisms across credit categories. Lagged changes in regional output are statistically significant, confirming intertemporal persistence and inertia in economic growth. Consumer credit produces significant positive effects at several lagged differences, suggesting that its influence unfolds gradually rather than instantaneously. This pattern aligns with cumulative demand effects, in which increases in household borrowing stimulate consumption and, in turn, reinforce output expansion over successive periods.


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Working capital credit exhibits a mixed short-run pattern, characterized by negative coefficients at initial lags followed by positive and significant effects at later stages. These dynamics indicate a delay in transmission from business financing to realized production, reflecting operational adjustments, production cycles, and inventory accumulation before the effects are fully reflected in output growth. Investment credit predominantly displays lagged effects, consistent with the gestation periods inherent in capital formation. Its short-run impact is limited, reinforcing the conceptual distinction between demand-driven credit channels and capacity-expanding investment mechanisms. Overall, the empirical results indicate that credit's growth effects are both category-specific and time-dependent. The intertemporal configuration of credit allocation thus emerges as a key determinant of regional growth dynamics, underscoring that not only the quantity but also the composition and timing of credit expansion are critical for sustainable economic development.

**Table 5. ARDL Bounds Test Results**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| H0: no level relationship | | | | F | = | 49.056 | | |
| | | | | t | = | -5.884 | | |
| Critical Values (0.1-0.01), F-statistic, Case 3 | | | | | | | | |
| | [I_0] | [I_1] | [I_0] | [I_1] | [I_0] | [I_1] | [I_0] | [I_1] |
| | L_1 | L_1 | L_05 | L_05 | L_025 | L_025 | L_01 | L_01 |
| k_3 | 2.72 | 3.77 | 3.23 | 4.35 | 3.69 | 4.89 | 4.29 | 5.61 |
| accept if F < critical value for I(0) regressors | | | | | | | | |
| reject if F > critical value for I(1) regressors | | | | | | | | |
| Critical Values (0.1-0.01), F-statistic, Case 3 | | | | | | | | |
| | [I_0] | [I_1] | [I_0] | [I_1] | [I_0] | [I_1] | [I_0] | [I_1] |
| | L_1 | L_1 | L_05 | L_05 | L_025 | L_025 | L_01 | L_01 |
| k_3 | -2.57 | -3.46 | -2.86 | -3.78 | -3.13 | -4.05 | -3.43 | -4.37 |
| accept if t > critical value for I(0) regressors | | | | | | | | |
| reject if t < critical value for I(1) regressors | | | | | | | | |

Source: Author's calculations using Stata

The existence of a long-run relationship among the variables is examined using the ARDL bounds testing approach developed by Nkoro and Uko, (2016). The results, summarized in Table 5, indicate that the computed F-statistic exceeds the upper bound critical value at the 1% significance level. Additionally, the corresponding t-statistic falls below the lower bound critical value. The results confirm the presence of a long-run cointegrating relationship between real GRDP and the composition of bank credit in East Nusa Tenggara (NTT). Despite the mixed order of integration among the variables, the evidence indicates the existence of a stable long-run equilibrium relationship. The confirmation of cointegration justifies the estimation of long-run coefficients and the corresponding Error Correction Model (ECM). It also implies that short-run fluctuations in credit allocation and regional output converge toward a common equilibrium path

rather than diverging over time, reinforcing the stability of the financial–growth linkage in the regional economy. To ensure the robustness of the estimated ARDL model, a series of diagnostic and stability tests was performed. The results indicate that the model satisfies all key classical assumptions necessary for valid statistical inference, confirming the reliability and stability of the estimated relationships.

**Table 6. Autocorrelation Diagnostic Test Results**

| | | | | |
|---|---|---|---|---|
| Metode 1 | Durbin-Watson d-statistic( 6, 23) = 2.18633 | | | |
| Metode 2 | Breusch-Godfrey LM test for autocorrelation | | | |
| | lags(p) | chi2 | df | Prob > chi2 |
| | 4 | 3.318 | 4 | 0.5062 |

Source: Author's calculations using Stata.

Serial correlation was assessed using both the Durbin–Watson statistic and the Breusch–Godfrey LM test. The Durbin–Watson value is close to two, indicating no evidence of first-order serial correlation. This result is corroborated by the Breusch–Godfrey LM test, which fails to reject the null of no autocorrelation. These findings suggest that the residuals are free of serial correlation, confirming that the estimated coefficients are unbiased and that the model's dynamic specification adequately captures temporal dependence.

**Table 7. Cameron & Trivedi's IM-Test for Heteroskedasticity**

| | | | |
|---|---|---|---|
| chi2(20) | = | 21 | |
| Prob > chi2 | = | 0.3971 | |
| Cameron & Trivedi's decomposition of IM-test | | | |
| Source | chi2 | df | p |
| Heteroskedasticity | 21 | 20 | 0.3971 |
| Skewness | 18.23 | 18 | 0.4407 |
| Kurtosis | 1.15 | 1 | 0.2832 |
| Total | 40.38 | 39 | 0.4091 |

Source: Author's calculations using Stata

The heteroskedasticity test indicates that the null hypothesis of homoskedastic residuals cannot be rejected. The reported p-value exceeds the conventional 5% significance level, suggesting that the residuals' variance remains constant across observations. This conclusion is further supported by the Cameron and Trivedi IM-test decomposition, which indicates that the heteroskedasticity component is statistically insignificant. Moreover, the skewness and kurtosis components do not reveal any specification issues. Overall, these findings confirm that the model does not suffer from heteroskedasticity. Consequently, the estimated standard errors are reliable, and statistical inference based on t- and F-statistics remains valid.


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The normality assumption was evaluated using the Skewness/Kurtosis test. The joint test yields a probability value of 0.2942, which exceeds the conventional 5% significance level. The individual p-values for skewness and kurtosis are also statistically insignificant, indicating that the residuals do not exhibit systematic asymmetry or excess kurtosis. These findings suggest that the residuals are approximately normally distributed, supporting the validity of the t- and F-statistics used in the model. Consequently, statistical inference derived from the ARDL estimation can be considered robust and reliable.

**Table 8. Skewness/Kurtosis Test for Normality**

| Variable | Obs | Pr(Skewness) | Pr(Kurtosis) | adj | chi2(2) | Prob>chi2 |
|---|---|---|---|---|---|---|
| ehat | 21 | 0.6482 | 0.1601 | | 2.45 | 0.2942 |

Source: Author's calculations using Stata

The results of the stability test based on the CUSUM procedure indicate that the cumulative sum of recursive residuals remains within the critical bounds throughout the observation period (2004–2024). At no point does the CUSUM line cross either the upper or lower 5% significance limits. Methodologically, this finding suggests that there are no significant structural breaks in the estimated parameters over the sample period. In other words, the relationship between credit composition and regional economic growth in East Nusa Tenggara (NTT) remains dynamically stable despite external shocks, including the economic contraction during the pandemic. The stability of the estimated parameters reinforces the reliability of the ARDL and ECM estimation results presented earlier. Therefore, the inferences regarding the long-run relationship, adjustment mechanism, and short-run dynamics are robust and not influenced by structural instability in the model.

The findings of this study indicate that credit composition has structural implications for regional economic growth, extending beyond its role as an aggregate liquidity factor. The confirmation of a long-run cointegrating relationship reinforces the finance–growth nexus literature, which posits that the financial and real sectors are intertemporally linked through equilibrium mechanisms (Fukuda, 2025). The principal contribution of this study is to show that the type of credit fundamentally determines the effectiveness of growth transmission—a dimension still underexplored in subnational studies of Indonesia.

The finding that consumer credit serves as a significant long-run determinant of real GRDP aligns with evidence from developing economies, where household credit expansion drives output through the consumption-multiplier mechanism (Çayır, 2021), further demonstrating that household lending exerts stronger effects than productive credit in economies that have not yet achieved industrial deepening. Within East Nusa Tenggara (NTT), whose economy is dominated by trade, services, and domestic consumption, this pattern suggests that growth transmission primarily occurs through demand-side channels rather than long-term capital accumulation.

Consistent with this structural perspective, the insignificant long-run effect of working capital credit indicates that operational financing alone has not generated

measurable productivity gains at the regional level. In structurally less diversified economies such as NTT, where firm size remains small and informal activities dominate, short-term operational credit may support liquidity without necessarily enhancing technological upgrading or production efficiency. This finding aligns with recent literature that emphasizes that the effectiveness of productive credit is conditional on institutional quality, absorptive capacity, and real-sector efficiency (Amaluddin et al., 2024).

Recent empirical studies suggest that the growth impact of bank credit is highly contingent upon structural and institutional conditions. Evidence from dynamic panel analyses indicates that productive lending contributes to sustained output expansion primarily in economies characterized by higher institutional quality, deeper financial markets, and stronger industrial capacity (Uddin et al., 2023). In structurally less diversified regions, where economic activities are dominated by small-scale and informal enterprises, the transmission of productive credit to long-run output tends to be weaker and often delayed (Anama & Lubis, 2025; Idroes et al., 2024). In East Nusa Tenggara (NTT), where structural transformation remains limited and the production base is relatively narrow, credit expansion may not automatically translate into sustained output growth.

Investment credit exhibits a positive yet moderate effect on regional output. This pattern likely reflects implementation lags in project realization as well as the relatively limited scale of capital formation at the regional level. Consistent with the macro-finance literature, investment-related credit often requires adjustment periods before translating into statistically significant output gains, particularly in developing and structurally constrained economies (Uddin et al., 2023). In subnational settings with limited industrial depth, delayed effects are frequently associated with infrastructure bottlenecks, weak project selection mechanisms, and heterogeneous investment quality (Anama & Lubis, 2025; Idroes et al., 2024; Tampubolon et al., 2021)

Interestingly, the rapid error-correction mechanism identified in this study indicates that East Nusa Tenggara's economy is highly responsive to shifts in credit composition. The statistically significant, strongly negative error-correction term suggests that deviations from the long-run equilibrium are swiftly corrected. This finding implies that, although short-run transmission differs across credit categories, a structural integration exists between the financial system and real-sector activities, enabling intertemporal rebalancing and preventing persistent destabilization of regional output.

From a scientific standpoint, this study makes three principal contributions. First, it extends the finance–growth nexus literature to the subnational level by employing a time-series framework in Eastern Indonesia. While much of the existing literature relies on cross-country or interprovincial panel estimations to examine the conditional relationship between bank credit and economic growth (Ho & Saadaoui, 2022), subnational dynamic adjustments are often obscured within aggregated panel structures. In contrast, by focusing on a single province, this study captures within-region intertemporal dynamics and structural responsiveness, complementing recent evidence on heterogeneous regional financial transmission in Indonesia (Aginta & Someya, 2022; Budiman et al., 2024).


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Second, this study demonstrates that analyzing credit composition provides more nuanced insights than aggregate credit indicators. Recent empirical work emphasizes that different categories of lending exhibit heterogeneous transmission channels and asymmetric growth effects (Huda et al., 2025; Rahman et al., 2022). By disaggregating consumer, working capital, and investment credit, this study identifies distinct short- and long-run dynamics that would remain concealed under aggregate credit measures, thereby aligning with emerging evidence that financial structure—not merely financial depth—shapes growth outcomes (Idroes et al., 2024; Uddin et al., 2023).

Third, the findings suggest that in consumption-driven regional economies, consumer credit may function as a long-run growth driver. While conventional development theory prioritizes productive credit as the principal engine of sustainable growth, recent studies indicate that household and consumption-based lending can stimulate output through aggregate demand multipliers, particularly in structurally constrained developing economies (Xiao & Tao, 2020). Consistent with this perspective, evidence from Indonesia also shows that credit allocation patterns influence the pace and nature of economic transformation at the regional level (Anama & Lubis, 2025). Accordingly, this study not only reaffirms the existence of a finance–growth relationship but also elucidates how the composition and structural allocation of bank credit shape regional growth dynamics within subnational developing contexts.

## CONCLUSIONS

This study examines whether the composition of bank credit influences regional economic growth in East Nusa Tenggara (NTT) and how its effects differ in the short and long run. Using an ARDL approach with annual data from 2004–2024, the results confirm a statistically significant long-run relationship between real GRDP and credit structure. Consumer credit emerges as the strongest long-run growth determinant, investment credit shows a positive but moderate effect, and working capital credit is not significant in the long run. These findings indicate that regional growth depends not merely on the volume of credit expansion but on its composition and alignment with local economic conditions. Policy strategies in structurally constrained regions should therefore emphasize targeted credit allocation, institutional strengthening, and real-sector development to ensure that financial intermediation supports sustainable regional growth.

## REFERENCES

Aginta, H., & Someya, M. (2022). Regional Economic Structure and Heterogeneous Effects of Monetary Policy : Evidence from Indonesian Provinces. *Journal of Economic Structures*, *11*(1), 1–25. https://doi.org/10.1186/s40008-021-00260-6.

Amaluddin, A., Indiastuti, R., Effendi, N., & Cupian, C. (2024). Rural ICT Penetration, Bank Credit, and Agricultural Sector Performance : A Panel ARDL Analysis in Eastern Indonesia. *Agris On-Line Papers in Economics and Informatics*, *XVI*(1), 3–14. https://doi.org/10.7160/aol.2024.160101.

Anama, Y. C., & Lubis, D. A. (2025). Is the Bank Credit able to Accelerate Economic Transformation ? A Multivariate Modeling of Key Sectors in Indonesia. *Jurnal Ekonomi Indonesia*, *14*(2), 192–208. https://doi.org/10.52813/jei.v14i2.571.

Anton, Rahim, M., Armawaddin, M., Rostin, Syarif, M., & Barani, L. O. S. (2023). Pengaruh Investasi dan Kredit Perbankan terhadap Pertumbuhan Ekonomi di Indonesia. *JPEP: Jurnal Progres Ekonomi Pembangunan*, *8*(2), 171–182.

Asllani, G., Luboteni, G., & Grima, S. (2020). Financial Integration, Banking Supervision and Sustainability of the Western Balkan Countries. *International Journal of Economics and Business Administration*, *VIII*(1), 3–14. https://doi.org/10.35808/ijeba/404.

Azolibe, C. B. (2020). Banking Sector Intermediation Development and Growth of a Developing Economy : An Empirical Investigation of Nigeria. *Harvard University Press*, 1–18. https://doi.org/10.21203/rs.3.rs-95127/v1.

Bellaa, F. I., Mawardia, I., & Amelia, I. (2022). Islamic Finance-Growth Nexus : Evidence from Indonesia. *Shirkah: Journal of Economics and Business*, *7*(2), 139–154. https://doi.org/10.22515/shirkah.v7i2.472.

Budiman, A., Juhro, S. M., & Safuan, S. (2024). Capital Flow and Bank Lending Channels in a Small Open Economy : Evidence from Indonesia. *Bulletin of Monetary Economics and Banking*, *27*(2), article 1. https://doi.org/10.59091/2460-9196.2190.

Çayır, B. (2021). The Impacts of International Capital Flows on Household Credits. *Central Bank Review*, *21*(4), 131–140. https://doi.org/10.1016/j.cbrev.2021.12.001.

Firmansyah, M. (2024). Analysis of The Effect of Credit and Financial Technology on Economic Growth in ASEAN-5. *JRIE: Jurnal Riset Ilmu Ekonomi*, *4*(2), 75–85.

Fukuda, T. (2025). India's Finance -Growth Nexus with Carbon Emissions, Globalization, and Government Expenditure: A Non-Linear Approach Using ARDL and VARX Techniques. *Journal of Economics, Finance and Management Studies*, *8*(5), 2572–2590.

Ho, S., & Saadaoui, J. (2022). Bank Credit and Economic Growth: A Dynamic Threshold Panel Model for ASEAN Countries. *International Economics*, *170*, 1–26. https://doi.org/10.1016/j.inteco.2022.03.001.

Huda, S., Yuliati, A., & Setyawan, D. (2025). Revisiting Finance-Led Growth: Evidence From Disaggregated Bank Credit In Indonesia (Period 2009 – 2023). *Journal of Economics and Business Letters*, *5*(5), 72-81. https://doi.org/10.55942/jebl.v5i5.755.

Idroes, G. M., Maulidar, P., Marsellindo, R., Afjal, M., & Hardi, I. (2024). The Impact of Credit Access on Economic Growth in SEA Countries. *Indatu Journal of Management and Accounting*, *2*(2), 96–104. https://doi.org/10.60084/ijma.v2i2.256.

Kripfganz, S., & Schneider, D. C. (2023). ARDL: Estimating Autoregressive Distributed Lag and Equilibrium Correction Models. *The Stata Journal*, *23*(4), 983–1019. https://doi.org/10.1177/1536867X231212434.

Lestari, R. M., Febriani, R. E., & Putri, N. T. (2021). Pengaruh Kredit Perbankan terhadap Pertumbuhan Ekonomi Provinsi di Sumatera. *Convergence: The Journal Of Economic Development*, *3*(2), 179–195.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50180

Lotto, J. (2023). Does Banking Sector Advancement Provide a Growth-Supporting Role to Tanzania's Economy? *Economics and Business Quarterly Reviews*, *6*(3), 76–85. https://doi.org/10.31014/aior.1992.06.03.521.

Mamun, M. S. Al, & Ariffin, M. I. (2018). Does Domestic Credit of The Banking Sector Promote Economic Growth? Evidence from Bangladesh. *International Journal of Islamic Business*, *3*(1), 33–55. https://doi.org/10.32890/ijib2018.3.1.3.

Mustofa, H. Z., & Faizin, M. (2025). The effect of Macroeconomic Factors on Economic Growth in Indonesia. *JDE: Journal of Developing Economies*, *10*(1), 48–72. https://doi.org/10.20473/jde.v10i1.60620.

Naula, F., Zamora, C., & Gómez, K. (2025). The Influence of Bank Loans and Deposits on Ecuador's Economic Growth: A Cointegration Analysis. *International Journal of Studies*, *13*(76), 1–17. https://doi.org/10.3390/ijfs1302007.

Nkoro, E., & Uko, A. K. (2016). Autoregressive Distributed Lag (ARDL) Cointegration Technique: Application and Interpretation. *Journal of Statistical and Econometric Methods*, *5*(4), 63–91.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, *16*(3), 289–362. https://doi.org/10.1002/jae.616.

Rahman, M. M., Vu, X.-B. (Benjamin)., & Nghiem, S. (2022). Economic Growth in Six ASEAN Countries : Are Energy, Human Capital, and Financial Development Playing Major Roles? *Sustainability*, *14*(450), 4540. https://doi.org/10.3390/su14084540.

Razak, A. R., Soedarmono, W., Salasi, W., & Yudhi, A. (2020). Banking, Labor Force, and Regional Economic Growth: Evidence from Indonesia. *Jurnal Keuangan Dan Perbankan*, *24*(2), 156–163.

Sinay, L. J., & Kembauw, E. (2023). The Influence of Macroeconomic Factors on Credit Risk of Banks in Indonesia using the ARDL Model. *Pattimura International Journal of Mathematics (PIJMath)*, *2*(02), 79–88. https://doi.org/10.30598/pijmathvol2iss2pp79-88

Sipahutar, M. A. (2024). The Journal of Academic Science Linkage of Money Growth on Banks Credit – Evidence from Indonesia. *The Journal of Academic Science*, *1*(1), 27–36. https://doi.org/10.59613/m84y4381.

Sudrajad, O. Y., Wiryono, S. K., Kitri, M. L., & Rahadi, R. A. (2023). Does Financial Digitalization Affect Macroeconomic Stability in Indonesia? An Application of the Autoregressive Distributed Lag (ARDL) Model. *IASE International Journal of Advanced and Applied Sciences*, *10*(10), 46–54. https://doi.org/10.21833/ijaas.2023.10.005.

Suhendra, I., & Ronaldo, E. (2017). Pengaruh Intermediasi Perbankan terhadap Pertumbuhan Ekonomi Indonesia. *Tirtayasa Ekonomika*, *12*(1), 4443. https://doi.org/10.35448/jte.v12i1.4443.

Sumarni, L. (2019). Financial Development and Economic Growth in Indonesia: An ARDL-Bounds Testing Approach. *EJEM Economic Journal of Emerging Markets*, *11*(1), 89–96. https://doi.org/10.20885/ejem.vol11.iss1.art9.

Tampubolon, J., Sihol, T., & Loh, A. (2021). The Nexus of Export, FDI, Financial Development, and Economic Growth in North Sumatra, Indonesia. *Integrated Journal Of Business And Economics*, *5*(1), 10–24. https://doi.org/10.33019/ijbe.v4i3.328.

Uddin, I., Ahmad, M., Ismailov, D., Eid, M., Akhmedov, A., Khasanov, S., & Ul, M. (2023). Research in Globalization: Enhancing Institutional Equality to Boost Economic Development in Developing Nations: New Insights from the CS-ARDL Approach. *Research in Globalization*, *7*, 100137. https://doi.org/10.1016/j.resglo.2023.100137.

Xiao, J., & Tao, C. (2020). Consumer Finance/Household Finance: The Definition and Scope. *China Finance Review International*, *11*(1), 1–25. https://doi.org/10.1108/CFRI-04-2020-0032.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50180

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# Revisiting Trade Liberalization for Agriculture Productivity: Dynamic Evidence from a Global Panel of Countries

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## ABSTRACT

**Research Originality:** This study contributes to the literature by providing a comparative analysis of the dynamic relationship between agricultural trade liberalisation and total factor productivity (TFP) growth across income groups. It highlights how differences in structural capacity and innovation systems shape heterogeneous productivity outcomes across countries.

**Research Objectives:** This study re-examines the dynamic impact of agricultural trade liberalisation on TFP growth across income groups and identifies the mechanisms underlying divergent productivity outcomes.

**Research Methods:** A panel Autoregressive Distributed Lag (ARDL) model is applied to panel data from 35 major agricultural-producing countries over the period 2007–2024 to capture heterogeneous short-run dynamics and common long-run relationships.

**Empirical Results:** The results reveal heterogeneous effects. Trade liberalisation significantly increases TFP growth in high-income countries through stronger technology diffusion and absorptive capacity. However, it generates weak or negative effects in middle-income countries due to structural constraints and limited innovation capacity.

**Implications:** Agricultural trade liberalisation does not automatically enhance productivity; its benefits depend on domestic structural readiness and innovation capacity.

**Keywords:**
heterogeneous trade effects; transmission channels; structural readiness; cross country Analysis

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## INTRODUCTION

Agricultural trade liberalization has long been promoted as a key strategy to improve efficiency, facilitate technological diffusion, and enhance productivity in global agriculture (Barros & Martínez-Zarzoso, 2022; Bilgin, 2019; Ma et al., 2025; Sukoco et al., 2020). Reducing trade barriers through liberalization is expected to intensify competition, expand access to modern inputs, and support reallocation of resources toward sectors with comparative advantage (Dinh et al., 2020; Zhou & Ji, 2022). Within this framework, total factor productivity (TFP) represents the primary mechanism through which trade openness translates into sustained agricultural performance (Solow, 1957).

Nevertheless, the empirical relationship between agricultural trade liberalisation and productivity remains highly contested. A substantial body of research has documented the positive impact of trade openness on productivity, particularly in developed countries (Farrokhi & Pellegrina, 2023; Xu et al., 2023). While some countries have experienced sustained TFP growth following trade openness, others have faced stagnant or declining productivity despite deeper integration into global market structures (Sunge & Ngepah, 2022).. These outcomes, which are divergent from the conventional assumption that trade liberalisation is inherently productivity-enhancing, point to a trade liberalisation paradox in global agriculture. As demonstrated by Bai et al. (2024), there is clear evidence that comparable liberalisation policies result in significantly divergent productivity levels across countries.

Theoretically, trade liberalization influences agricultural productivity through several interconnected transmission channels rather than through a direct and automatic mechanism (Dinh et al., 2020; Zhou & Ji, 2022). These channels include technology diffusion through imported machinery and intermediate inputs (Wang et al., 2021). Incentives for domestic research and development (R&D) arising from competitive pressure (Barros & Martínez-Zarzoso, 2022). The real exchange rate that shapes the price competitiveness of agricultural production (Hung, 2021). When these mechanisms function effectively, liberalization can support long-run productivity growth. When domestic innovation capacity is weak or macroeconomic conditions are unstable, however, exposure to global competition may undermine agricultural productivity (Fiankor et al., 2021; FAO, 2022).

The observed heterogeneity in productivity responses highlights the importance of country-specific absorptive capacity. Developed countries typically possess stronger innovation systems, more developed financial markets, and better infrastructure (Yunita et al., 2022). This condition enables them to internalize foreign technologies and convert trade openness into productivity gains (Xu et al., 2023). In contrast, many developing countries face structural constraints, including limited human capital and weak innovation institutions (Feriansyah, 2020). Under such conditions, trade liberalization may intensify import competition without generating compensating productivity improvements, leading to weak or negative long-run effects on agricultural TFP (Sunge & Ngepah, 2022).


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Despite the substantial research conducted on trade liberalisation and productivity, several significant gaps remain. A substantial proportion of the extant literature relies on static or semi-dynamic panel approaches to estimate average effects, including fixed effects, GMM, and DEA (Dai et al., 2023; Liu et al., 2020; Xu et al., 2023). This tendency to prioritise average effects can lead to misinterpretations of short-run adjustment dynamics and long-run productivity divergence across countries. Furthermore, trade liberalisation is frequently regarded as a homogeneous catalyst for productivity enhancement. However, limited attention has been paid to the transmission mechanisms and structural conditions that generate asymmetric outcomes across countries. Consequently, extant studies furnish a paucity of responses to the question of why analogous liberalisation policies engender advantageous outcomes for certain nations while concomitantly engendering disadvantageous outcomes for others (Hung, 2021; Wang et al., 2021)

The present study aims to address the aforementioned gaps by conducting a thorough examination of the dynamic effects of agricultural trade liberalisation on TFP growth. The study also explicitly identifies the key factor that drives asymmetric productivity outcomes across different country contexts. The analysis uses panel data from 35 major agricultural producing countries over the period 2007–2024. Employing a panel autoregressive distributed lag (ARDL) framework, the study captures heterogeneous short-run dynamics alongside common long-run relationships (Jabuya et al., 2023; Pesaran et al., 1999). It also implicitly incorporates transmission channels, such as technology diffusion, R&D investment, and real exchange rate (Wang et al., 2021; Yunita et al., 2017).

The novelty of this study lies in its methodological innovation and in its integrated explanation of why trade liberalisation generates asymmetric productivity outcomes across countries. The present study has sought to demonstrate that trade liberalisation is not, in itself, a productive force. To achieve this objective, the study has documented and explained the paradox of trade liberalisation. The findings further emphasise the importance of aligning liberalisation strategies with domestic absorptive capacity and structural readiness.

## METHODS

The present study employs balanced panel data covering 35 countries over the period 2007–2024. The selection of these countries is based on two main considerations. Firstly, the sample includes countries that make significant contributions to global agricultural production. The analysis is thus guaranteed to reflect economies that are highly relevant to global agricultural productivity and trade. Secondly, the selected countries represent a range of income levels, thus enabling the study to examine how the effects of agricultural trade liberalisation vary across stages of economic development. In accordance with the World Bank's income classification system, countries are categorised into three distinct income groups: high income, upper-middle income, and lower-middle

income. The following countries have been designated as high-income countries: the United States, France, Australia, Japan, Italy, Spain, South Korea, Canada, Germany, the United Kingdom, the Netherlands, Poland, and Chile. The following countries have been designated as upper-middle-income countries: China, Brazil, Russia, Argentina, Turkey, Mexico, Iran, Thailand, Malaysia, Colombia, and Peru. The following countries have been designated as lower-middle-income countries: India, Indonesia, Nigeria, Pakistan, Bangladesh, Vietnam, the Philippines, Kenya, Egypt, Morocco, and Ukraine. This classification facilitates a comparative analysis of structural differences in productivity, trade openness, and technological capacity across income groups (Martínez-Zarzoso & Chelala, 2021).

Table 1 summarizes the variables used in this study along with their definitions, measurements, and data sources. Agricultural productivity is measured as the percentage growth in TFP relative to 2005, in accordance with the methodology developed by Fuglie (2019). The term 'Agricultural TFP' denotes the efficiency with which the agricultural sector converts all inputs (land, labour, capital, and intermediate inputs) into agricultural output. It has been demonstrated that such gains are not driven by increased input use, but rather by improvements in technology, efficiency, management practices, institutional quality, and resource allocation. The concept of agricultural trade liberalization is measured by an agricultural trade openness index, calculated as the ratio of total agricultural exports and imports to GDP. The data for this variable is obtained from FAOSTAT.

**Table 1. Description of Variables**

| Data | Definition | Unit of Measurement | Literature Source |
|---|---|---|---|
| Agricultural Productivity | Represents the percentage growth of Total Factor Productivity (TFP) in the agriculture and livestock sectors, calculated relative to the base year 2005. | Percentage | Fuglie (2019) |
| Agricultural Trade Liberalization | % GDP | FAOSTAT | Sunge & Ngepah (2022) |
| Technology Transfer | Index | Unesco institute for statistic | Sunge & Ngepah (2022) |
| Research and development | % GDP | Govdata world bank | Sunge & Ngepah (2022) |
| Real effective exchange rate | Percentage | Brugel Dataset | Sunge & Ngepah (2022) |

Source: Author Calculation

Research and development (R&D) is measured as total R&D expenditure as a percentage of GDP, reflecting national investment in innovation capacity. The data have been sourced from UNESCO, in accordance with the approach of Sunge and Ngepah (2022). The transfer of technology is measured using an index ranging from 1 to 7. Higher values indicate greater technology transfer through international trade. This


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index is derived from the Global Competitiveness Index, which is published by the World Economic Forum, and reflects firms' access to foreign technologies embedded in imports. The real effective exchange rate (REER) is constructed from the Consumer Price Index (CPI) and incorporates trade with 172 partner countries. The REER data are obtained from Bruegel and capture international price competitiveness effects relevant for agricultural exports and imports.

To analyze both short-run and long-run relationships between agricultural trade liberalization and productivity growth, this study employs the panel Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al. (1999). The panel ARDL is particularly appropriate for this study for three main reasons. First, it accommodates variables with mixed orders of integration, I(0) and I(1), without requiring all variables to be stationary at the same level. Second, it allows for the estimation of long-run equilibrium relationships alongside short-run dynamic adjustments. Third, it permits heterogeneity across countries, enabling country-specific short-run coefficients while maintaining common long-run relationships within income groups.

In the model, agricultural TFP growth is the dependent variable. The explanatory variables include agricultural trade openness, technology transfer, R&D expenditure, and the real effective exchange rate. The panel ARDL framework is specified as ARDL (p, q, q, q, q). The lag structure captures dynamic adjustments over time. The error correction term reflects the speed at which short-run deviations converge toward the long-run equilibrium. These variables can be expressed in the form of a panel ARDL (*p,q,q,...,q*) equation as follows:

$$gtfp_{it} = \theta_i(\Delta gtfp_{it-1} - \lambda_i^{'} Xit) + \sum_{j=1}^{p-1} \xi_{ij} \Delta gtfp_{it-j} + \sum_{j=0}^{q-1} \beta_{ij}^{'} \Delta X_{it-j} + \phi_i + e_{it} \qquad (1)$$

Where $X$ is the vector of explanatory variables, X (agrTO, tech_trf, R&D, REER), $\theta_i = -(1 - \delta_i)$ as the coefficient of the group specific of adjustment (which is expected to $(\theta_i < 0)$. $\lambda_i'$ is the vector of long-run relationships. $ECT = (gtfp_{it-1} - \lambda_i' X_{it})$ is the error correction term, and finally $\xi_{ij}$, $\beta'_{ij}$ is the dynamic short-run coefficient.

Prior to estimation, a series of diagnostic tests is conducted to ensure the validity of the panel ARDL framework. The results of the stationarity test presented in Table 2, using the Im, Pesaran, and Shin (IPS) approach variables across all income groups have a mixed order of integration (I(0) and I(1)). These findings confirm that the Panel ARDL model is suitable for capturing both short and long-run relationships.

The results of the Pedroni cointegration test in Table 3 indicate a long-run relationship between agricultural trade liberalization and agricultural productivity growth across all income groups, though with varying degrees of strength.These results justify the use of the panel ARDL methodology. Furthermore, the Pedroni panel cointegration test provides strong evidence of a long-run cointegrating relationship between agricultural productivity growth and its determinants across all income groups. Although the strength of cointegration varies, the overall results confirm the presence of long-term equilibrium relationships and validate the empirical model.

**Table 2. Unit Root Test**

| Country Group | Variable | Im, Pesaran and Shin (IPS) | Level |
|---|---|---|---|
| High income | Gtfp | -8.887*** (0.000) | I(0) |
| | agrTO | -1.395* (0.081) | I(0) |
| | Tech_trf | -3.397** (0.003) | I(1) |
| | RnD | -4.026*** (0.000) | I(1) |
| | REER | -3.162** (0.008) | I(0) |
| Middle upper | Gtfp | -5.834*** (0.000) | I(0) |
| | agrTO | -2.129** (0.000) | I(0) |
| | Tech_trf | -4.704*** (0.000) | I(1) |
| | RnD | -2.934** (0.002) | I(1) |
| | REER | -5.166*** (0.000) | I(0) |
| Middle lower | Gtfp | -5.774*** (0.000) | I(0) |
| | agrTO | -8.439*** (0.000) | I(1) |
| | Tech_trf | -6.292*** (0.000) | I(1) |
| | RnD | -3.815*** (0.000) | I(1) |
| | REER | -3.806*** (0.0000) | I(1) |

Source: Author Calculation

**Table 3. Results of the Panel Cointegration Test**

| Country Group | Pedroni residual cointegration test common AR coefficients (within dimension) | | | | Common AR coefficients (between dimensions) | | |
|---|---|---|---|---|---|---|---|
| | Panel v-statistic | Panel rho-statistic | Panel PP-statistic | Panel ADF-statistic | Group rho-statistic | Group PP-statistic | Group ADF-statistic |
| High income | -0.967 | -1.398 | -17.24** | -4.075** | -0.074 | -21.65** | -4.695** |
| Middle upper | -0.146 | -2.044** | -15.29** | -4.382** | -0.934 | -18.76** | -1.235 |
| Middle lower | -0.223 | -3.259** | -14.59** | -1.01 | -2.207** | -18.76** | -0.225 |

Note: The t table value is 2.07387, and alpha 5%


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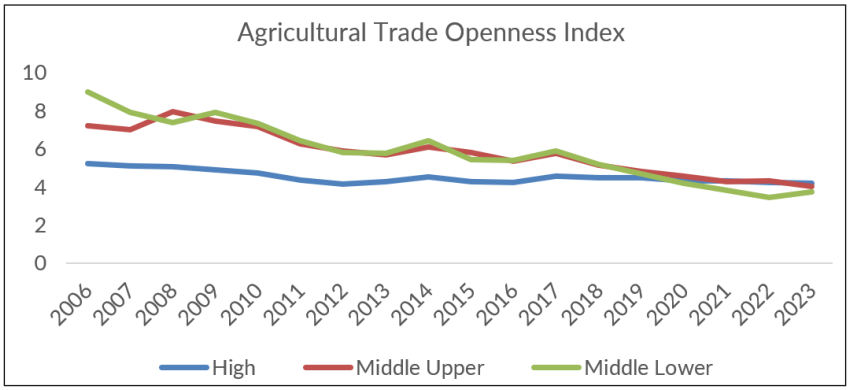
## RESULTS AND DISCUSSION

The subsequent section provides a synopsis of the principal empirical findings, followed by an exhaustive discussion of the long-run and short-run mechanisms. The primary conclusions from this analysis are as follows. Firstly, the process of agricultural trade liberalisation has been shown to exert a positive and statistically significant long-run effect on TFP growth in high-income countries. Whilst the impact is deemed negative or insignificant in upper- and lower-middle-income countries. Secondly, technology transfer and R&D investment emerge as transmission channels. Thirdly, the short-run effects of trade liberalisation are highly heterogeneous across countries. The findings of this study provide robust empirical evidence supporting the existence of a trade liberalization paradox in global agriculture. The conclusion drawn is that analogous liberalisation policies engender disparate productivity outcomes across nations.

Over the past decade, agricultural trade liberalization has slowed, particularly in upper- and lower-middle-income countries. This trend does not indicate a simple reversal toward protectionism. It reflects a strategic recalibration of trade openness amid heightened global uncertainty. As countries become more exposed to external shocks, policymakers increasingly reassess the balance between efficiency gains from liberalization and the risks associated with excessive dependence on international markets, especially in food systems.

As shown in Figure 1, lower-middle-income countries experienced an initial expansion of agricultural trade openness. This expansion was followed by a sharp decline after the 2008 global financial crisis. This pattern indicates that trade liberalization in these economies is highly sensitive to global disruptions. Such disruptions include food price volatility, climate-related shocks, and geopolitical tensions (Anderson, 2022). Similar post-crisis retrenchment patterns are documented by Sunge & Ngepah (2022) and Fiankor et al. (2021). These studies find that trade openness in developing economies often amplifies vulnerability to external shocks when domestic productivity and innovation capacity are weak.

**Figure 1. Trade Liberalization by Country Income Group**




Source: FAOSTAT (2024)

In this context, selective adjustment of liberalization policies reflects an adaptive response aimed at safeguarding domestic agricultural production. It does not represent a rejection of openness. This finding is consistent with recent empirical evidence indicating that the stagnation of global trade since the 2010s has been driven more by structural adjustment and domestic capacity-building strategies. This phenomenon has been less driven by rising tariff protection (FAO, 2023). The present study draws upon the findings of Almeida et al. (2024) and Chiarella et al. (2024), which underscore the necessity for complementary domestic policies. Conversely, high-income countries have tended to maintain relatively stable levels of agricultural trade openness (Xu et al., 2023; Farrokhi & Pellegrina, 2023). Farrokhi & Pellegrina (2023) posit that diversified production structures, strong institutional frameworks, and specialisation in high-value-added commodities support system stability. The studies' findings indicate that advanced economies are better equipped to convert trade openness into sustained productivity growth through effective technology diffusion and innovation.

The Panel ARDL in this study was estimated using three approaches: Pooled Mean Group (PMG), Mean Group (MG), and Difference Fixed Effect (DFE). The selection of the appropriate estimator was based on the Hausman test to ensure consistency and efficiency in the long-run parameters. The results indicate that the PMG estimator is preferred for all country groups except the lower-middle-income, for which the MG estimator was applied. Table 4 reports the summary of the long-run Panel ARDL estimation results. The long-run results reveal a pronounced asymmetry in the productivity effects of agricultural trade liberalization across income groups. This asymmetry provides strong evidence of a trade liberalization paradox. In high-income countries, agricultural trade openness has a positive and statistically significant impact on TFP growth, with a relatively large coefficient (0.229). The magnitude of this coefficient suggests not only statistical relevance but also substantive economic importance. This result indicates that trade liberalization functions as a productivity-enhancing mechanism in structurally advanced agricultural systems.

**Table 4. Long Run ARDL Estimation Results**

| Variabel | High | Middle upper | Middle lower |
|---|---|---|---|
| Agr_TO | 0.229***<br>(0.000) | -0.004***<br>(0.002) | -0.021<br>().533) |
| Tech_trf | 0.005***<br>(0.000) | 0.003***<br>(0.002) | 0.0449<br>(0.800) |
| RnD | 0.002 *<br>(0.048) | 0.003***<br>(0.003) | -1.164<br>(0.415) |
| Reer | 0.0006***<br>(0.000) | 0.009***<br>(0.000) | 0.013<br>(0.307) |

Note: *, **, and ** indicate estimated coefficients significant at the alpha 1%, 5% and 10%

This finding suggests that openness facilitates the reallocation of resources towards more productive farms and agribusinesses. Concurrently, it expedites the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implementation of frontier technologies embedded in imported capital goods and intermediate inputs. This interpretation is consistent with recent empirical evidence showing that trade openness strengthens technical progress and allocative efficiency. (Farrokhi & Pellegrina, 2023). It is imperative to demonstrate that, within the G20 countries, technical change is the predominant source of agricultural productivity growth. The amplifying effect of trade openness on these phenomena is attributable to technology diffusion (Xu et al., 2023).

Conversely, the estimated coefficients for upper- and lower-middle-income countries are either negative or statistically insignificant. This finding suggests that trade liberalisation does not necessarily lead to long-term productivity gains. In such contexts, heightened exposure to import competition may exceed domestic adjustment capacity. Consequently, local producers may experience a decline in competitiveness before substantial technological upgrades and institutional consolidations are implemented. Similar adverse or insignificant productivity effects are reported by Sunge & Ngepah (2022). Their study finds that trade openness in African agriculture often exacerbates vulnerability to external shocks when innovation systems are underdeveloped. Recent studies further document that in structurally constrained agricultural sectors, trade liberalization can generate adjustment costs that dominate potential efficiency gains (Almeida et al., 2024; Chiarella et al., 2023). These sectors are typically characterized by labor-intensive production and limited R&D investment.

Almeida et al. (2024) demonstrate that, in the absence of concomitant investments in institutions and technology, liberalisation can exacerbate disparities in productivity between nations. Rather than promoting convergence, it could widen existing gaps. These findings highlight a structural paradox at the core of agricultural trade liberalization. While openness has been demonstrated to expand market access and learning opportunities, its productivity benefits are conditional on domestic readiness.

This study also finds that in the long run, results further highlight the central role of technology transfer and R&D investment as some transmission channels. These channels explain how trade liberalization affects agricultural productivity. In high-income countries, both variables exhibit positive and statistically significant effects. This result indicates that openness enhances productivity primarily by facilitating access to advanced machinery, high-quality inputs, and embodied technological knowledge. Trade liberalization reduces the cost of importing capital goods.

Furthermore, this phenomenon has been shown to expand market incentives for innovation, thereby reinforcing cumulative productivity gains. These findings are consistent with recent literature emphasising the importance of absorptive capacity in determining the productivity impact of trade-induced technology diffusion. Graf et al. (2023) and Gollin (2023) demonstrated that economies with robust educational frameworks, advanced research infrastructures, and effective extension services are better equipped to assimilate foreign technologies. Furthermore, they are better able to adapt these technologies to

local production conditions. In such contexts, trade openness serves as a complementary mechanism to domestic R&D investment, rather than a substitute. This interaction has been shown to result in sustained improvements in productivity.

In upper-middle-income countries, technology transfer and R&D exhibit weaker yet positive long-run effects. This finding suggests that foreign technologies are only partially absorbed. The fragmentation of innovation systems, limited coordination between research institutions and producers, and inconsistent policy support all constrain the depth and persistence of spillover effects. Consequently, productivity gains become increasingly constrained over time. Luo & Qu (2023) state that without sustained investment in domestic innovation ecosystems, trade-induced technology inflows remain shallow. Consequently, they fail to generate long-term productivity growth, a pattern consistent with the estimates reported in Table 4.

In lower-middle-income countries, insignificant coefficients for technology transfer and R&D may indicate persistently low investment levels. The importation of technologies is often undertaken without sufficient local adaptation. This curtails the potential for experiential learning and hinders the diffusion of innovations. These results align with Fuglie (2018), who emphasizes that R&D and capital accumulation remain the primary drivers of agricultural productivity growth. Trade liberalization, therefore, plays a complementary rather than a leading role. More recent evidence by Sunge and Ngepah (2022) demonstrates that, in contexts characterised by limited capacity, the influx of technology alone is inadequate. It has been demonstrated that such measures do not engender sustained productivity gains.

Overall, the empirical results are internally consistent and economically coherent across income groups. The analysis demonstrates that the productivity effects of agricultural trade liberalization are conditional rather than universal. Specifically, the direction and magnitude of the impact depend on structural characteristics, institutional quality, and domestic innovation capacity.

Trade openness enhances productivity in countries with strong absorptive capacity and well-developed innovation systems, whereas its effects are limited in economies with weak institutional and technological foundations. By explicitly linking the empirical estimates to structural mechanisms and recent empirical literature, this discussion provides a coherent explanation of the observed heterogeneity. The results, therefore, contribute to the broader debate by demonstrating that agricultural trade liberalization serves as a productivity multiplier only when complemented by domestic capabilities.

The short-run panel ARDL estimates are presented in Table 5. In contrast to the long-run coefficients, which reflect structural relationships, the short-run estimates represent adjustment processes characterised by learning costs, institutional frictions, and temporary responses to intensified competitive pressure. The heterogeneous short-run coefficients on agricultural trade liberalization are consistent with recent empirical


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evidence emphasising the presence of adjustment costs following trade liberalization. The positive short-run effects observed in several countries suggest that increased openness can generate immediate productivity gains through rapid factor reallocation and improved market integration. This is particularly evident in contexts where market institutions and production structures are highly flexible. Documented cases of short-run efficiency gains are numerous. Farrokhi and Pellegrina (2023) and Trakem and Fan (2024) highlight the importance of identifying which economic model exhibits stronger absorptive capacity, as this determines how quickly an economy can internalize competitive pressures arising from trade.

Conversely, the prevalence of adverse short-term effects across numerous countries suggests that import competition frequently escalates more rapidly than producers can adapt their production technologies and organizational structures. This finding is consistent with the conclusions of recent studies indicating that the initial phase of liberalization may result in a temporary decline in productivity due to transitional challenges, despite the subsequent realization of long-term benefits (Chiarella et al., 2023; Sunge & Ngepah, 2022). Consequently, these short-run productivity losses reflect adjustment costs rather than a failure of trade openness to enhance productivity. This finding reinforces the distinction between transitional dynamics and long-run equilibrium effects.

The short-run responses to technology transfer further underscore the non-linear nature of the adjustment process. In some countries, the presence of positive coefficients suggests that the diffusion of technology can lead to immediate productivity gains, provided that the learning channels and the economy's absorptive capacity are sufficiently developed. However, the negative short-run effects observed in other contexts suggest that adopting foreign technologies initially increases production complexity and coordination costs before efficiency improvements are realized. This pattern is consistent with the recent body of evidence emphasizing delayed productivity effects of technology diffusion in the presence of institutional and skill constraints (Sandström et al., 2024; OECD, 2023).

In a similar vein, the volatility of short-run R&D coefficients mirrors the inherently forward-looking nature of innovation activities. Although a few cases have demonstrated positive short-term effects, indicating the potential of applied R&D to deliver immediate productivity benefits, the preponderance of negative coefficients in many countries suggests that R&D primarily functions as an investment cost in the short term. This interpretation is corroborated by recent empirical studies, which demonstrate that the productivity impact of R&D is predominantly realized over extended periods. The short-run effects of R&D are often weak or negative, owing to implementation and learning delays (Xu et al., 2023).

A comprehensive analysis of the short-run outcomes reveals that heterogeneous and asymmetric adjustment dynamics influence the convergence toward a long-run equilibrium

between trade openness and agricultural productivity. The short-term outcomes across countries are characterized by a combination of factors, including variations in adjustment speed, absorptive capacity, and institutional readiness. These elements contribute to the generation of mixed short-term outcomes (Hartwell, 2022). In line with recent empirical findings, these dynamics do not contradict the positive long-run relationship identified in this study; rather, they elucidate the mechanisms through which structural productivity gains from trade liberalization are gradually realized.

## CONCLUSION

This study undertakes a re-examination of the dynamic relationship between agricultural trade liberalization and agricultural TFP growth across. The findings of this study demonstrate that agricultural trade liberalization exerts a positive, statistically significant long-run effect on TFP growth. However, this effect is observed only in high-income countries. In these economies, strong absorptive capacity, sustained R&D investment, and effective technology diffusion enable trade liberalization to translate into productivity gains. Conversely, upper- and lower-middle-income countries have been observed to exhibit weak, insignificant, or negative long-term productivity outcomes. The short-run impacts of these policies are also highly heterogeneous. These results confirm the existence of a trade liberalization paradox in global agriculture. The extant literature does not support the hypothesis that trade liberalization automatically enhances productivity. The effectiveness of this approach depends on the nation's structural readiness and domestic innovation capacity. Absent these conditions, heightened exposure to international competition may amplify adjustment costs and impede productivity growth.

These findings offer clear policy implications. The pursuit of agricultural trade liberalization should be a deliberate and strategic endeavor, carefully aligned with the domestic structural readiness of the respective nation. It is incumbent upon policymakers in upper- and lower-middle-income countries to prioritize strengthening agricultural research and development (R&D) systems, the effective transfer of technology, and the extension of services to cultivate absorptive capacity prior to further trade liberalization. A coordinated strategy that integrates gradual liberalization with investment in innovation and macroeconomic stability is essential to ensure that trade liberalization translates into sustained agricultural productivity growth.

## REFERENCES

Almeida, E. O., Cateia, J. V., Barbosa, W., & de Freitas, C. A. (2024). Trade Liberalization and Total Factor Productivity in Brazil: A VECM Modeling. *PLoS ONE*, *19(*11), 0312599. https://doi.org/10.1371/journal.pone.0312599.

Anderson, K. (2022). Trade-Related Food Policies in A More Volatile Climate and Trade Environment. *Food Policy, 109*(3), 102253. https://doi.org/10.1016/j.foodpol.2022.102253.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.49654

Bai, Y., Jin, K., & Lu, D. (2024). Misallocation Under Trade Liberalization. *American Economic Review*, *114*(7), 1949–1985. https://doi.org/10.1257/aer.20200596.

Barros, L., & Martínez-Zarzoso, I. (2022). Systematic Literature Review on Trade Liberalization and Sustainable Development. *Sustainable Production and Consumption*, *33*(4), 921–931. https://doi.org/10.1016/j.spc.2022.08.012.

Bilgin, M. H. (2019). Trade Liberalization: Is It Desirable for All Developing Economies. *Research in World Economy*, *10*(3), 199–204. https://doi.org/10.5430/RWE.V10N3P199.

Chiarella, C., Meyfroidt, P., Abeygunawardane, D., & Conforti, P. (2023). Balancing the Trade-offs between Land Productivity, Labor Productivity, and Labor Intensity. *Ambio*, *52*(10), 1618–1634. https://doi.org/10.1007/s13280-023-01887-4.

Dai, M., Wang, G., Wang, J., Gao, Y., & Lu, Q. (2023). Study of the Spatial Spillover Effects of the Efficiency of Agricultural Product Circulation in Provinces Along The Belt and Road Under the Green Total Factor Productivity Framework. *Sustainability, 15*(16), 12560. https://doi.org/10.3390/su151612560.

Dinh, B. H., Phuc, H. N., Bui, T., & Nguyen, H. (2020). Declining Protection for Vietnamese Agriculture Under Trade Liberalization: Evidence from an Input-Output Analysis. *Economies*, *8*(2), 43. https://doi.org/10.3390/economies8020043.

Farrokhi, F., & Pellegrina, H. S. (2023). Trade, Technology, and Agricultural Productivity. *Journal of Political Economy*, *131*(9), 2509–2555. https://doi.org/10.1086/724319.

Fiankor, D., Haase, O. K., & Brümmer, B. (2021). The Heterogeneous Effects of Standards on Agricultural Trade Flows. *Journal of Agricultural Economics*, *72*(1), 25–46. https://doi.org/10.1111/1477-9552.12405.

Fuglie, K. (2018). R & D Capital, R & D Spillovers, and Productivity Growth in World Agriculture. *Applied Economic Perspectives and Policy*, *40*(3), 421–444. https://doi.org/10.1093/AEPP/PPX045.

Gollin, D. (2023). Agricultural Productivity and Structural Transformation: Evidence and Questions for African Development. *Oxford Development Studies*, *51*(4), 375–396. https://doi.org/10.1080/13600818.2023.2280638.

Graf, H., & Mohamed, H. (2023). Beyond Trading: Knowledge Spillovers and Learning by Exportingin Global Value. *Jena Economics Research Papers,* 2023-008, Friedrich Schiller-University Jena.

Hartwell, C. (2022). Institutions and Trade-Related Inequality. *International Journal of Finance and Economics*, *27*(3), 3246–3264. https://doi.org/10.1002/ijfe.2319.

Hung, N. T. (2021). Volatility Behaviour of the Foreign Exchange Rate and Transmission among Central and Eastern European Countries: Evidence from the EGARCH Model. *Global Business Review*, *22*(1), 36–56. https://doi.org/10.1177/0972150918811713.

Jabuya, D. O., Sule, F. O., & Ndwiga, M. J. (2023). The Effect of Agricultural Trade Openness on Economic Growth in the East African Community. *Cogent Economics and Finance*, *11*(2). https://doi.org/10.1080/23322039.2023.2250632

Liu, J., Wang, M., Yang, L., Rahman, S., & Sriboonchitta, S. (2020). Agricultural Productivity Growth and Its Determinants in South and Southeast Asian Countries. *Sustainability*, *12*(12), 4981. https://doi.org/10.3390/su12124981.

Luo, H., & Qu, X. (2023). Export Trade, Absorptive Capacity, and High-Quality Economic Development in China. *Systems*, *11*(2), 54. https://doi.org/10.3390/systems11020054.

Ma, Z., Wang, D., Feng, F., & Zhao, T. (2025). Moving Out of Agriculture: How Trade Liberalization Affects Agricultural Productivity in China. *China Economic Review*, *91*, 102388. https://doi.org/10.1016/j.chieco.2025.102388.

Martínez-Zarzoso, I., & Chelala, S. (2021). Trade Agreements and International Technology Transfer. *Review of World Economics*, *157*(3), 631–665. https://doi.org/10.1007/s10290-021-00420-7.

Pesaran, H. M., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association, 94*(446), 621–634. https://doi.org/10.1080/01621459.1999.10474156.

Sandström, V., Huan-Niemi, E., Niemi, J., & Kummu, M. (2024). Dependency on Imported Agricultural Inputs: Global Trade Patterns and Recent Trends. *Environmental Research: Food Systems*, *1*(1), 015002. https://doi.org/10.1088/2976-601x/ad325e.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, *39*(3), 312–320.

Sukoco, S., Hartono, D., & Patunru, A. (2020). The Impacts of Liberalization and Trade Facilitation on Economic Performance, Poverty, and Income Inequality: An Analytical Study. *Economic Journal of Emerging Markets*, *12*(1), 67–79. https://doi.org/10.20885/ejem.vol12.iss1.art6.

Sunge, R., & Ngepah, N. (2022). Agricultural Trade Liberalisation, Agricultural Total Factor Productivity Growth and Food Security in Africa. *Agrekon*, *61*(3), 292–313. https://doi.org/10.1080/03031853.2022.2066551.

Trakem, V., & Fan, H. (2024). Agricultural Trade Liberalization, Governance Quality, and Technical Efficiency in the Agricultural Sector of Southeast Asia. *Heliyon*, *10*(21), e39553. https://doi.org/10.1016/j.heliyon.2024.e39553.

Wang, J., Wang, C., & Wan, X. (2021). Trade Liberalization, Energy Saving Technological Change and Energy Intensity: Some Empirical Evidence from China. *Contemporary Economic Policy, 39*(2), 365–376. https://doi.org/10.1111/coep.12514.

Xu, J., Wang, Y., Zhao, X., Etuah, S., & Liu, Z. (2023). Can Agricultural Trade Improve Total Factor Productivity? Empirical Evidence from G20 Countries. *Frontiers in Sustainable Food Systems, 7,* 1100038. https://doi.org/10.3389/fsufs.2023.1100038.

Zhou, Y., & Ji, Y. (2022). Trade Policy Uncertainty, Innovation and Total Factor Productivity. *Sustainability*, *14*(1), 266. https://doi.org/10.3390/su14010266.

**Table 5. Short Run ARDL Estimation Results**

| High | | | | Middle upper | | | | Middle lower | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negara | Agr_TO | Tech_trf | R&D | Negara | Agr_TO | Tech_trf | R&D | Negara | Agr_TO | Tech_trf | R&D |
| United States | - | - | - | China | - | - | -0.13** (0.024) | India | - | - | - |
| France | 0.08** (0.05) | 0.002** (0.017) | -0.27** (0.014) | Brazil | -0.29*** (0.000) | 2.48** (0.002) | 2.23*** (0.000) | Indonesia | -0.-19** (0.016) | 0.225** (0.05) | - |
| Australia | -0.13*** (0.000) | -0.13* (0.067) | (0.42** (0.015) | Russia | -0.48* (0.083) | 0.145* (0.064) | - | Nigeria | - | - | 2.778** (0.033) |
| Japan | - | - | 0.089* (0.053) | Argentina | - | - | -1.15** (0.007) | Pakistan | - | 0.097* (0.076) | - |
| Italy | - | - | -0.88** (0.044) | Turkey | - | -0.18*** (0.000) | 0.248** (0.016) | Bangladesh | - | - | - |
| Spain | - | 0.24*** (0.003) | 0.80*** (0.003) | Mexico | 0.043*** (0.000) | -0.091** (0.015) | -0.288** (0.007) | Vietnam | - | 0.089* (0.085) | -1.203** (0.045) |
| Korea | - | - | - | Iran | -0.08*** (0.000) | 0.85*** (0.000) | -1.08*** (0.000) | Philippines | 0.156* (0.066) | - | 1.742* (0.069) |
| Canada | -0.06** (0.046) | - | -1.39* (0.072) | Thailand | -0.03*** (0.000) | 0.139*** (0.000) | 0.47*** (0.000) | Kenya | 0.021*** (0.000) | 0.216*** (0.008) | -2.598*** (0.000) |
| Germany | 0.015** (0.012) | -0.17** (0.030) | - | Malaysia | - | 0.105* (0.064) | - | Egypt | - | -0.165** (0.018) | 0.703*** (0.004) |
| United Kingdom | - | 0.41*** (0.000) | 0.19* (0.098) | Colombia | - | -0.168** (0.041) | 1.12** (0.019) | Morocco | - | - | - |
| Netherland | - | 0.25** (0.024) | -0.22* (0.097) | Peru | -.024** (0.036) | - | - | Ukraina | -0.29*** (0.000) | 0.154*** (0.000) | 0.373** (0.031) |
| Poland | 0.012** (0.014) | 0.018*** (0.000) | 0.038*** (0.000) | | | | | | | | |
| Chile | 0.01*** (0.000) | 0.012** (0.013) | - | | | | | | | | |

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# The Role of Fertilizer Subsidies in Rice Productivity and Profitability: Evidence from Indonesian Smallholder Farmers

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## ABSTRACT

**Research Originality**: This study provides micro-level evidence on the dual effects of fertilizer subsidies on rice farmers' production and profitability, a dimension rarely examined simultaneously at the household level in Indonesia. Using data from two contrasting rice-producing regions, the study isolates subsidy effects on both physical output and farm profit while controlling for input costs and price conditions.

**Research Objectives**: To analyze the effects of fertilizer subsidies on rice production and farm profit in Karawang (West Java) and Lombok (West Nusa Tenggara).

**Research Methods**: OLS regression was applied to cross-sectional data from 51 rice-farming households. Two models were estimated: a production function and a profit function.

**Empirical Results:** Fertilizer quantity, land size, and labor positively influence rice production. Farm profit is significantly affected by production quantity, rice price, total cost, and pesticide cost. Fertilizer cost is not a significant determinant of profit.

**Implications**: Fertilizer quantity, not cost, drives production. Subsidies should be maintained but reoriented toward targeted, quantity-based schemes and improved distribution efficiency to maximize welfare impact.

**Keywords:**
inputs; profit; production; welfare

**How to Cite:**

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## INTRODUCTION

The agricultural sector remains a major absorber of labor and plays a critical role in Indonesia's national food security. Accordingly, input subsidy policies, particularly fertilizer subsidies, have been maintained in Indonesia for more than five decades (Osorio, 2023). Fertilizer subsidies are intended to reduce fertilizer prices at the farm level, encourage the use of inorganic fertilizer, increase land productivity, and ultimately improve farmers' household income and welfare (Osorio, 2023). In various developing countries, including Malawi, Zambia, Tanzania, Mozambique, Ethiopia, Nigeria, Ghana, India, and Nepal, fertilizer and seed subsidy programs have been shown to increase yields and farm income by approximately 10–20 percent on average (Hemming et al., 2018; Nguyen, 2023).

Several studies in Indonesia indicate that the productivity or income gap between subsidy recipients and non-recipients in several locations remains within the range of only about 5–10 percent lower than the estimated 10–20 percent effects reported in international meta-analyses of input subsidy programs in low- and lower-middle-income countries (Hemming et al., 2018; Nguyen, 2023; Wildayana, 2017). The magnitude of fertilizer subsidy impacts in Indonesia also varies substantially across regions, commodities, and years of observation. It is strongly influenced by distributional issues such as delays, quota limitations, and mistargeting, as identified in numerous studies on subsidized fertilizer policies (PATTIRO, 2023). These challenges have the potential to weaken the subsidy's effects on production and farmer welfare (PATTIRO, 2023; Arodha, 2024; Goacademica, 2024).

A range of studies in Indonesia have examined the influence of fertilizer subsidies on rice production and farmers' income at both provincial and national levels (Wildayana, 2017; Prasetyo, 2024; Zulfikar et al., 2024). Common findings suggest that fertilizer subsidies can increase production or yield per hectare. However, the increase in farmers' profits does not always correspond to the rise in production due to fluctuations in output prices, the cost of other production factors, and varying levels of technical efficiency (Wildayana, 2017). Several recent studies in Aceh and West Java also emphasize that restrictions and reductions in subsidized fertilizer allocations may disrupt production and undermine the role of subsidies as an income safety net for farmers, although the eventual welfare impacts remain heterogeneous across locations and farmer types (Zulfikar et al., 2024; Rahmawati & Nurhidayah, 2024).

Despite the growing body of literature on fertilizer subsidies, most existing studies are conducted at the macro or regional level, focusing on aggregate production outcomes or policy cost-efficiency rather than on individual farm-level performance. Evidence from Bangladesh shows that fertilizer subsidies improved farm efficiency primarily for marginal and small farms, whereas the effect was less pronounced for medium and large farms (Nasrin et al., 2018). Similarly, in Pakistan, subsidized fertilizer enabled farmers to apply recommended input doses, resulting in measurable yield gains for wheat and rice crops, with broader implications for household welfare (Ali et al., 2019).


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In Indonesia, studies confirm that subsidized fertilizer use among recipient farmers affects urea and NPK application rates, though the relationship between input use and farm outcomes is not always linear (Januarisky et al., 2025). At the same time, evidence from Mali suggests that poorly designed subsidy programs can produce unintended consequences, including reduced crop species diversity as farmers concentrate land use on subsidized target crops (Theriault & Smale, 2021). From a governance perspective, Malaysia's experience highlights that achieving sustainable development goals through fertilizer subsidy programs requires a robust regulatory framework, as weak governance mechanisms undermine the effectiveness of subsidy distribution (Amin et al., 2022).

Beyond direct subsidy studies, research on nutrient management systems provides complementary insights. In China, the Nutrient Expert advisory system demonstrated that optimizing fertilizer recommendations can simultaneously improve productivity, profitability, and sustainability, increasing net profits while reducing nitrogen application (Xu et al., 2023). Likewise, long-term assessments of diverse nutrient management strategies in rice-rice cropping systems in India over 16 years confirmed that integrated nutrient management improves yield trends, resource-use efficiency, and economic viability (Garnaik et al., 2024). In the Philippines, soil-test-based fertilizer application under improved nutrient management practices increased rice productivity and profitability compared to conventional farmer practices (Rollon et al., 2021). Precision nutrient management approaches in Indonesia further demonstrated rice yield enhancements alongside improvements in environmental sustainability (Jauhari et al., 2025), while site-specific nutrient management in India has been shown to enhance yields and contribute to greenhouse gas mitigation (Chaudhary et al., 2025). Notably, in China's rice sector, subsidies have been found to affect allocative efficiency differently across farm sizes, with large farms experiencing efficiency distortions that smaller farms do not (Cai et al., 2025). Together, these studies offer partial but fragmented evidence that subsidies and improved nutrient management affect production and profitability. Yet, they rarely examine both outcomes simultaneously within the same household-level analytical framework.

Based on prior research, three specific gaps remain in the literature. First, empirical studies that simultaneously assess the impact of fertilizer subsidies on both farm production and farm profitability at the household level are scarce. Most studies treat these as separate outcomes rather than as linked dimensions of farm performance (Nasrin et al., 2018; Rollon et al., 2021; Xu et al., 2023). Second, the distinction between subsidies acting primarily as instruments of production intensification or profit enhancement has not been clearly established, particularly in smallholder rice-farming contexts (Ali et al., 2019; Januarisky et al., 2025). Third, existing studies rarely apply a rigorous comparative framework between subsidy recipients and non-recipients using micro-level data with adequate controls for farm size, labor, and complementary input use, making causal attribution of the subsidy's effects difficult (Cai et al., 2025; Theriault & Smale, 2021; Amin et al., 2022).

Input subsidies generally increase yields and income, but their effectiveness depends heavily on program design, targeting, and implementation (Hemming et al., 2018;

Nguyen, 2023). The long-term impacts of fertilizer subsidies on input-use efficiency, potential farmer dependency, and environmental sustainability further underscore the need for more comprehensive research on farmers' welfare, rather than relying solely on production indicators (Druilhe & Barreiro Hurlé, 2012; Ricome et al., 2024; Yovo & Ganiyou, 2023). Amid these developments, there remains limited research that explicitly separates and estimates the effects of fertilizer subsidies on two key dimensions of farmers' welfare, namely physical production and farm profits at the household level, while accounting for the cost structure and price conditions faced by farmers (Wildayana, 2017).

In addition, more detailed empirical evidence is required for specific commodities and regions in Indonesia to determine whether fertilizer subsidies truly function as instruments to improve farmer welfare or merely stimulate production without generating commensurate gains in profits (Zulfikar et al., 2024; Rahmawati & Nurhidayah, 2024). To date, studies specifically analyzing the effects of subsidized fertilizer use on farmers' production and profits in key rice-producing areas such as Karawang (West Java) and strategically important food-producing regions such as Lombok (West Nusa Tenggara) remain highly limited, leaving a critical gap that this study seeks to address.

This study addresses these gaps by adopting an integrated household-level analytical framework that simultaneously examines the effects of fertilizer subsidies on both rice production levels and farm profits. By comparing subsidy recipients and non-recipients using micro-level farm data and controlling for key confounding factors, including land size, labor input, and the use of complementary inputs, the study provides more rigorous causal evidence than prior aggregate-level analyses. Furthermore, this study explicitly tests whether subsidies function as drivers of productivity or as welfare instruments through profit enhancement. This distinction carries significant implications for subsidy policy design and targeting.

This study examines the impact of fertilizer subsidies on agricultural sector performance by focusing on two key indicators: farm production and farmer profits. The analysis is conducted at the farmer/household level, enabling direct measurement of the subsidy's influence on input costs, revenues, and profit margins. Empirically, the study uses micro-level data on both subsidy recipients and non-recipients, allowing estimation of differences in production and profits associated with access to subsidized fertilizer while controlling for other factors such as land size, labor, and the use of complementary inputs. This approach enables an assessment of whether fertilizer subsidies primarily function as drivers of production intensification or as instruments for profit enhancement, as a proxy for farmer welfare, and whether there are indications of inefficiency or dependency that may weaken the policy's benefits.

Accordingly, the findings are expected to provide richer evidence on the effectiveness of fertilizer subsidies as a policy instrument for protecting and empowering smallholder farmers, while also informing the design and targeting of future subsidy programs. Based on this rationale, the objective of this study is to analyze the effects of fertilizer subsidies on farmers' production levels and farm profits in rice cultivation, and to formulate policy implications for improving future subsidy interventions.


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## METHODS

This study employs quantitative cross-sectional data obtained from a household-level survey of rice farmers conducted in two study areas: Karawang Regency (West Java Province) and Lombok Island (West Nusa Tenggara Province). The use of two geographically distinct locations is intentional, as it allows for comparative analysis across regions with differing agronomic conditions, subsidy implementation dynamics, and farming system characteristics.

Primary data were collected directly from farmer respondents and constitute the main analytical dataset. The primary data encompass: (1) household and farm characteristics, including the respondent's age, level of formal education, years of farming experience, and cultivated land size; (2) fertilizer use variables, specifically the quantity of subsidized urea and NPK fertilizer received and applied, as well as the use of non-subsidized fertilizers; (3) other production inputs, including seed quantity, labor hours (family and hired), and pesticide use; (4) rice production output, measured in kilograms per planting season per hectare; and (5) economic variables, including input purchase prices, output (paddy) selling prices, total production costs, and gross farm revenues from which farm profit is derived as the primary welfare proxy variable.

Secondary data were used as complementary sources to contextualize primary findings and to validate farm-level information. These include data on subsidized fertilizer allocation quotas per district, government-regulated Highest Retail Prices for subsidized fertilizers, and regional agricultural profiles at the district level. Secondary data were obtained from local agricultural offices at the district and provincial levels, as well as from official government publications, including regional agricultural statistics and subsidy implementation reports issued by the relevant authorities.

Karawang Regency and Lombok Island were selected purposively as study locations based on two considerations: first, both represent major rice-producing regions Karawang as one of the most productive wetland rice areas in Java, and Lombok as a strategically important food-producing region outside Java; and second, both regions exhibit distinct dynamics in the implementation of fertilizer subsidy programs, providing an opportunity to capture variation in subsidy access and utilization across different policy and institutional contexts.

Farmer samples were selected using a multistage sampling technique. In the first stage, subdistricts and villages were purposively selected based on their designation as rice production centers within each study area, in coordination with local agricultural extension offices. In the second stage, individual farmer households were randomly selected from the available sampling frames, namely, farmer group membership lists (RDKK or village-level subsidized fertilizer recipient registries. This approach ensures that the sample captures both subsidy recipients and, where applicable, non-recipients, enabling direct comparison between the two groups in the analytical stage.

This study employs two complementary analytical approaches to estimate the effects of fertilizer subsidies on rice farm production and profitability, respectively. First, to

estimate the effects of farm inputs, including subsidized fertilizer, on rice production output, the study uses a Cobb-Douglas production function estimated via Ordinary Least Squares (OLS) regression on cross-sectional data. The Cobb-Douglas specification is appropriate for agricultural production analysis because it captures diminishing marginal returns to individual inputs and allows direct interpretation of the coefficients as output elasticities.

The study sample consists of 51 wetland rice farmers observed in two main locations, namely Karawang Regency (West Java) and Lombok (West Nusa Tenggara The dependent variable is rice production per planting season ($Y_i$), while the independent variables consist of cultivated rice field area ($X_{1i}$), total amount of subsidized fertilizer used (urea+NPK, $X_{2i}$), pesticide costs ($X_{3i}$), and the amount of labor used ($X_{4i}$).

Functionally, the estimated rice production model can be expressed as follows:

$$Y_i = \beta_0 + \beta_1 X_{\{1i\}} + \beta_2 X_{\{2i\}} + \beta_3 X_{\{3i\}} + \beta_4 X_{\{4i\}} + \varepsilon_i \quad (1)$$

where $Y_i$ is the rice production of farmer i, $\beta_0$ is the intercept, $\beta_1 - \beta_4$ is the regression coefficient that measures the average change in production resulting from a one-unit change in the corresponding input, and $\varepsilon_i$ is the error term that captures other factors outside the model. The estimation was carried out using OLS in Stata software, such that the parameters are obtained by minimizing the sum of squared residuals $\sum_i \hat{\varepsilon}_i^2$.

Second, to estimate the effect of fertilizer subsidies on farm profit, this study uses an OLS regression on a profit function in which farm profit per hectare (calculated as total revenue minus total production costs) serves as the dependent variable. Farm profit is specified as a function of subsidized fertilizer receipt status, land size, labor, farming experience, education, and other relevant control variables. This dual-model approach, in which the production function and profit function are estimated separately, allows the study to explicitly distinguish whether subsidies operate primarily as instruments of production intensification (through input access) or as profit enhancement instruments (through cost reduction and income improvement), directly addressing the central research question. The rice farming profit function is modeled as follows:

$$\pi_i = \alpha_0 + \alpha_1 Q_i + \alpha_2 P_{\{rice,i\}} + \alpha_3 C_{\{tot,i\}} + \alpha_4 C_{\{fert,i\}} + \alpha_5 C_{\{pest,i\}} + \alpha_6 C_{\{seed,i\}} + u_i \quad (2)$$

where $\pi_i$ = is the rice farming profit of farmer i (profit), $Q_i$ = rice production, $P_{rice,i}$ = the farm-gate paddy price, $C_{tot,i}$ = total farming costs, $C_{fert,\ i,}$ = total subsidized fertilizer costs, $C_{pest,i}$ = pesticide costs, $C_{seed,i}$ = seed costs, and $\alpha_0$ = intercept, $\alpha_1$, ..., $\alpha_6$ = regression coefficient, dan $u_i$ = error term.

Fertilizer subsidies reduce the input prices faced by farmers, which theoretically shift the cost function downward, encourage an increase in the quantity of inputs used, and, in turn, raise production and potential profits. From the perspective of profit-maximization theory, producers choose the combination of inputs that maximizes the difference between revenue and cost; when fertilizer prices are lowered through subsidies, the optimal input


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combination shifts toward higher fertilizer use, thereby potentially increasing profits as long as the additional revenue exceeds the additional costs of other inputs.

## RESULTS AND DISCUSSION

The characteristics of rice farmers in this study indicate that respondents are, on average, middle-aged, with a wide age distribution that includes young and elderly farmers, each with different physical capacities and levels of experience. The average age of farmers is 51, with the oldest being 75. This finding aligns with BPS data. According to the 2023 Agricultural Census, the majority of Indonesian farmers are already in the older age category, predominantly above 55 years, while the proportion of young (millennial) farmers continues to decline (approximately 21.93 percent aged 19–39). This data indicates a regeneration challenge, with a large share of farmers aged 45 and above (around 71 percent) and only a small portion below 45 years, resulting in an average farmer age of about 50 years (Appendix 1). The average level of formal education is approximately nine years (equivalent to junior secondary school), which is generally adequate to understand basic technical information and adopt agricultural innovations. Farmers also have extensive experience in rice cultivation, reflecting strong practical knowledge. Most respondents manage less than one hectare of rice land, indicating that smallholders dominate the farming structure, although a few cultivate larger areas. The distance to fertilizer kiosks varies substantially, from a few dozen to several thousand meters, implying differences in accessibility, potential delays in fertilizer application, and transportation cost burdens.

In terms of technical and economic aspects of rice farming, seed use per planting season reflects a combination of land size and variation in seed quality, as shown by differences in per-kilogram prices and total seed expenditures. Subsidized urea and NPK fertilizers constitute the principal inputs with relatively uniform unit prices. However, the quantities applied vary considerably, suggesting that some farmers apply fertilizer at rates below recommended levels while others practice intensive fertilization. Total fertilizer expenditure (urea + NPK) is one of the largest variable cost components, alongside labor, tractor services, and land size, making fertilization decisions highly influential on production costs and potentially affecting both technical and financial efficiency.

Beyond fertilizers, expenditures on pesticides, tractor services, and labor also show wide variation, reflecting differences in pest pressure, land preparation methods, crop management intensity, and farm scale. These combinations of inputs generate average rice harvests per planting season that are relatively high yet heterogeneous across farmers. In contrast, farmers' grain prices are generally uniform, with minor variations linked to quality and marketing channels. Overall, the nominal farm revenue far exceeds total production costs, indicating that rice farming within the sample tends to be profitable.

The amount of subsidized fertilizer redeemed by lowland rice farmers in Karawang and Lombok shows a clear upward trend in line with the increase in cultivated land area. Among farmers with less than 0.5 hectares of land, the total amount of subsidized fertilizer (urea and NPK combined) redeemed per planting season averages approximately

96 kilograms, with usage ranging from 19 to 200 kilograms. This variation indicates that even within small landholdings, there are notable differences in fertilization practices, ranging from relatively low application to levels approaching the upper limit of the group (Appendix 2). For farmers with land between 0.5 and 1 hectare, the average amount of subsidized fertilizer redeemed increases sharply to around 333 kilograms per planting season. The minimum of 100 kilograms and the maximum of 600 kilograms demonstrate that nearly all farmers in this land category use significantly more subsidized fertilizer than smallholders. The relatively high standard deviation reflects heterogeneous fertilization strategies, suggesting that some farmers may follow moderate recommended doses while others apply fertilizer more intensively.

Among farmers cultivating more than 1 hectare, the total amount of subsidized fertilizer redeemed is the highest, averaging about 712.5 kilograms per planting season. The broad usage range from 200 to 2,000 kilograms indicates that this group includes farmers applying moderate to very large quantities of fertilizer. Such variation may be associated with differences in capital capacity, production objectives, and preferences regarding fertilization intensity among large-scale farmers. When urea and NPK are examined separately, the patterns are consistent with total subsidized fertilizer usage. Average urea redemption increases from approximately 47 kilograms for farmers with less than 0.5 hectares, to 175 kilograms for the 0.5–1 hectare group, and 337.5 kilograms for farmers with more than 1 hectare. Meanwhile, average NPK redemption stands at around 48.9 kilograms, 158.3 kilograms, and 375 kilograms for the respective land-size categories. These figures indicate that increases in total subsidized fertilizer use are driven by simultaneous increases in both urea and NPK, rather than by increases in only one. Thus, farmers operating larger land areas tend to apply fertilizers more intensively and in a more balanced manner between urea and NPK.

The table showing urea and NPK dosage by compliance with recommended rates shows that sampled farmers fall into three groups: those applying fertilizer below the recommended rate, those applying fertilizer in accordance with the recommended rate, and those applying fertilizer above the recommended rate. In the "below recommendation" group, the average urea dosage applied is approximately 136 kg/ha, ranging from 50 to 181.8 kg/ha. In comparison, the average NPK dosage is about 116 kg/ha within a similar range. These averages are explicitly lower than those in the "in accordance with recommendation" category, reflecting farmers who either still economize on subsidized fertilizer use or face access constraints that prevent them from reaching recommended dosage levels.

The "in accordance with recommendation" group uses an average of about 228 kg/ha of urea, with a range of 200–285.7 kg/ha, while the average NPK dosage is around 229 kg/ha, with a range of 200–300 kg/ha. These figures are classified as compliant because they fall within the government's recommended range, referenced in this study, of around 200–300 kg/ha for both urea and compound NPK fertilizers in medium-productivity irrigated rice fields. These recommendations are stipulated in the Regulation of the Minister of Agriculture No. 40/Permentan/OT.140/4/2007 on Nitrogen, Phosphorus, and


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Potassium Fertilization Recommendations for Site-Specific Lowland Rice, as well as its technical manuals. Thus, this group can be regarded as representing farmers who follow the official technical guidelines in practice.

Meanwhile, the "above recommendation" group displays substantially higher fertilization intensity. The average urea dosage reaches approximately 370 kg/ha, with a range of 307.7–500 kg/ha, while the average NPK dosage is about 361 kg/ha, ranging from 307.7 to 428.6 kg/ha. Compared with the compliant group, farmers in this category apply around 140 kg/ha more urea and 130 kg/ha more NPK than the recommended averages. This condition indicates a tendency toward over-fertilization among some farmers, potentially driven by the perception that higher fertilizer quantities always lead to higher yields, even though such practices are not necessarily agronomically or economically efficient (Appendix 3). Overall, the distribution of urea and NPK dosages relative to recommendations indicates that the sample includes farmers who have not yet met the fertilization guidelines, those who adhere to government guidance, and those who apply fertilizer excessively. Categorization based on the 200–300 kg/ha benchmark set by Ministerial Regulation No. 40/2007 and the manual "Site-Specific Recommendations for N, P, and K Fertilizers for Lowland Rice" enables researchers to assess the extent to which fertilization recommendation policies are implemented at the farm level.

The tabulation results indicate that most farmers in the sample have not applied both subsidized fertilizers (urea and NPK) simultaneously at the recommended rates. Among farmers whose urea dosage falls below the recommendation, approximately 73.08 percent also applied NPK below the recommended level. In comparison, 23.08 percent applied NPK in line with the recommendation, and none applied NPK above the recommendation (Appendix 4). This pattern reflects a group of farmers who generally underutilize both urea and NPK fertilizers. However, about one-quarter have begun to adjust their NPK dosage toward the recommended guidelines.

Within the group of farmers whose urea application matches the recommendation, 80 percent apply NPK in accordance with the recommendation, while 13.33 percent remain below the recommendation and 6.67 percent exceed it. This pattern suggests that once farmers align their urea dosage with official recommendations, most also follow the recommended NPK dosage, resulting in a relatively balanced pattern of subsidized fertilizer use. The most intensive group comprises farmers who exceed the recommended urea dosage. Among them, 70 percent apply NPK above the recommendation, 30 percent apply NPK in line with the recommendation, and none fall into the below-recommendation category for either fertilizer. These findings indicate a tendency among some farmers to apply both types of subsidized fertilizers simultaneously at high doses, which may technically exceed the crop's agronomically optimal requirement.

The comparative data on costs, production, and revenue per hectare across land-size categories reveal substantial differences in rice farming performance. For farmers cultivating less than 0.5 hectares, the average cost per hectare is approximately IDR 11.37 million, with considerable variability, and yields around 7.93 tons of paddy per hectare, with revenue of roughly IDR 49.52 million per hectare. Meanwhile, farmers with landholdings

of 0.5–1 hectare incur slightly lower per-hectare costs, at around IDR 9.96 million, with an average yield of approximately 6.35 tons per hectare and revenue of about IDR 42.95 million per hectare (Appendix 5).

In contrast, farmers with more than 1 hectare exhibit even lower per-hectare costs around IDR 5.72 million, but their average yield declines to about 3.68 tons per hectare, resulting in revenue of approximately IDR 25.23 million per hectare. This pattern suggests that smallholders tend to incur higher per-hectare input costs but also achieve higher yields and revenue compared with farmers operating larger land areas. From an economic perspective, these results imply differences in input intensity and farm management practices. On small plots, inputs and labor are likely used more intensively, thereby generating higher productivity per hectare. Conversely, on larger plots, lower input intensity is associated with reduced costs, production, and revenue per hectare.

The Cobb-Douglas regression reveals that three of four independent variables exert statistically significant positive effects on rice production in Karawang and Lombok: paddy field area, total amount of subsidized fertilizer, and labor. It confirms that land is a foundational productive input in smallholder rice farming, and that subsidized fertilizer is the most influential production factor in this model. Where greater access to subsidized inputs enables farmers to apply fertilizer at levels closer to agronomically recommended doses, thereby improving yields. Besides, the result also reflects the labor-intensive nature of rice cultivation across key stages of the production cycle. In contrast, pesticide costs do not reach statistical significance, suggesting that in the study areas, variations in pesticide expenditure do not translate into measurable differences in rice output, possibly due to relatively uniform pest pressure or inconsistent application practices across respondents.

The finding that paddy field area exerts a significant positive effect on rice production is consistent with a substantial body of empirical literature. Chandio et al. (2022) demonstrated that land area is among the most influential factors determining rice output in Asian farming systems, where expanded cultivation area directly increases productive capacity. Similar evidence was documented in sub-Saharan contexts: Basorun and Fasakin (2012) found that the size of cultivated land was a primary driver of rice production performance among smallholder farmers in Nigeria, confirming that larger farm areas enable greater resource absorption and yield generation. At the farm management level, Salam et al. (2024) employed a Cobb-Douglas production function framework and confirmed that land area allocation is a statistically significant determinant of rice output, with an output elasticity indicating positive returns to land expansion. These findings collectively affirm that, in smallholder rice farming systems such as those in Karawang and Lombok, access to and utilization of paddy land remain foundational conditions for production improvement.

These findings are also consistent with the study by Putra et al. (2018) regarding urea fertilizer, which showed a positive and significant impact on rice production. The regression coefficient in Putra et al. (2018) was higher than in this study, at 0.528,


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indicating that a 1 percent increase in urea application would increase rice production by 0.52 percent. In contrast, their findings for NPK indicated a negative, non-significant effect, suggesting that NPK application did not significantly increase production. While chemical fertilizers and subsidies increase rice productivity, the claim that subsidies alone achieved 6.4 tons/ha is not directly supported by the abstracts. However, optimized fertilization strategies, including subsidies, can enhance yield and sustainability (Guo et al., 2021; Iqbal et al., 2022; Kadigi, 2026; Kundu & Mallick, 2024; Pan et al., 2022; Wu et al., 2025; Xin, 2022).

**Table 1. Cobb–Douglas Model Analysis of the Impact of Fertilizer on Rice Production in Karawang and Lombok**

| Variable independent | Coef. |
|---|---|
| Paddy field area | .27* |
| Total amount of subsidized fertilizer | .306** |
| Pesticide cost | .082 |
| Labor use | .156* |
| Constant | 2.236*** |

R-squared: 0.707
*** p<.01, ** p<.05, * p<.1
Source: Primary Data (processed)

The positive and significant effect of subsidized fertilizer on rice production found in this study aligns with existing evidence on the role of fertilizer access in smallholder agricultural productivity. Yardha et al. (2021) identified fertilizer availability as a key factor influencing production risk in rice farming in Indonesia, where restricted access to inputs was associated with increased output variability and reduced yields. The centrality of subsidized fertilizer in ensuring affordability and accessibility for resource-constrained farmers is particularly emphasized by Olubanjo and Oyebanjo (2008), who found that fertilizer use was among the most significant determinants of profitability in rain-fed paddy production, underscoring fertilizer's dual role as both a productivity and an income-enhancing instrument.

The fertilizer-enhancing mechanism is further elaborated in agronomic studies. Takahashi et al. (2025) showed that optimized fertilizer application methods, including basal dressing techniques, significantly improved paddy yields while simultaneously reducing labor requirements associated with repeated topdressing. Controlled-release nitrogen fertilizers offer yield advantages in paddy cultivation by supplying nutrients in alignment with crop demand, thereby reducing losses associated with conventional single-application methods. Furthermore, Jiang-ming (2023) cautioned that while fertilizer application is essential for yield maximization, the manner of application critically determines nutrient use efficiency, with split-application strategies shown to reduce potential nutrient losses from paddy fields while sustaining production levels. Taken together, these findings suggest that the productivity impact of subsidized fertilizer in this study reflects not only the

quantity of fertilizer received but also its role in enabling farmers to meet recommended application thresholds that would otherwise be cost-prohibitive without subsidy support.

Yusriah et al. (2024) found different results in Gorontalo: a 1% increase in fertilizer use slightly reduced rice production by 0.087% in Limboto District, assuming other factors remain constant. Meanwhile, Nizar and Ariyanto (2016) showed that subsidized NPK fertilizer and pre-harvest labor significantly increased rice production in Riau Province. However, the elasticity value of 0.622 indicates decreasing returns to scale, meaning additional fertilizer use produced less than proportional output gains, suggesting inefficiency and overuse of inputs. Other studies (Adhikary et al., 2023; Chang et al., 2024; Naghdyzadegan Jahromi et al., 2023; Phillips et al., 2022; Tan et al., 2025; Yang et al., 2022) highlight that improving nitrogen availability is more effective when combining good water management with organic matter. This approach increases efficiency, supports soil health, and reduces environmental impact compared to simply increasing chemical fertilizer use. Therefore, applying organic fertilizers based on land conditions is important. It can maintain or increase yields, reduce dependence on chemical inputs, and improve long-term soil quality. Overall, these findings suggest that some farmers still use chemical fertilizers inefficiently, with significant variation in fertilizer practices across regions in Indonesia.

**Table 2. Variation in Location and Use of Fertilizers and Other Inputs for Rice Production**

| Provinsi | Benih | Organik | Urea | TSP | KCL | Obat | Pestisida | TK | Provinsi | Benih | Organik | Urea | TSP | KCL | Obat | Pestisida | TK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aceh | 1.24 | 0.00 | 0.60 | 0.06 | 0.00 | 0.04 | 0.00 | -0.04 | NTB | 1.35 | 0.00 | 1.85 | 0.40 | 0.01 | 0.07 | -0.09 | -0.46 |
| Sumut | -0.76 | | 1.59 | -0.20 | -0.03 | -0.15 | 0.01 | -0.02 | NTT | 0.98 | 0.00 | 0.01 | 0.23 | -0.03 | 0.03 | 0.03 | -0.06 |
| Sumbar | -1.81 | -0.06 | 1.20 | -0.40 | 0.01 | 0.03 | -0.01 | 0.26 | Kalbar | 1.90 | | -0.46 | 0.24 | 0.06 | -0.17 | 0.06 | 0.02 |
| Riau | 2.76 | | 0.01 | -0.10 | 0.45 | 0.02 | 0.25 | -2.07 | Kalteng | 1.13 | 0.01 | 3.25 | -1.63 | 0.00 | -0.14 | 0.44 | 0.73 |
| Jambi | 1.42 | | 0.29 | 0.35 | -0.29 | -0.02 | -0.05 | -0.18 | Kalsel | 1.24 | | 0.35 | 0.04 | -0.01 | -0.04 | -0.09 | 0.25 |
| Sumsel | 0.68 | 0.01 | 0.83 | -0.06 | 0.01 | -0.04 | -0.20 | 0.08 | Kaltim | -0.91 | -0.01 | 0.71 | -0.16 | 0.07 | 0.02 | 0.19 | -0.03 |
| Bengkulu | -1.59 | 0.00 | 1.26 | -0.98 | -0.25 | -0.07 | -0.20 | 0.05 | Sulut | -0.21 | 0.00 | 0.74 | 0.26 | 0.10 | 0.10 | -0.08 | -0.18 |
| Lampung | -0.23 | 0.00 | 0.64 | 0.19 | -0.01 | -0.01 | -0.04 | 0.06 | Sulteng | 0.47 | 0.03 | 0.96 | -0.21 | 0.00 | -0.05 | -0.08 | 0.26 |
| Babel | 3.75 | 0.00 | -0.83 | -0.17 | -0.14 | 0.57 | -0.02 | -0.33 | Sulsel | 2.28 | 0.00 | 0.58 | -0.51 | -0.01 | -0.11 | 0.07 | 0.11 |
| Kepri | 1.12 | | 0.04 | 1.39 | -1.77 | -0.07 | | -0.25 | Sultra | 0.11 | 0.00 | 1.00 | -0.09 | -0.10 | 0.01 | 0.04 | -0.01 |
| Jakarta | -3.78 | | -1.08 | 2.01 | 0.32 | 0.54 | -0.06 | 0.36 | Gorontalo | -0.99 | 0.02 | 0.38 | 0.09 | 0.12 | -0.01 | 0.00 | 0.14 |
| Jabar | -0.85 | 0.00 | 0.00 | 0.40 | -0.17 | -0.10 | 0.06 | 0.14 | Sulbar | 4.05 | 0.86 | 1.20 | -0.01 | 0.04 | 0.36 | -0.81 | 1.10 |
| Jateng | 4.60 | 0.09 | 4.78 | 1.06 | 0.30 | -0.12 | 0.17 | -1.21 | Maluku | -1.73 | 0.04 | 0.29 | -0.18 | 0.01 | 0.02 | 0.07 | 0.12 |
| DIY | 0.38 | 0.00 | 0.12 | -0.01 | 0.04 | 0.12 | -0.02 | -0.06 | Malut | -0.20 | | -0.44 | -0.01 | -0.07 | -0.02 | 0.16 | 0.38 |
| Jatim | 3.83 | | -0.92 | -0.61 | 0.25 | 0.03 | 0.28 | -0.24 | Papua Barat | 0.76 | | 0.35 | -0.01 | 0.00 | 0.10 | -0.01 | 0.37 |
| Banten | -0.40 | 0.02 | -1.07 | 0.89 | 0.04 | -0.02 | -0.01 | 0.11 | Papua | -1.60 | | 0.20 | -0.04 | 0.00 | -0.02 | 0.06 | 0.30 |
| Bali | 0.23 | 0.00 | 1.54 | 0.09 | 0.06 | -0.09 | 0.00 | 0.10 | | | | | | | | | |

e>1 (Irrasional)
e<0 (Irrasional)
0<e<1 (Rasional

| Jenis Input | Benih | Organik | Urea | TSP | KCL | Obat | Pestisida | TK |
|---|---|---|---|---|---|---|---|---|
| e < 0 | 39% | 27% | 22% | 56% | 50% | 55% | 48% | 3% |
| 0 ≤ e ≤ 1 | 21% | 73% | 50% | 34% | 50% | 45% | 52% | 55% |
| e > 1 | 39% | 0% | 28% | 9% | 0% | 0% | 0% | 42% |

Source: Firdaus (2018)

There are regions where the use of rice production inputs remains economically irrational, particularly for seeds, urea, and TSP (e > 1). In contrast, the use of organic


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fertilizers is entirely economically rational. In rice production, irrational use of urea fertilizer was identified in North Sumatra, West Sumatra, Bengkulu, Central Java, Bali, West Nusa Tenggara, Central Kalimantan, and West Sulawesi. Meanwhile, irrational use of TSP was found in Jakarta and Central Java. The studies by IPB and BPS also indicate that several regions still apply urea and other chemical fertilizers, such as TSP and KCl, rationally.

According to this study's regression results, farm size has a positive and significant effect on rice production. This finding aligns with Putra et al. (2018), who reported a positive effect of land area on rice production in Subak Carik Tangis, Tabanan, Bali, albeit with a lower coefficient of 0.163. The current study also indicates that land in Karawang and Lombok has not yet reached the leveling-off stage. Meanwhile, labor quantity was found to have a positive effect. With adequate labor, farmers can perform more meticulous crop management, such as regular weeding, timely fertilization, and faster pest control, thereby enhancing rice production. Labor use in rice farming in Karawang and Lombok has not yet reached the stage of diminishing returns. Finally, the amount of pesticide applied does not significantly affect rice production in Karawang and Lombok. This may be due to inappropriate dosages, incorrect timing of application, or the use of pesticides that are not well-suited to the specific pests, resulting in an insignificant impact on production.

From the production function estimation, it is evident that subsidized fertilizers have the highest input elasticity among inputs, such as land area and labor. The positive elasticity values indicate the ranking of the positive impact of each input type on rice production in Karawang and Lombok. The significant contribution of labor to rice production observed in this study is consistent with the broader literature on input use in smallholder rice farming systems. Rice cultivation is inherently labor-intensive, encompassing activities from land preparation and transplanting through crop maintenance, fertilizer application, and harvesting. Pathirana et al. (2018) demonstrated that labor allocation at critical growth stages, particularly during panicle development, has measurable implications for both yield outcomes and the cost efficiency of fertilization, confirming that labor is not merely a routine input but a strategically important factor in production management.

The vulnerability of rice production systems to labor constraints is driven in part by rural-to-urban migration, which poses a structural challenge to paddy production, and by the mechanization of input application tasks, which offers a viable pathway to sustaining productivity in labor-scarce environments. Additionally, Takahashi et al. (2025) showed that innovative cultivation techniques, such as sparse planting combined with consolidated fertilizer application, can reduce per-cycle labor requirements without compromising yield, highlighting labor efficiency, not merely labor quantity, as a determinant of production performance. In the context of this study, the significance of labor lies in the continued reliance of smallholder rice farmers in Karawang and Lombok on manual labor throughout the production cycle, where optimizing labor deployment remains an important lever for improving farm-level productivity.

The findings of this study regarding the effect of subsidized fertilizer on rice production present a nuanced position relative to the existing literature, neither fully aligned nor entirely contradictory, but rather occupying an intermediate ground that reflects the context-specific nature of subsidy effectiveness in smallholder rice farming. On the one hand, the positive effect of subsidized fertilizer on rice production found in this study is broadly consistent with the mainstream body of evidence, which generally confirms that improved fertilizer access through subsidy programs enables farmers to apply inputs closer to agronomically recommended levels, thereby supporting yield improvement. In this regard, the direction of the effect of subsidized fertilizer on production is consistent with the preponderance of prior findings from Indonesian and other developing-country contexts, in which fertilizer access has consistently been identified as a binding constraint on smallholder productivity.

On the other hand, the magnitude of the fertilizer effect observed in Karawang and Lombok is notably more modest than that observed in several prior studies conducted in other Indonesian provinces. Some earlier studies documented substantially higher output elasticities with respect to subsidized fertilizer, suggesting that, in those settings, each additional unit of fertilizer translated into proportionally larger production gains. The relatively lower elasticity obtained in this study implies that rice farms in Karawang and Lombok have progressed further along the fertilizer response curve, reaching a zone of diminishing marginal returns where additional subsidized fertilizer application no longer generates the same productivity gains observed in earlier or less intensively farmed regions. This condition of decreasing returns to scale is not unique to this study; parallel evidence from other Indonesian provinces has reported similarly low or even slightly negative fertilizer coefficients, suggesting that the phenomenon of fertilizer over-application and declining marginal productivity is a broader pattern emerging across multiple rice-producing regions in Indonesia, rather than an anomaly specific to the study areas.

This positioning carries an important implication: the fertilizer subsidy program, which was originally designed to overcome access and affordability barriers in contexts of underutilization, may now be operating in environments where the primary constraint on production is no longer fertilizer availability but rather fertilizer use efficiency. In Karawang and Lombok, where agricultural intensification is already relatively advanced, the subsidy continues to support production, but its incremental contribution to output has diminished. This result suggests that the effectiveness of the current subsidy design, centered on quantity provision at regulated prices, may be approaching its productive limits in intensively farmed regions, and that future productivity gains may require complementary interventions focused on improving fertilizer application rather than simply on how much is received.

This second model captures the cost efficiency of optimal input use, the farmer's ability to earn profit after covering all costs, and indicates the viability of rice farming. The study results indicate that rice production quantity has a positive and highly significant effect on profit. Higher rice production directly increases farmers' profits. This finding aligns with Laelasari (2018), who reported that production quantity positively and


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significantly affects farmers' income in Saleh Jaya Village, Banyuasin. Generally, agricultural production fluctuates annually due to various factors, including weather, climate, and other natural conditions such as excessive rainfall, floods, or prolonged drought. In addition, pest and disease attacks can affect agricultural yields, consequently impacting farmers' income. The volume of rice produced has a substantial influence on farmers' earnings. Similar findings were reported by Hidayati (2017), and Alitawang and Sutrisna (2017), all of whom concluded that production quantity positively and significantly affects farmers' income.

**Table 3. Cobb–Douglas Model Analysis of the Impact of Fertilizer Costs on Rice Farmer's Profit in Karawang and Lombok**

| Variable independent | Coef. |
|---|---|
| Total production | 1.002*** |
| Rice price | .98*** |
| Total cost | -.999*** |
| Total cost of subsidized fertilizer | -.002 |
| Pesticide cost | -.003* |
| Tractor cost | -.003 |
| Seed cost | .003 |
| Constant | .092 |

R-squared: 0.901
*** p<.01, ** p<.05, * p<.1
Source: Primary Data (processed)

Meanwhile, rice price has a positive impact on profit. Higher selling prices directly increase farmers' profit. Price is a critical factor in economic activities, particularly in rice farming. One key incentive for producers, such as farmers, to increase output is the market price; a higher price translates into higher income. Rice prices positively and significantly influence farmers' incomes, particularly when supported by policies such as price guarantees, contract farming, and improved market access. However, challenges such as income inequality, market inefficiencies, and price volatility must be addressed to ensure sustainable benefits for farmers (Mgale, Y. J., & Yunxian, Y., 2021; Nikiema et al., 2023). In general, farmers' income fluctuates annually due to factors such as weather, climate, and pest or disease attacks on rice. Production costs are directly related to the farmer's role as a manager of their farming enterprise. The level of input use depends on the available budget, and consequently, the amount of production factors employed affects production costs and ultimately farmers' income. Total cost has a negative and highly significant effect on profit. The higher the total production cost (including labor, tractors, seeds, harvesting, and other costs), the lower the profit.

Meanwhile, total fertilizer cost has no significant effect on rice farm profit. Unlike fertilizer quantity, which affects rice production, fertilizer expenditure does not significantly influence farm profitability. Fertilizer cost is relatively insignificant in rice farming because, in several farms, it accounts for only about 12–15% of the total production cost structure;

other factors, such as land rent, labor wages, seeds, and operational costs like tractor rental, are more dominant. The IRRI (2016) study also reported that fertilizer costs represent a relatively small proportion of total rice production costs compared to other expenses (Appendix 6). Pesticide costs are statistically high, indicating that pesticide expenditure in the model has a negative and statistically significant effect on farmers' profits. Pesticide costs negatively affect farm income, particularly for small-scale farmers, by increasing production expenses and imposing indirect health and environmental costs. However, adopting sustainable practices like organic farming or biopesticides, supported by appropriate policies, can mitigate these costs and enhance farm profitability (Huang, et al,, 2022; Mack, et al, 2023; Tipi, T., & Erbaslar, O, 2021).

The results of the profitability model reveal that rice farming profits in Karawang and Lombok are fundamentally determined by three forces operating simultaneously: the volume of output produced, the price at which that output is sold, and the total cost burden incurred in production. These three variables dominate the profit function to such a degree that individual input cost components, including subsidized fertilizer cost, contribute relatively little independent variation to profit outcomes once these overarching factors are accounted for.

The most consequential technical implication of this finding is that **s**ubsidized fertilizer functions primarily as a production enabler rather than a direct profit driver. The subsidy reduces the cost of a critical input, but its ultimate contribution to farmer welfare is realized only when access to that input successfully translates into higher output volumes. If a farmer receives subsidized fertilizer but applies it suboptimally, whether due to incorrect timing, improper dosage, or insufficient complementary inputs such as water, quality seeds, or pest management, the production gains necessary to generate profit improvement will not materialize. This suggests that the subsidy program, in its current form, addresses the input access constraint but does not inherently address the input use efficiency constraint.

A further technical implication concerns the role of output price. The near-equivalence of the influence of rice prices and production volume on profitability indicates that farmers are exposed to significant price risk that lies entirely outside the scope of the fertilizer subsidy program. Even when subsidized fertilizer successfully raises yields, profit outcomes remain highly sensitive to fluctuations in farmgate prices at harvest time. This condition means that subsidy policy, if not complemented by stable price support mechanisms, may deliver production gains that are subsequently eroded by unfavorable market prices, particularly during harvest seasons when paddy supply peaks and prices tend to decline.

The significance of total production costs as a negative determinant of profit further implies that the fertilizer subsidy partially achieves its welfare objective: it reduces one component of the cost structure, but farmers remain exposed to the cumulative burden of other unsubsidized input costs, including labor, tractor services, seeds, and pesticides. The finding that pesticide cost is the only individual cost item


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that independently reduces profitability suggests that pesticide expenditure management represents an underexplored area for efficiency improvement, in which farmer decision-making around chemical pest control may not always be economically rational relative to the yield protection achieved. Collectively, these results imply that the effectiveness of fertilizer subsidies as a farmer welfare instrument is contingent on a broader enabling environment, one that ensures not only input availability at affordable prices, but also supports farmers in converting those inputs into marketable output efficiently, and protects the value of that output through stable and remunerative farmgate prices. Policy interventions that address only the input supply side, without attending to production efficiency and output market conditions, will yield suboptimal welfare outcomes for smallholder rice farmers.

This study finds that subsidized fertilizer costs do not directly determine farm profits once factors like total costs, production volume, and rice prices are considered. This partly aligns with earlier research, which shows that fertilizer subsidies work indirectly rather than directly increasing farmers' income. Subsidies reduce input costs and help farmers produce more, but it is the higher output—not the lower cost itself—that drives profit. This pattern is also seen in Karawang and Lombok, where production volume and rice prices are the main factors affecting profit, not fertilizer spending. Overall, the findings support the idea that subsidized fertilizer mainly acts as a production enabler. Its benefits depend on how effectively farmers can turn increased access to inputs into higher yields that can be sold in the market.

However, the study's finding that subsidized fertilizer costs have no significant independent effect on profit also departs from studies that treat input cost reductions as a direct and measurable welfare benefit of subsidy programs. In contexts where fertilizer expenditure constitutes a substantial proportion of total production costs, a reduction in fertilizer prices through subsidy is expected to improve farm margins directly. The evidence from Karawang and Lombok challenges this expectation by revealing that fertilizer cost, at current subsidy-regulated price levels, accounts for a relatively small share of total production expenditure estimated at approximately 12 to 15 percent, such that its variation across farms does not generate meaningful differences in profit outcomes. This finding suggests that the subsidy has been effective in suppressing fertilizer costs to a level where they no longer constitute a financially distinguishing burden for farmers, paradoxically undermining the measurability of the subsidy's direct welfare impact in the profitability model.

Furthermore, the finding that pesticide cost rather than subsidized fertilizer cost emerges as the only individual input cost item that significantly and negatively affects farm profit introduces a dimension that has received relatively limited attention in the Indonesian rice subsidy literature. While prior studies have predominantly focused on the production and income effects of fertilizer subsidies, this study's evidence suggests that unsubsidized input costs, particularly pesticide expenditures, may exert a more immediate drag on farm profitability than fertilizer costs under the current subsidy regime. This result implies that cost pressures from other unsubsidized inputs may partially offset the

welfare benefits of the fertilizer subsidy, and that a narrow focus on fertilizer subsidy policy, without addressing the broader input cost structure, will deliver only partial improvements in smallholder farm welfare.

Taken together, the profitability findings from Karawang and Lombok position this study as one that affirms the indirect and mediated nature of fertilizer subsidy welfare effects, while simultaneously highlighting the limitations of treating input cost reduction as a sufficient condition for profit improvement. The study contributes to the literature by demonstrating that in intensively farmed smallholder contexts where subsidy programs are already well-established, the binding constraints on farm profitability have shifted away from fertilizer access and toward output market conditions and the management of unsubsidized input costs, a transition that has important implications for how future subsidy policy should be designed and evaluated.

## CONCLUSIONS

This study finds that rice production in Karawang and Lombok increases with more subsidized fertilizer, larger paddy fields, and greater labor use, while pesticide costs have no significant effect. Farm profits mainly depend on output, rice prices, and total costs, not on the cost of subsidized fertilizer, which supports production rather than directly boosting profit. The findings also show decreasing returns to scale, meaning additional inputs produce smaller output gains, indicating overuse of inputs. This is supported by evidence that farmers who reduced chemical fertilizers by 50% and combined them with compost and local microbes still achieved yields of 6.8 tons/ha, showing that integrating organic and biological inputs can maintain productivity while improving efficiency.

Based on these findings, fertilizer subsidies should be maintained given that fertilizer quantity, not its cost, remains a significant driver of rice production; however, the current subsidy design warrants reform. Policy should gradually shift from price-based fertilizer subsidies toward productivity-enhancing innovations, including support for integrated nutrient management, mechanization, and organic fertilizer adoption, thereby reducing chemical fertilizer dependency, lowering total production costs, and improving soil health in the long term. On the revenue side, stabilizing farmgate paddy prices through price floor mechanisms is essential to protect farm profitability, given that rice prices are an equally critical determinant of farmer welfare alongside production volume. Addressing only the input supply side, without accounting for production efficiency and output market conditions, will yield suboptimal welfare outcomes for smallholder rice farmers in Indonesia.


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https://doi.org/10.15408/sjie.v15i1.50435

## REFERENCES

Adhikary, P. P., Mohanty, S., Rautaray, S. K., Manikandan, N., & Mishra, A. (2023). Alternate Wetting and Drying Water Management can Reduce Phosphorus Availability Under Lowland Rice Cultivation Irrespective of Nitrogen Level. *Environmental Monitoring and Assessment*, *195*(12), 1420. https://doi.org/10.1007/s10661-023-12052-5.

Ali, A., Rahut, D. B., & Imtiaz, M. (2019). Affordability Linked with Subsidy: Impact of Fertilizers Subsidy on Household Welfare in Pakistan. *Sustainability*, *11*(19), 5161. https://doi.org/10.3390/su11195161.

Amin, R. M., Ahamat, H., & Hassan, M. S. (2022). Regulatory Framework of Rice Fertiliser Subsidy Management to Attain Sustainable Development Goals: Malaysia's Perspective. *Journal of Sustainability Science and Management*, *17*(8), 179–199. Arodha, D. (2024). Optimizing Strategy of Subsidized Fertilizer Distribution to Improve Service Quality. *Idarotuna: Journal of Administrative Science*, 5(2), 184–195.

Cai, R., Zhao, H., Wang, S., & Ma, J. (2025). Subsidies and Allocative Efficiency in China's Rice Production: Does Farm Size Matter? *Applied Economics*. *In-press*. https://doi.org/10.1080/00036846.2025.2482242

Chandio, A. A., Gokmenoglu, K. K., Ahmad, M., & Jiang, Y. (2022). Towards Sustainable Rice Production in Asia: The Role of Climatic Factors. *Earth Systems and Environment*, *6*(1), 1-14. https://doi.org/10.1007/s41748-021-00210-z

Chang, F., Yang, W., Wang, S., Yin, L., & Deng, X. (2024). Long-term Optimization of Agronomic Practices Increases Water Storage Capacity and Available Water in Soil. *Agronomy*, *14*(10), 2286. https://doi.org/10.3390/agronomy14102286.

Chaudhary, A., Mishra, A. K., Venkatramanan, V., & Sharma, S. (2025). Enhancing Yield and GHG Mitigation through Site-Specific Nutrient Management for Transplanted and Direct-Seeded Rice in Odisha, India. *Frontiers in Sustainable Food Systems*, *9*, 1571263. https://doi.org/10.3389/fsufs.2025.1571263.

Garnaik, S., Samant, P. K., Mandal, M., Sethi, D., Wanjari, R. H., Mohanty, T. R., Dwibedi, S. K., Parihar, C. M., & Nayak, H. S. (2024). Long-term Assessment of Diverse Nutrient Management Strategies in A Rice-Rice Cropping System: Analyzing Yield Trends, Resource Use Efficiency and Economic Viability Over A Sixteen-Year Period. *Journal of Plant Nutrition*, *47*(6), 905–925. https://doi.org/10.1080/01904167.2023.2291018.

Goacademica. (2024). Dynamics of Fertilizer Subsidy Implementation: A Case Study from Indonesia. *International Journal of Science and Society*, 6(1), 47–60.

Gobel, Y. A., Hasan, D., & Djibran, M. M. (2024). Analisis Produksi Padi di Kecamatan Limboto Kabupaten Gorontalo. *Jurnal Agriovet*, *7*(1), 1312. https://doi.org/10.55180/agriovet.v7i1.1312

Guo, L., Li, H., Cao, X., Cao, A., & Huang, M. (2021). Effect of Agricultural Subsidies

on the Use of Chemical Fertilizer. *Journal of Environmental Management, 299*, 113621. https://doi.org/10.1016/j.jenvman.2021.113621.

Hemming, D. J., Chirwa, E., Ruffhead, H. J., Hill, R., Osborn, J., Langer, L., & Harman, L. (2018). Agricultural Input Subsidies for Improving Productivity, Farm Income, Consumer Welfare and Wider Growth in Low- and Lower-Middle-Income Countries: A Systematic Review. *Campbell Systematic Reviews*, 14(1), e1052.

Huang, B., Kong, H., Yu, J., & Zhang, X. (2022). A Study on the Impact of Low-Carbon Technology Application in Agriculture on The Returns of Large-Scale Farmers. *International Journal of Environmental Research and Public Health*, *19*(16), 10185. https://doi.org/10.3390/ijerph191610185.

Iqbal, A., Ali, I., Zhao, Q., Yuan, P., Huang, M., Liang, H., Zeeshan, M., Muhammad, I., Wei, S., & Jiang, L. (2022). Effect of Integrated Organic–Inorganic Amendments on Leaf Physiological and Grain Starch Viscosity Characteristics of Rice and Ultisols Soil Quality. *Agronomy, 12*(4), 863. https://doi.org/10.3390/agronomy12040863

Januarisky, H. A., Syaukat, Y., & Rifin, A. (2025). The Effect of Urea and NPK Fertilizer Usage on Farmers Receiving Fertilizer Subsidies. *Agro Bali*, *8*(2), 352–363. https://doi.org/10.37637/ab.v8i2.2098.

Jauhari, S., Minarsih, S., Hindarwati, Y., Pramono, J., Susila, A., Sudarto, S., Basuki, S., Hariyanto, W., Utomo, B., Suhendrata, T., Oelviani, R., Arianti, F. D., Supriyo, A., Aristya, V. E., & Samijan, S. (2025). Rice Yield Enhancement and Environmental Sustainability with Precision Nutrient Management. *Global Journal of Environmental Science and Management*, *11*(1), 77–92. https://doi.org/10.22034/gjesm.2025.01.05.

Kadigi, I. L. (2026). The Role of Fertilizers in Tanzania's Rice Production: Policy insights from the National Sample Census of Agriculture. *Frontiers in Sustainable Food Systems*, *10*, 1683883. https://doi.org/10.3389/fsufs.2026.1683883.

Kundu, P., & Mallick, U. K. (2024). Modeling the Analysis for The Exploitation of Fertilizers And Pesticides on Rice Production in Bangladesh. *Organic Farming, 10*(1), 13–42. https://doi.org/10.56578/of100102.

Mack, G., Finger, R., Ammann, J., & El Benni, N. (2023). Modelling Policies towards Pesticide-Free Agricultural Production Systems. *Agricultural Systems*, *208*, Article 103654. https://doi.org/10.1016/j.agsy.2023.103654.

Mgale, Y. J., & Yunxian, Y. (2021). Price Risk Perceptions and Adoption of Management Strategies by Smallholder Rice Farmers in Mbeya Region, Tanzania. *Cogent Food and Agriculture*, *7*(1), 1964739. https://doi.org/10.1080/23311932.2021.1964739.

Naghdyzadegan Jahromi, M., Razzaghi, F., & Zand-Parsa, S. (2023). Strategies to Increase Barley Production and Water Use Efficiency by Combining Deficit Irrigation and Nitrogen Fertilizer. *Irrigation Science*, *41*(2), 261–275. https://doi.org/10.1007/s00271-022-00811-0.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50435

Nasrin, M., Bauer, S., & Arman, M. (2018). Assessing the Impact of Fertilizer Subsidy on Farming Efficiency: A Case of Bangladeshi Farmers. *Open Agriculture*, *3*(1), 567–577. https://doi.org/10.1515/opag-2018-0060.

Nguyen, L. (2023). The Effect of Agricultural Input Subsidies on Productivity. *Policy Research Working Paper No. 10399*. Washington, DC: World Bank.

Nikiema, R. A., Shiratori, S., Rafalimanantsoa, J., & Sakurai, T. (2023). How are Higher Rice Yields Associated with Dietary Outcomes of Smallholder Farm Households of Madagascar? *Food Security*, *15*, 1–15. https://doi.org/10.1007/s12571-022-01335-3.

Nizar, R., & Ariyanto, A. (2016). Model Fungsi Produksi Padi pada Petani Pengguna Pupuk Subsidi di Provinsi Riau. *Pekbis Jurnal*, *8*(1), 34–44.

Osorio, C. G. (2023). Update on Fertilizer Subsidy Policy in Indonesia: Perspective and Challenges. *Food and Fertilizer Technology Center (FFTC) Policy Article*.

Pan, Y., Guo, J., Fan, L., Ji, Y., Liu, Z., Wang, F., Pu, Z., Ling, N., Shen, Q., & Guo, S. (2022). The Source–Sink Balance During the Grain Filling Period Facilitates Rice Production Under Organic Fertilizer Substitution. *European Journal of Agronomy, 134*, 126468. https://doi.org/10.1016/j.eja.2022.126468.

Pathirana, U. A. P., Matsue, Y., Nanseki, T., Yokota, S., & Chomei, Y. (2018). Effect of Topdressing at Panicle by Pouring Nitrogen Fertilizer Application on Growth, Yield of Rice and Labor Cost of Fertilization in Large-Scale Paddy Field. *Journal of the Faculty of Agriculture, Kyushu University*, *63*(2), 487–494. https://doi.org/10.5109/1955672.

PATTIRO. (2023). The Map of Subsidized Fertilizer Problems In Indonesia. *Research Report*. Jakarta: PATTIRO. Retrieved from https://pattiro.org/download/laporan-penelitian-peta-masalah-pupuk-bersubsidi-di-indonesiapattiro+1

Phillips, I., Paungfoo-Lonhienne, C., Tahmasbian, I., Hunter, B., Smith, B., Mayer, D., & Redding, M. (2022). Combination of Inorganic Nitrogen and Organic Soil Amendment Improves Nitrogen Use Efficiency while Reducing Nitrogen Runoff. *Nitrogen*, *3*(1), 4. https://doi.org/10.3390/nitrogen3010004.

Prasetyo, O. R. (2024). Does Government Assistance Increase the Yield of Food Crops? *Jurnal ISEI*, *10*(1), 45–60.

Putra, I. G. N. Y., Antara, M., & Oka Suardi, I. D. P. (2018). Efisiensi Penggunaan Faktor-faktor Produksi pada Usaha Tani Padi Subak Carik Tangis Wongaya Gede Tabanan–Bali. *Jurnal Manajemen Agribisnis*, *6*(1), 70–77. https://doi.org/10.24843/JMA.2018.v06.i01.p10.

Rahmawati, S., & Nurhidayah, A. (2024). The Impact of Subsidized Fertilizer Usage on Farmer Welfare in West Java. *International Journal of Research and Innovation in Social Science (IJRISS)*, 8(5), 1785–1805.

Ricome, A., et al. (2024). Government Fertilizer Subsidies, Input Use, and Income. *Agricultural Economics*, 55(3), 467–485.

Rollon, R. J. C., Golis, J. M., & Salas, E. (2021). Impacts of Soil Nutrient Management Practices on Soil Fertility, Nutrient Uptake, Rice (Oryza sativa L.) Productivity, and Profitability. *Journal of Applied Biology and Biotechnology*, *9*(2), 75–84. https://doi.org/10.7324/JABB.2021.9207.

Salam, M., Rustan, Y., Rukka, R. M., Rahmadanih, Maulidiyah, R., Muslim, A. I., Ali, H. N. B., & Ridwan, M. (2024). Employing the Cobb-Douglas Function Model to Examine How Input Allocation Affects Rice Production: In Search of Ways to Improve the Rice Farming Management. *Yuzuncu Yil University Journal of Agricultural Sciences*, *34*(4), 584–595. https://doi.org/10.29133/yyutbd.1492753.

Takahashi, Y., Tozuka, Y., Saiga, M., Tsukada, K., Hoshino, M., & Anazawa, T. (2025). Growth and Yield of Paddy Rice Cultivation by Applying the Whole Amount of Fertilizer as Basal Dressing in the Nursery Box and Planting Sparsely. *Japanese Journal of Crop Science*, *94*(4), 408–417. https://doi.org/10.1626/jcs.94.408.

Tan, C., Du, Y., Gu, X., Niu, W., Zhang, J., Müller, C., & Cao, X. (2025). Aerated Irrigation Increases Tomato Production by Improving Soil Nitrogen Availability. *Journal of Integrative Agriculture*, *24*(1), 322–338. https://doi.org/10.1016/j.jia.2024.04.004.

Theriault, V., & Smale, M. (2021). The Unintended Consequences of the Fertilizer Subsidy Program on Crop Species Diversity in Mali. *Food Policy*, *102*, 102121. https://doi.org/10.1016/j.foodpol.2021.102121.

Tipi, T., & Erbaslar, O. A. (2021). Importance of Sustainable Use of Pesticides: The Case of Pear Production in Bursa, Turkey. *Fresenius Environmental Bulletin*, *30*(4), 3563–3570.

Wildayana, E. (2017). The Role of Subsidized Fertilizers on Rice Production and Farmers' Income. *Jurnal Ekonomi Pertanian dan Agribisnis*, 1(2), 101–112.

Wu, P., Wang, G., Dai, Z., Zhou, X., Wu, Y., Gong, X., & Li, X. (2025). Effects of Reduced Mechanical Side-Deep Fertilization on Rice Yield and Fertilizer Use Efficiency. *Transactions of the Chinese Society of Agricultural Engineering, 41*(15), 57–65. https://doi.org/10.11975/j.issn.1002-6819.202410227.

Xin, L. (2022). Chemical Fertilizer Rate, Use Efficiency and Reduction of Cereal Crops in China, 1998–2018. *Journal of Geographical Sciences, 32*(1), 65–78. https://doi.org/10.1007/s11442-022-1936-2.

Xu, Z., He, P., Yin, X., Huang, Q., Ding, W., Xu, X., & Struik, P. C. (2023). Can the Advisory System Nutrient Expert® Balance Productivity, Profitability and Sustainability for Rice Production Systems in China? *Agricultural Systems*, *205*, 103575. https://doi.org/10.1016/j.agsy.2022.103575;

Yang, W., Feng, G., Jia, Y., Yang, Y., Gao, X., Gao, L., & Qu, Z. (2022). Impact of Single Biochar Application on Maize Growth and Water-Fertilizer Productivity Under Different Irrigation Regimes. *Frontiers in Plant Science*, *13*, 1006827. https://doi.org/10.3389/fpls.2022.1006827.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50435

Yardha, Wahyudi, E., & Wafi, A. (2021). Analysis on Factors Affecting the Risk of Rice Farming Production in West Tanjung Jabung Regency. *IOP Conference Series: Earth and Environmental Science*, *715*(1), 012009. https://doi.org/10.1088/1755-1315/715/1/012009.

Yovo, A. F., & Ganiyou, A. (2023). *Fertilizer Subsidies in Developing Countries*. Muscle Shoals, AL: IFDC. Retrieved from https://hub.ifdc.org/items/5b225a40-1302-41de-8c59-a93e26270556hub.ifdc

Zulfikar, A., et al. (2024). Fertilizer Subsidies and Their Impact on Farmer Welfare in Aceh. *Jurnal Bina Administrasi*, 11(2), 155–170.

# APPENDIX

**Appendix 1. Characteristics of Farmers and Rice Farming**

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Farmer Characteristics** | | | | | |
| Age (years) | 51 | 51.67 | 9.56 | 26.00 | 75.00 |
| Years of schooling (years) | 51 | 9.94 | 4.62 | 3.00 | 20.00 |
| Farming experience (years) | 51 | 23.94 | 12.47 | 2.00 | 50.00 |
| Distance to fertilizer kiosk (meters) | 51 | 591.67 | 589.48 | 25.00 | 2,500.00 |
| **Land Characteristics** | | | | | |
| Rice field area (ha) | 51 | 0.97 | 1.01 | 0.05 | 5.00 |
| **Seed Inputs per Planting Season** | | | | | |
| Seed price (IDR/kg) | 51 | 22,147.06 | 33,721.55 | 6,500.00 | 250,000.00 |
| Seed quantity (kg) | 51 | 22.67 | 18.17 | 2.00 | 85.00 |
| Seed cost (IDR) | 51 | 403,960.78 | 381,199.58 | 50,000.00 | 1,600,000.00 |
| **Fertilizer Inputs per Planting Season** | | | | | |
| Urea quantity (kg) | 51 | 175.60 | 171.32 | 9.00 | 1,000.00 |
| Urea price (IDR/kg) | 51 | 2,462.75 | 319.19 | 1,500.00 | 3,500.00 |
| Urea cost (IDR) | 51 | 426,593.14 | 425,470.99 | 22,500.00 | 2,500,000.00 |
| NPK quantity (kg) | 51 | 177.12 | 220.21 | 10.00 | 1,300.00 |
| NPK price (IDR/kg) | 51 | 2,488.89 | 334.16 | 1,500.00 | 3,500.00 |
| NPK cost (IDR) | 51 | 437,564.71 | 552,307.34 | 26,000.00 | 3,250,000.00 |
| Total subsidized fertilizer (urea + NPK) (kg) | 51 | 352.72 | 382.66 | 19.00 | 2,000.00 |
| Total cost of subsidized fertilizer (IDR) | 51 | 864,157.84 | 956,178.65 | 48,500.00 | 5,000,000.00 |
| **Other Inputs per Planting Season** | | | | | |
| Pesticide quantity (ml) | 51 | 3,228.24 | 2,214.30 | 500.00 | 8,500.00 |
| Pesticide cost (IDR) | 51 | 668,843.14 | 971,399.60 | 15,000.00 | 4,000,000.00 |
| Tractor cost (IDR) | 51 | 1,458,137.30 | 1,214,715.20 | 100,000.00 | 8,000,000.00 |
| Labor (persons) | 51 | 14.57 | 10.14 | 2.00 | 40.00 |
| Total cost (IDR) | 51 | 7,132,056.40 | 6,641,054.50 | 400,000.00 | 33,995,000.00 |
| **Production and Revenue per Planting Season** | | | | | |
| Production quantity (kg) | 51 | 4,358.14 | 3,117.11 | 300.00 | 16,000.00 |
| Paddy price (IDR/kg) | 51 | 6,629.41 | 470.87 | 5,000.00 | 8,000.00 |
| Revenue (IDR) | 51 | 29,277,892.00 | 21,231,956.00 | 1,950,000.00 | 108,800,000.00 |


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**Appendix 2. Quantity of Subsidized Fertilizers Redeemed by Farmers**

| Type of Subsidized Fertilizer | Rice Field Area | | |
|---|---|---|---|
| | < 0,5 ha | 0,5–1 ha | > 1 ha |
| **Urea + NPK (kg/season)** | | | |
| Mean | 95.9 | 333.3 | 712.5 |
| Standard deviation | 50.6 | 157.9 | 615.0 |
| Min | 19 | 100 | 200 |
| Max | 200 | 600 | 2000 |
| **Urea (kg/season)** | | | |
| Mean | 47.0 | 175.0 | 337.5 |
| Standard deviation | 25.9 | 87.2 | 256.0 |
| Min | 9 | 50 | 100 |
| Max | 100 | 350 | 1000 |
| NPK (kg/season) | | | |
| Mean | 48.9 | 158.3 | 375.0 |
| Standard deviation | 24.8 | 81.7 | 373.9 |
| Min | 10 | 50 | 100 |
| Max | 100 | 350 | 1300 |

**Appendix 3.Dosage of Urea and NPK Fertilizers by Recommendation-Compliance Category (kg/ha)**

| Dose Category vs Recommendation | Urea | | | | NPK | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Min | Max | Mean | Std. Dev. | Min | Max |
| Below recommendation | 136,087 | 43,932 | 50,000 | 181,818 | 116,164 | 45,241 | 50,000 | 181,818 |
| According to recommendation | 228,095 | 35,762 | 200,000 | 285,714 | 229,048 | 34,266 | 200,000 | 300,000 |
| Above recommendation | 369,757 | 59,346 | 307,692 | 500,000 | 360,634 | 39,262 | 307,692 | 428,571 |

**Appendix 4.Number of Farmers Applying Subsidized Fertilizers in Accordance with Recommendations**

| Urea use | NPK Use | | | Total |
|---|---|---|---|---|
| | Below Recommendation | According to Recommendation | Above Recommendation | |
| Below Recommendation | 73.08 | 23.08 | 0.00 | 100.00 |
| According to Recommendation | 13.33 | 80.00 | 6.67 | 100.00 |
| Above Recommendation | 0.00 | 30.00 | 70.00 | 100.00 |

**Appendix 5.Cost Structure, Production, and Revenue of Rice Farming per Hectare by Land-Size Category**

| | Mean | SD | Min | Max |
|---|---|---|---|---|
| Cost (Rp/ha) | 9,962,198.30 | 5,206,963.80 | 2,960,000.00 | 22,764,286.00 |
| Production (Kg/ha) | 6,352.72 | 2,741.31 | 2,769.23 | 16,000.00 |
| Revenue (Rp/ha) | 42,947,979.00 | 18,564,169.00 | 19,107,694.00 | 104,000,000.00 |
| **<0.5** | | | | |
| Cost (Rp/ha) | 11,374,796.00 | 2,916,530.20 | 6,725,000.00 | 15,736,666.00 |
| Production (Kg/ha) | 7,927.87 | 7,381.40 | 1,912.50 | 30,000.00 |
| Revenue (Rp/ha) | 49,523,750.00 | 45,278,105.00 | 12,431,250.00 | 180,000,000.00 |
| **>1** | | | | |
| Cost (Rp/ha) | 5,717,581.20 | 4,250,271.20 | 285,714.28 | 11,542,963.00 |
| Production (Kg/ha) | 3,683.33 | 1,973.90 | 1,200.00 | 7,000.00 |
| Revenue (Rp/ha) | 25,225,000.00 | 13,541,988.00 | 8,400,000.00 | 49,700,000.00 |

Source: Primary Data (processed)

**Appendix 6.Comparison of Rice Production Factor Costs Across Different Countries (PhP per kg)**

| Component | Filipina | Cina | Indonesia | India | Thailand | Vietnam |
|---|---|---|---|---|---|---|
| Seed | 0.54 | 0.93 | 0.14 | 0.51 | 1.13 | 0.39 |
| Fertilizer | 1.73 | 1.93 | 0.96 | 0.93 | 1.54 | 0.96 |
| Agrochemical | 0.32 | 1.72 | 0.92 | 0.21 | 0.90 | 0.63 |
| Paid labor | 3.39 | 0.52 | 4.23 | 0.21 | 0.68 | 0.35 |
| Operator. Family. & Reciprocal labor exchange | 0.56 | 2.84 | 1.04 | 0.56 | 0.64 | 0.67 |
| Livestock. Machinery. Fuel. & Oil | 1.54 | 2.88 | 0.48 | 1.78 | 1.83 | 0.63 |
| Irrigation | 0.45 | 0.00 | 0.14 | 0.12 | 0.13 | 0.08 |
| Food | 0.19 | 0.00 | 0.29 | 0.12 | 0.05 | 0.00 |
| Transportation | 0.05 | 0.11 | 0.10 | 0.04 | 0.16 | 0.03 |
| Tax | 0.03 | 0.00 | 0.19 | 0.03 | 0.00 | 0.00 |
| Land rent | 1.60 | 3.45 | 6.17 | 1.96 | 1.94 | 1.20 |
| Capital interest | 0.40 | 0.01 | 0.31 | 0.10 | 0.06 | 0.04 |
| Other input | 0.10 | 0.02 | 0.12 | 0.13 | 0.00 | 0.09 |
| Total Cost | 11.13 | 14.39 | 15.08 | 9.27 | 9.07 | 5.14 |

Source: IRRI (2016)


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# The Dynamics of Indonesian Migrant Workers: Their Short- and Long-Term Impact

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**ABSTRACT**

**Research Originality**: This study integrates factors influencing Indonesian migrant workers into a Panel VECM model that captures both short- and long-term dynamics.

**Research Objectives**: This study investigates the factors that affect the short- and long-term migration of Indonesian migrant workers.

**Research Methods**: This study uses the Vector Error Correction Model (VECM) approach. Panel data were analyzed for six provinces on Java Island, covering the period 2008 to 2023.

**Empirical Results**: This study found significant positive effects of provincial minimum wage, employment opportunity rates, and poverty levels on the short-term migration of Indonesian migrant workers in Java. In the long term, all variables positively influenced Indonesian migrant worker migration, except for poverty, which had a non-significant effect.

**Implications**: These findings indicate an anomaly in the factors influencing the PMI. Therefore, we assert that policymakers in Indonesia must periodically review and adjust the UMP and implement effective price-control measures to ensure that workers' basic needs are met at a reasonable cost of living.

**Keywords:**
migrant workers; minimum wage; job opportunities; poverty

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## INTRODUCTION

Labor migration is an important indicator of a country's socio-economic development. Reducing unemployment, increasing community welfare, and increasing job availability positively impact labor migration (Sukesi et al., 2022). In addition, globalization has expanded the labor market (Todorov et al., 2018). The emergence of a global labor market with an internationalized workforce is driving international labor migration (Pekarskiene et al., 2016). According to Lee (1966), individuals' decision to migrate is influenced by two factors, namely driving factors and pulling factors. Lee's (1966) theory of international migration posits that individuals' decisions to migrate are influenced by two factors: driving factors and pulling factors.

In the process, Lee described four factors that motivate individuals to migrate internationally: individual factors, factors in the region of origin, factors in the destination area, and obstacles. Driving factors include low minimum wages and uneven development within a country, which can result in limited employment opportunities and reduced social access for the community (Hoffmann et al., 2019). In contrast, pulling factors involve incentives such as higher wages and greater availability of job opportunities in the destination area (Zuhra et al., 2024).

In the theory of international migration (1993), Massey et al. asserted that labor migration would not occur without wage differentials between countries of origin and destination. In other words, people are not encouraged to migrate if the income difference between countries is slight (Santoso et al., 2022). Most workers in low-income countries migrate to countries with relatively higher wages (Parreñas et al., 2019). However, Stark and Bloom (1985), in their New Economics of Migration theory, explain that wages are not the primary reason individuals migrate; rather, migration is driven by family, household, and cultural factors. This means that the most important part of migration is how individuals find work and income to meet their needs, regardless of wages. In other words, poverty is a significant factor driving international migration (Muslihatinningsih et al., 2020).

In addition to poverty and low minimum wages, Nunley et al. (2017) have identified that job opportunities significantly influence individuals' decisions to migrate. They found a negative correlation between the availability of employment opportunities and overseas labor migration. Conversely, research conducted by Husnah et al (2019) indicates that job opportunities positively impact migration and the workforce. Despite an increase in job opportunities, the number of Indonesian migrant workers has continued to rise. According to Kwilinski et al. (2022), other factors, particularly poverty, have also played a positive role in driving international labor migration. Recent data reveal that nearly two-thirds of Indonesian migrant workers originate from districts with relatively high poverty rates, exceeding the national average. Furthermore, Lohmann and Marx (2018) found that poverty tends to decrease the number of Indonesian migrant workers, due to the substantial pre-departure costs involved (Muhammad et al., 2023).

Figure 1 illustrates that Indonesian migrant workers predominantly originate from Java, with the Island consistently ranking as the largest contributor to the shipment of


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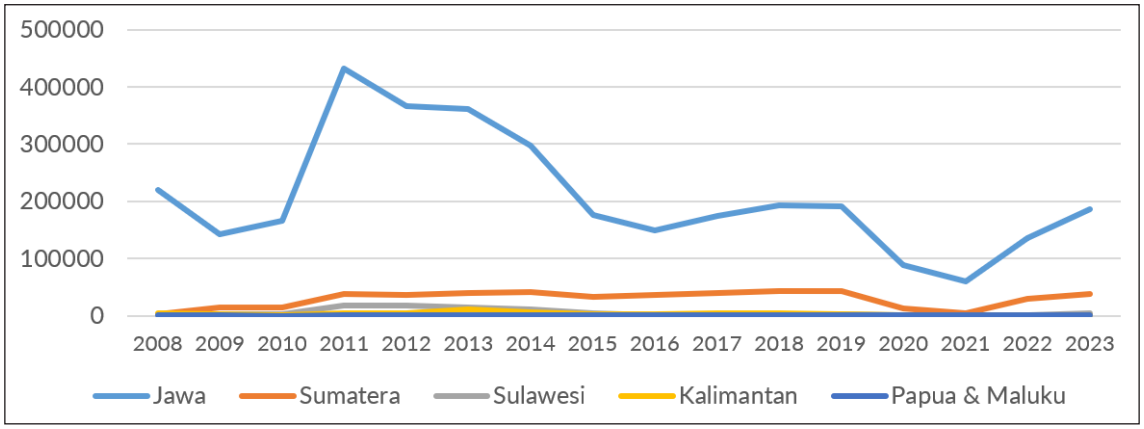
Indonesian Migrant Workers. In 2023, Indonesian migrant workers from Java are projected to comprise 67.7% of the total Indonesian migrant workers (BP2MI, 2023). Java Island stands out as the most populous and economically and infrastructure-wise significant island in Indonesia, characterized by its relatively advanced economy and infrastructure compared to other regions. It is well-known as Indonesia's primary centre for industrial and trade activities (Ifa et al., 2024). However, the high population density leads to a shortage of available jobs, intensifying competition among job seekers on the island. Consequently, many individuals face challenges in securing employment, prompting them to seek work abroad. This situation highlights the need for further research to identify the factors influencing the migration of Javanese workers abroad, both in the short and long term.

**Figure 1. Number of Indonesian Migrant Workers (PMI) by Island (Soul)**




Source: Badan Pusat Statistik

Several studies yield conflicting results on the relationship between minimum wages and international labor migration. An empirical study by Yagura (2024) in Cambodia, using the VECM approach, found a negative and significant relationship between minimum wages and international labor migration. Specifically, high wages in the country of origin tend to reduce international migration (Edo, 2019). Additionally, Cedillo et al. (2019) and Wright and Clibborn (2019) indicated that, in addition to factors such as limited language skills, work experience, and the complexity of work procedures, minimum wages also influence workers' interest in seeking employment abroad (Purna & Sulistian, 2019). Conversely, a study by Sy and Hosoe (2023) found that labor migration abroad continues to increase even with rising minimum wages. This trend is attributed to higher wages and strong labor demand in destination countries (Pholphirul, 2019; Tabuga et al., 2021; Susanto & Sulaiman, 2022).

Ayanie et al. (2020) and Schewel and Asmamaw (2021) explain that population drives international migration in Ethiopia, highlighting a labor surplus and a lack of job opportunities within the country. Nunley et al. (2017) note that the abundant availability of jobs abroad significantly influences this migration trend. For instance, Afghanistan has implemented managed labor migration to channel excess labor into the international

market (Holzmann, 2018). Similarly, Husnah et al. (2019) observed a positive relationship between job opportunities and overseas labor migration in various cases in Indonesia. The disconnect between public interest and available job opportunities leads many individuals to prefer to remain as Indonesian migrant workers (Rabbani et al., 2022). Moreover, the creation of untargeted job opportunities increases unemployment, which in turn affects individuals' ability to meet their needs and contributes to rising poverty rates (Hellgren & Serrano, 2019; Kwilinski et al., 2022).

Stark & Bloom (1985) in the New Economics of Migration theory argue that migration often arises from a person's aspirations to fulfill basic necessities of life. The decision to migrate is considered integral to a family's strategy to enhance income and mitigate financial risk (Hia et al., 2024). Key factors such as family dynamics, household conditions, and cultural aspects must be taken into account, with the expectation that migration can diversify household income and ultimately improve family welfare. Research by Purna and Sulistian (2019), and Muslihatinningsih et al. (2020) indicates that poverty has a significant positive impact on labor migration abroad; specifically, higher poverty rates are associated with greater labor migration in the global labor market. Conversely, research by Mangara et al. (2024) presents differing findings, asserting that poverty levels do not influence the number of migrant workers. Furthermore, Robot et al. (2023) note that limitations and complexities in processing paperwork required to become a migrant worker contribute to these issues (Hikmawati & Pierewan, 2020).

Numerous studies on international migration have produced mixed results, highlighting a literature gap, particularly concerning the impact of minimum wages, employment opportunities, and poverty. This study helps address this gap by offering deeper insights into the dynamic interactions among factors that influence overseas labor migration. Unlike previous studies on Indonesian migrant workers, which mainly used static regression analysis, this study employs a dynamic framework by integrating determinants of Indonesian migrant worker migration into a panel-data Vector Error Correction Model (VECM). Additionally, the focus is placed on six provinces in Java, the largest source of migrant workers in Indonesia. The objective of this study is to capture both the short- and long-term effects of provincial minimum wages, employment opportunities, and poverty on migration of Indonesian migrant workers. Consequently, this research aims to serve as a valuable reference for policymakers and to contribute to the empirical literature on factors influencing Indonesian migrant worker migration.

## METHODS

This study uses secondary data from a panel dataset collected over 16 years, spanning 2008 to 2023. The data was sourced from various official entities, including the Central Statistics Agency (BPS), the Indonesian Migrant Workers Protection Agency (BP2MI), and additional literature from institutions and websites pertinent to the research topic. The analysis focuses on six provinces on the island of Java: DKI Jakarta, West Java, Central Java, DI Yogyakarta, East Java, and Banten. Java was selected as the study area because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it is the origin of the majority (67%) of Indonesian migrant workers. The dependent variable in this research is Indonesian Migrant Workers (PMI). while the independent variables consist of the Provincial Minimum Wage (UMP), Employment Opportunity Rate (TKK), and Poverty Rate (KMS). To analyze the panel data, this study employs the Vector Error Correction Model (VECM) approach.

This research employs the Vector Error Correction Model (VECM) to analyze the relationship between interdependent or cointegrated variables and to explain short- and long-term economic phenomena using panel data. The VECM is a variant of the VAR model, constrained by the fact that the data are not stationary at the level but are cointegrated (Az-Zahra & Widarjono, 2022). In this context, VECM is viewed as a multivariate time-series model in which all variables are treated as endogenous, reflecting uncertainty about their exogenous status. This approach allows for a more accurate representation of real-world dynamics. It also helps mitigate parameter bias that can occur when relevant variables are overlooked and alleviates limitations often encountered in various economic theories.

VECM provides methodological advantages over traditional regression analysis by identifying causal relationships, assessing long-term equilibrium, and capturing short-term adjustment dynamics simultaneously. As a result, this method is particularly pertinent for addressing gaps in the previous research that have not thoroughly explored the determinants of Indonesian labor migration, especially regarding migrant workers from Java. The analysis within this framework also uses an impulse response function (IRF) to assess how a variable responds to shocks to other variables in the model (Az-Zahra & Widarjono, 2022

The VECM methodology treats all variables as endogenous and incorporates lagged values for each variable. This research model is represented in equations (1)-(5), where delta denotes changes at the first-different level of a variable. Here, PMI is the Indonesian Migrant Workers, measured in individuals; TKK indicates the level of job opportunities, expressed as a percentage; KMS reflects the percentage of the population living in poverty. The coefficients β0, β1, β2, β3, and β4 denote the intercepts. Additionally, ECT denotes the error-correction term, which measures the speed at which the short-term model adjusts toward a long-term equilibrium point.

$$PMI_{it} = \beta_0 + \beta_1 UMP_{it} + \beta_2 TKK_{it} + \beta_3 KMS_{it} + \mu_{it} \quad (1)$$

$$\begin{aligned}\Delta PMI_{it} = {} & \beta_{10} + \sum_{i=1}^{m}\beta_{111}\Delta PMI_{it-1} + \sum_{i=1}^{m}\beta_{112}\Delta PMI_{it-2} + \sum_{i=1}^{m}\beta_{121}\Delta UMP_{it-1} + \\ & \sum_{i=1}^{m}\beta_{122}\Delta UMP_{it-2} + \sum_{i=1}^{m}\beta_{131}\Delta TKK_{it-1} + \sum_{i=1}^{m}\beta_{132}\Delta TKK_{it-2} + \\ & \sum_{i=1}^{m}\beta_{141}\Delta KMS_{it-1} + \sum_{i=1}^{m}\beta_{142}\Delta KMS_{it-2} + \theta ECT + \mu_{it}\end{aligned} \quad (2)$$

$$\begin{aligned}\Delta UMP_{it} = {} & \beta_{20} + \sum_{i=1}^{m}\beta_{211}\Delta UMP_{it-1} + \sum_{i=1}^{m}\beta_{212}\Delta UMP_{it-2} + \sum_{i=1}^{m}\beta_{221}\Delta PMI_{it-1} + \\ & \sum_{i=1}^{m}\beta_{222}\Delta PMI_{it-2} + \sum_{i=1}^{m}\beta_{231}\Delta TKK_{it-1} + \sum_{i=1}^{m}\beta_{232}\Delta TKK_{it-2} + \\ & \sum_{i=1}^{m}\beta_{241}\Delta KMS_{it-1} + \sum_{i=1}^{m}\beta_{242}\Delta KMS_{it-2} + \theta ECT + \mu_{it}\end{aligned} \quad (3)$$

$$\begin{aligned}\Delta TKK_{it} = {} & \beta_{30} + \sum_{i=1}^{m}\beta_{311}\Delta TKK_{it-1} + \sum_{i=1}^{m}\beta_{312}\Delta TKK_{it-2} + \sum_{i=1}^{m}\beta_{321}\Delta PMI_{it-1} + \\ & \sum_{i=1}^{m}\beta_{322}\Delta PMI_{it-2} + \sum_{i=1}^{m}\beta_{331}\Delta UMP_{it-1} + \sum_{i=1}^{m}\beta_{332}\Delta UMP_{it-2} + \\ & \sum_{i=1}^{m}\beta_{341}\Delta KMS_{it-1} + \sum_{i=1}^{m}\beta_{342}\Delta KMS_{it-2} + \theta ECT + \mu_{it}\end{aligned} \quad (4)$$

$$\Delta KMS_{it} = \beta_{40} + \sum_{i=1}^{m}\beta_{411}\Delta KMS_{it-1} + \sum_{i=1}^{m}\beta_{412}\Delta KMS_{it-2} + \sum_{i=1}^{m}\beta_{421}\Delta PMI_{it-1} + \sum_{i=1}^{m}\beta_{422}\Delta PMI_{it-2} + \sum_{i=1}^{m}\beta_{431}\Delta UMP_{it-1} + \sum_{i=1}^{m}\beta_{432}\Delta UMP_{it-2} + \sum_{i=1}^{m}\beta_{441}\Delta TKK_{it-1} + \sum_{i=1}^{m}\beta_{442}\Delta TKK_{it-2} + \theta ECT + \mu_{it} \quad (5)$$

## RESULTS AND DISCUSSION

The unit root test conducted in this study revealed that all variables were non-stationary at the level but demonstrated relative stationarity at the first difference level. The analysis employed the Augmented Dicky Fuller (ADF) method. As shown in Table 1, the P-value at the level exceeded 0.05. Conversely, at the First Difference level, the P-value for all variables fell below the alpha threshold of 0.05, indicating that all variables are stationary at this level.

**Table 1. Unit Root Test**

| Variable | *Level* | | | *First Difference* | | |
|---|---|---|---|---|---|---|
| | T-Statistic | *Prob* | Description | T-Statistic | *Prob* | Description |
| **PMI** | 183.384 | 0.1058 | Not Stationary | 412.727 | 0.0000 | Stasionary |
| **UMP** | 538.739 | 0.9438 | Not Stationary | 212.371 | 0.0470 | Stasionary |
| **TKK** | 177.389 | 0.1239 | Not Stationary | 305.752 | 0.0023 | Stasionary |
| **KMS** | 158.075 | 0.2002 | Not Stationary | 262.641 | 0.0098 | Stasionary |

Source: Data Processing Results

According to Table 2, the optimal lag, as determined by the FPE, AIC, and HQ criteria, is lag 2. In contrast, the SC criterion suggests lag 1, whereas the LR criterion points to lag 4. Consequently, this study identifies lag 2 as the optimal lag. This indicates that the response of one variable to changes in other variables occurs within two years following the initial shock.

**Table 2. Lag Optimum Test**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -2253058 | NA | 1.42E-05 | 0.189487 | 0.322193* | 0.241925 |
| 1 | 1.775.767 | 3.698.953 | 1.26E-05 | 0.067949 | 0.731481 | 0.330142 |
| 2 | 4.713.329 | 5.073.969 | 8.44e-06* | -0.337372* | 0.856985 | 0.134575* |
| 3 | 5.457.380 | 1.194.991 | 1.11E-05 | -0.077994 | 1.647.189 | 0.603708 |
| 4 | 7.415.178 | 2.907.034* | 1.02e-05 | -0.186418 | 2.069.590 | 0.705038 |

Source: Data Processing Results

The cointegration test revealed that all variables are cointegrated, indicating a long-term relationship among them. According to Table 3, the Johansen test indicates that the t-statistics for all variables exceed the critical value, with the probability values below 0.05. This confirms the cointegration of the variables, supporting the use of the VECM model.


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**Table 3. Cointegration Test**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob** | Description |
|---|---|---|---|---|---|
| None* | 0.559573 | 1.127.837 | 4.785.613 | 0.0000 | Co-integrated |
| At most 1* | 0.313428 | 5.374.299 | 2.979.707 | 0.0000 | Co-integrated |
| At most 2* | 0.182036 | 2.666.778 | 1.549.471 | 0.0007 | Co-integrated |
| At most 3* | 0.155870 | 1.220.035 | 3.841.465 | 0.0005 | Co-integrated |

Source: Data Processing Results

The next step is to assess the model's stability. The results from the optimum lag test suggest that the model in this study is stable. As indicated in Table 4, the model exhibits a modulus value of less than one. A model is typically regarded as stable when the Root of the Characteristic Polynomial Modulus is below 1.

Table 5 presents the findings of the Granger Causality test, which is employed to evaluate the existence of a reciprocal relationship between variables. This test assesses whether the variables exhibit a one-way or two-way relationship. The estimated results shown in Table 5 indicate a one-way causal effect at the 10% significance level: UMP affects PMI, and KMS affects PMI. Additionally, at a significance level of 5%, a one-way relationship is observed between the TKK variable and PMI, with a probability value of 0.0214. This indicates that the TKK variable is particularly influential in affecting PMI. In summary, all variables display a one-way relationship with Indonesian migrant workers. Conversely, a two-way relationship is identified at the 5% significance level between KMS and TKK, indicating that KMS influences TKK and that TKK likewise impacts KMS.

**Table 4. Lag Optimum**

| Root | Modulus |
|---|---|
| 0.156838 - 0.652442i | 0.6671028 |
| 0.156838 + 0.652442i | 0.671028 |
| 0.475977 - 0.252676i | 0.538887 |
| 0.475977 + 0.252676i | 0.538887 |
| -0.446919 - 0.160013i | 0.474701 |
| -0.446919 - 0.160013i | 0.474701 |
| -0.162722 - 0.389004i | 0.421666 |
| -0.162722 + 0.389004i | 0.421666 |

Source: Data Processing Results

The short-term estimates derived from the VECM indicate that all variables significantly influence the positive coefficients for Indonesian migrant workers. The provincial minimum wage variables, lagged one and lagged two, have coefficients of 2.125547 and 1.344757, respectively. This suggests that a 1% increase in the minimum

wage (UMP) will result in a 2.12% rise in the number of Indonesian migrant workers in lag 1 and a 1.34% rise in lag 2.

**Table 5. Granger Causality Test**

| Null Hypothesis: | F-Statistic | Obs | Prob. |
|---|---|---|---|
| UMP does not Granger-cause PMI | 273.471 | 78 | 0.0711* |
| PMI does not Granger-cause UMP | 0.22794 | 78 | 0.7967 |
| TKK does not Granger-cause PMI | 403.998 | 78 | 0.0214** |
| PMI does not Granger-cause TKK | 0.20064 | 78 | 0.8186 |
| KMS does not Granger-cause PMI | 274.670 | 78 | 0.0703* |
| PMI does not Granger-cause KMS | 0.88878 | 78 | 0.4152 |
| TKK does not Granger-cause UMP | 0.92433 | 78 | 0.4010 |
| UMP does not Granger-cause TKK | 158.369 | 78 | 0.2177 |
| KMS does not Granger-cause UMP | 275.854 | 78 | 0.0695* |
| UMP does not Granger-cause KMS | 128.053 | 78 | 0.2836 |
| KMS does not Granger-cause TKK | 436.281 | 78 | 0.0160** |
| TKK does not Granger-cause KMS | 483.917 | 78 | 0.0104** |

Source: Data Processing Results

Additionally, the employment opportunity rate indicates that an increase in the previous year's TKK will raise the number of Indonesian Migrant Workers by 7.86688, while an increase in TKK from two years prior will raise the number of migrant workers by 3.78756. Furthermore, a rise in poverty levels from the previous year is associated with a 2.08700 increase in Indonesian Migrant Workers, and the increase in KMS from two years ago will result in a 2.76358 increase in the number of migrant workers. In contrast, the long-term VECM estimates indicate that only the poverty variable does not significantly affect the number of Indonesian migrant workers.

**Table 6. VECM Result**

| Variables | Coefficient | T-Statistic | Description |
|---|---|---|---|
| **Short Run Result** | | | |
| D(UMP(-1)) | 2.125.647 | 330.928 | Significant |
| D(UMP(-2)) | 1.344.757 | 231.153 | Significant |
| D(TKK(-1)) | 0.001823 | 786.688 | Significant |
| D(TKK(-2)) | 0.000850 | 378.756 | Significant |
| D(KMS(-1)) | 0.091155 | 208.700 | Significant |
| D(KMS(-2)) | 0.119892 | 276.358 | Significant |
| **Long Run Result** | | | |
| D(UMP(-1)) | 1.880.321 | 204.834 | Significant |
| D(TKK(-1)) | 0.001077 | 340.006 | Significant |
| D(KMS(-1)) | 0.069469 | 172.882 | Insignificant |

Source: Data Processing Results


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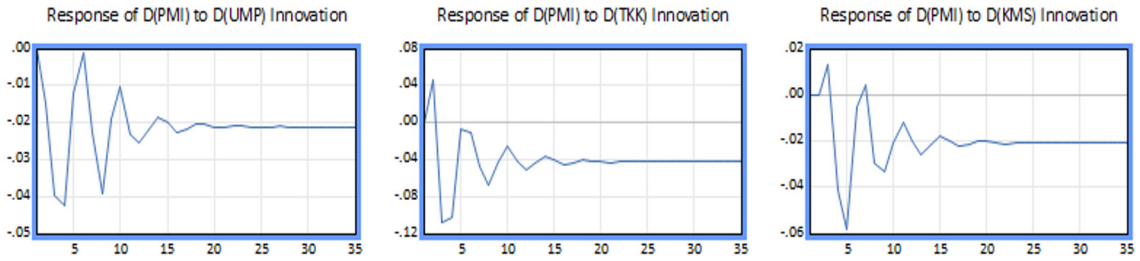
The UMP variable exhibits a positive impact on the PMI, suggesting that a 1% increase in the provincial minimum wage will lead to a 1.88% rise in the PMI over the long term. This finding aligns with research by Sy & Hosoe (2023) and Tabuga et al. (2021), which indicates that the rate of labor migration abroad continues to grow despite increases in the minimum wage. The employment opportunity variable also shows a significant positive effect. Specifically, a 1% increase in the TKK is associated with a 0.001077 increase in the PMI. This result is reinforced by a study from Husnah et al. (2019)and De Haas et al. (2019) which demonstrates that enhanced employment opportunities contribute to a rise in the number of labor migrants. On the other hand, while the poverty variable has a positive coefficient, it does not significantly influence the number of Indonesian migrant workers. This finding is consistent with research by Muslihatinningsih et al. (2020) and Tabuga et al. (2021) which suggests that the inability to meet family needs drives individuals toward international migration, as they seek higher wages to improve their welfare.

The Impulse Response Function shows the response of a variable over time to shocks in other variables. Figure 2 shows the response described by PMI to changes or shocks in other variables, including the provincial minimum wage, employment opportunity rate, and poverty. PMI's response to the shocks caused by UMP changes is negative, fluctuating until the 15th period. PMI began to decline in the 20th period. On the other hand, PMI's response to changes in employment opportunities and poverty was different: at the beginning of the period, PMI gave a positive response, though it lasted only a very short time. PMI's response to the TKK shock continued to move negatively, fluctuating, until in the 20th period, PMI showed a stable response. Meanwhile, PMI's response to the poverty shock was positive in the 8th period, then negative, and stabilized in the 25th period.

**Figure 2. Impulse Response Function**




Source: Data Processing Results

According to Table 7, the PMI variable exhibits self-influences from the first to the tenth period. In the second period, PMI declined by 93.69%, gradually falling to 54.91% by the tenth period. Meanwhile, the contribution of the provincial minimum wage to PMI tends to increase from the beginning to the tenth period. In the second period, it contributed 0.62%, and in the fourth period, it increased to 4.65%. This contribution continued to increase until in the tenth period, UMP contributed 5.88%. The employment opportunity rate variable contributing to the PMI tends to fluctuate. In

the second period, TKK had an effect of 5.67% and continued to rise, reaching 31.62% by the fourth period. In the fifth period, it decreased to 28%, but in the tenth period, TKK's contribution became 31.9%. Then, the contribution of poverty variables to PMI fluctuates. In the third period, it was 0.26% and continued to fluctuate until the tenth period; the influence of poverty on PMI was 7.29%.

**Table 7. Variance Decomposition of D(PMI)**

| Period | S.E. | D(PMI) | D(UMP) | D(TKK) | D(KMS) |
|---|---|---|---|---|---|
| 1 | 0.181636 | 1.000.000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.190498 | 9.369.783 | 0.628982 | 5.673.007 | 0.000178 |
| 3 | 0.247769 | 7.432.410 | 2.907.954 | 2.250.579 | 0.262161 |
| 4 | 0.277097 | 6.125.746 | 4.655.376 | 3.162.275 | 2.464.417 |
| 5 | 0.294726 | 6.162.210 | 4.282.753 | 2.800.101 | 6.094.140 |
| 6 | 0.298189 | 6.234.262 | 4.185.348 | 2.748.493 | 5.987.103 |
| 7 | 0.304457 | 6.082.758 | 4.562.060 | 2.884.587 | 5.764.485 |
| 8 | 0.31613 | 5.676.017 | 5.759.424 | 3.128.186 | 6.198.551 |
| 9 | 0.322298 | 5.525.006 | 5.884.015 | 3.184.623 | 7.019.702 |
| 10 | 0.325168 | 5.491.987 | 5.882.692 | 3.190.063 | 7.296.808 |

Source: Data Processing Results

Based on the results of all data tests, our findings align with those of Khan (2021), who stated that wages positively affect overseas labor migration in both the short and long term. Increasing the minimum wage can raise migrant worker (PMI) due to a significant wage gap between origin and destination regions (Husnah et al., 2019). Wages in destination countries remain higher than in the origin country (Pholphirul, 2019; Tabuga et al., 2021). Therefore, even if wages in the country of origin increase, they remain insufficient to cover living costs (Husnah et al., 2019; Trisetiyo & Haviz, 2020). Furthermore, the high cost of living on Java, especially in the larger provinces, means that wage increases are still insufficient to meet these needs. Central Java is one of the provinces with the lowest minimum wage levels on the island. Although the minimum wage in Central Java Province increases annually, this does not reduce the number of migrant workers from Central Java. In fact, according to data from the Indonesian Migrant Workers Association (BP2MI), Central Java is one of the provinces on Java Island with the highest number of migrant workers (PMI) dispatched. Furthermore, minimum wage increases are usually accompanied by rising regional costs of living. Suppose minimum wage increases are disproportionate to the overall increase in the cost of living. In that case, it can make it difficult for workers to meet their living expenses on local income (Müller, 2023). People tend to migrate to wealthier or higher-income areas.

The employment opportunity variable was found to have a positive effect in both the short- and long-term. This finding aligns with Husnah et al. (2019) and De Haas et al. (2019), who found that increased employment opportunities will still increase the number of labor migrants. Furthermore, when job opportunities are abundant in the region of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origin but do not align with the local community's interests, it will ultimately encourage people to become migrant workers (Rabbani et al., 2022). Many job opportunities are available in the region of origin, such as farm laborers, livestock breeders, and construction workers. These jobs tend to be low-paying and barely sufficient to meet daily needs. Therefore, people tend to work abroad as migrant workers to improve their families' economic situations and secure more adequate incomes (Husnah et al., 2019).

The findings on the poverty variable indicate a positive effect in the short term. This is in line with research by Muslihatinningsih et al. (2020) and Tabuga et al. (2021) that the inability to meet family needs makes international migration the best solution, and that individuals tend to seek higher-paying jobs to improve their well-being. Meanwhile, poverty has a positive but insignificant effect in the long term. These results align with research by Nugraha et al. (2023) and Hikmawati and Pierewan (2020), which state that underprivileged conditions make it difficult for them to establish relationships by participating in activities that require spending money. Other triggering factors include pre-departure costs and the complex, time-consuming processing of various administrative or document-related matters (Robot et al., 2023). Furthermore, training costs, which are relatively expensive and must be borne by the individual, are also a consideration in deciding to become a migrant worker (Spaan & van Naerssen, 2017).

## CONCLUSIONS

This study reveals that, in the short term, provincial minimum wages, employment opportunities, and poverty levels have a positive impact on the number of Indonesian migrant workers. Over the long term, although all variables also exhibit a positive trend, the influence of poverty became insignificant. There are anomalies observed in both the short and long term, where increases in provincial minimum wages and employment levels drive labor migration abroad due to suboptimal domestic job opportunities and consistently high wage disparities with destination countries. Consequently, these findings highlight the importance for policymakers in Indonesia of periodically reviewing and adjusting provincial minimum wages, alongside implementing effective price control measures, to ensure that workers' living needs are met at a reasonable cost of living. Failure to manage price controls effectively may lead to inflationary pressures following minimum wage increases. The ultimate goal is to ensure that such wage adjustments truly enhance workers' ability to achieve a decent standard of living.

## REFERENCES

Ayanie, F. T., Melese, D. T., Beze, E. T., & Fanta, T. A. (2020). Trends in Contemporary International Migration of Ethiopia. *PanAfrican Journal of Governance and Development*, *1(2)*, 30–60.

Az-Zahra, Q., & Widarjono, A. (2022). (2022). Determinants of Financial System Stability in ASEAN Countries. *Jurnal Keuangan dan Perbankan*, *19(1).*, 1–14. https://doi.org/10.35384/jkp.v19i1.347.

BP2MI. (2023). *Data Penempatan dan Pelindungan PMI 2023*. Jakarta: BP2MI.

Cedillo, L., Lippel, K., & Nakache, D. (2019). Factors Influencing the Health and Safety of Temporary Foreign Workers in Skilled and Low-Skilled Occupations in Canada. *New Solutions: a Journal of Environmental and Occupational Health Policy*, *29*(3), 422–458. https://doi.org/10.1177/1048291119867757.

De Haas, H., Czaika, M., Flahaux, M., Mahendra, E., Natter, K., Vezzoli, S., & Villares-Varela, M. (2019). International Migration: Trends, Determinants, and Policy Effects. *Population and Development Review*, *45*(4), 885–922. https://doi.org/10.1111/padr.12291.

Edo, A. (2019). The Impact of Immigration on the Labor Market. *Journal of Economic Surveys*, *33*(3), 922–948. https://doi.org/10.1111/joes.12300.

Hellgren, Z., & Serrano, I. (2019). Financial Crisis and Migrant Domestic Workers in Spain: Employment Opportunities and Conditions During The Great Recession. *International Migration Review*, *53*(4), 1209–1229. https://doi.org/10.1177/0197918318798341.

Hia, J. R., Waruwu, E., Gea, J. B. I. J., & Waruwu, R. M. P. (2024). Menguak Alasan di Balik Arus Migrasi dari Desa Hilidaura, Kecamatan Mandrehe Barat Nias Barat. *Management Perspective: Jurnal Penelitian Manajemen*, *1*(4), 203–214.

Hikmawati, U, N., & Pierewan, A. C. (2020). Hubungan Kemiskinan dan Pengangguran terhadap Migrasi di Indonesia. E-Societas. *Jurnal Pendidikan Sosiologi*, *9(3),* 17116. https://doi.org/10.21831/e-societas.v9i3.17116.

Hoffmann, E. M., Konerding, V., Nautiyal, S., & Buerkert, A. (2019). Is the Push-Pull Paradigm Useful to Explain Rural-Urban Migration? A Case Study in Uttarakhand, India. *PloS One*, *14*(4), e0214511. https://doi.org/10.1371/journal.pone.0214511.

Holzmann, R. (2018). *Managed Labor Migration in Afghanistan*. Washington D.C.: The World Bank Group.

Husnah, A., Sentosa, S. U., & Anis, A. (2019). Faktor-Faktor yang Mempengaruhi Migrasi Seumur Hidup di Indonesia. *Jurnal Kajian Ekonomi dan Pembangunan*, *1*(2), 331–340.

Ifa, K., Viphindrartin, S., Santoso, E., & Priyono, T. H. (2024). Spatial Patterns of Economic Growth In East Java Province. *Conference on SDGs Transformation through the Creative Economy: Encouraging Innovation and Sustainability (TCEEIS 2023)*, 184–187.

Khan, M. I. (2021). Consequences of Labour Migration on Wages and Employment: Evidence from India. *The Indian Journal of Labour Economics*, *64*(1), 23–47. https://doi.org/10.1007/s41027-020-00294-7.

Kwilinski, A., Lyulyov, O., Pimonenko, T., Dzwigol, H., Abazov, R., & Pudryk, D. (2022). International Migration Drivers: Economic, Environmental, Social, and Political Effects. *Sustainability*, *14*(11), 6413. https://doi.org/10.3390/su14116413.

Lee, E. S. (1966). A Theory of Migration. *Demography*, *3*(1), 47–57.

Lohmann, H., & Marx, I. (2018). *Handbook on in-Work Ooverty*. Cheltenham: Edward Elgar Publishing.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46422

Mangara, T. H., Saputri, W., & Putri, R. A. (2024). Pengaruh Kondisi Sosial, Ekonomi, dan Ketenagakerjaan terhadap Migrasi Luar Negeri di Indonesia:(Studi Kasus: 33 Provinsi di Indonesia Tahun 2013–2022). *Benefits: Journal of Economics and Tourism*, *1*(1), 16–32.

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., & Taylor, J. E. (1993). Theories of International Migration: A Review and Appraisal. *Population and Development Review*, 431–466. https://doi.org/10.2307/2938462.

Müller, T. (2023). Minimum Wage Developments in 2022: Fighting the Cost-of-Living Crisis. *ETUI Research Paper-Policy Brief*.

Muslihatinningsih, F., Sinaga, J. P., & Istiyani, N. (2020). Migrasi Internasional Penduduk Pulau Jawa Menjadi Pekerja Migran Indonesia di Luar Negeri. *Jurnal Ekonomi Pembangunan*, *9*(2), 106–115. https://doi.org/10.23960/jep.v9i2.100,

Nugraha, M. K. G., Komariyah, S., Viphindrartin, S., Istiyani, N., & Somaji, R. P. (2023). Determinan Migrasi Internasional Tenaga Kerja Wanita Indonesia Tahun 2012-2019. *Jurnal Perencanaan Wilayah dan Pembangunan*, *1*(2), 92–99.

Nunley, J. M., Pugh, A., Romero, N., & Seals, R. A. (2017). The Effects of Unemployment and Underemployment on Employment Opportunities: Results from a Correspondence Audit of the Labor Market for College Graduates. *Ilr Review*, *70*(3), 642–669. https://doi.org/10.1177/0019793916654686.

Parreñas, R. S., Silvey, R., Hwang, M. C., & Choi, C. A. (2019). Serial Labor Migration: Precarity and Itinerancy among Filipino and Indonesian Domestic Workers. *International Migration Review*, *53*(4), 1230–1258.

Pekarskiene, I., Laskiene, D., Saboniene, A., & Susniene, R. (2016). The Impact of Economic Globalization on the Labor Market of an Open Small Economy. *Financial Environment and Business Development: Proceedings of the 16th Eurasia Business and Economics Society Conference*, 199–216.

Pholphirul, P. (2019). South–South Labour Migration and Sustainable Development: Implications for Southeast Asian Countries. *Sustainable Development*, *27*(1), 1–12. https://doi.org/10.1002/sd.1876.

Purna, F. P., & Sulistian, B. D. (2019). International Migration In Indonesia and Its Affecting Factors: Data Panel Approach. *El-Iqtishod*, *3*(1), 16–27.

Rabbani, N. H., Kurniawan, R. A, & Suastrini, F. (2022). Analisis Faktor-Faktor Yang Menyebabkan Penduduk Memutuskan Menjadi Pekerja Migran Indonesia (Pmi) Di Dusun Bantir Desa Banyu Urip Kecamatan Gerung Kabupaten Lombok Barat. *Society*, *13*(2), 13-23.

Robot, M., Lambe, A., Syamsuriady, K. M. M., & Ande, A. (2023). Buruh Migran Timor: Sebab, Jejaring dan Risiko (Studi Kasus Desa Silu, Kabupaten Kupang, NTT). *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, *6*, 358–367. https://doi.org/10.54371/jiip.v6i1.1505.

Santoso, E., & Muslihatinningsih, F. (2022). Brain Drain Indonesia dan Dampaknya Bagi Indonesia. *JAE (Jurnal Akuntansi dan Ekonomi)*, *7*(1), 42–52. https://doi.org/10.29407/jae.v7i1.17702.

Schewel, K., & Asmamaw, L. B. (2021). Migration and Development in Ethiopia: Exploring the Mechanisms Behind an Emerging Mobility Transition. *Migration Studies*, *9*(4), 1673–1707. https://doi.org/10.1093/migration/mnab036.

Stark, O., & Bloom, D. E. (1985). The New Economics of Labor Migration. *The American Economic Review*, *75*(2), 173–178.

Sukesi, K., Rosalinda, H., Handayani, W., Inggrida, J. A., Anggraini, E., Hadi, R. P., & Farcha, R. (2022). "Decision to Migrate" of Female Migrant Workers in Sendang Biru, Malang Regency. *Salasika*, *5*(2), 125–140. https://doi.org/10.36625/sj.v5i2.111.

Susanto, J., & Sulaiman, N. F. C. (2022). Economic Prospects and International Labor Migration. *International Journal of Sustainable Development and Planning*, *17*(8), 2475–2483.

Sy, D. K., & Hosoe, N. (2023). Consequences of a Minimum Wage Increase in a Migrant-Sending Country. *Economic Analysis and Policy*, *80*, 1057–1066.

Tabuga, A. D., Baino, M. L. S., & Vargas, A. R. P. (2021). *Analyzing the Characteristics of International Migration in the Philippines using the 2018 National Migration Survey* (Issues 2021–40). Manila: Philippine Institute for Development Studies (PIDS).

Todorov, G. N., Kalinina, A. V., & Rybakova, A. I. (2018). Impact of Labour Migration on Entrepreneurship Ecosystem: Case of Eurasian Economic Union. *Entrepreneurship and Sustainability Issues*, *5*(4), 992–1007. https://doi.org/10.9770/jesi.2018.5.4(20).

Trisetiyo, W., & Haviz, M. (2020). The Effect of Wages, Investment, Number of Industrial Units, and Number of Job Opportunities on the Level of Migration to DKI Jakarta in 2008-2019. *Dinamika Ekonomi*, *12*(1), 123–132. https://doi.org/10.29313/.v12i1.6780.

Wright, C. F., & Clibborn, S. (2019). Migrant Labour and Low-Quality Work: A Persistent Relationship. *Journal of Industrial Relations*, *61*(2), 157–175. https://doi.org/10.1177/0022185618824137.

Yagura, K. (2024). Wage Rise for Unskilled Workers in Cambodia: Was Labour Migration to Thailand the Cause?. *Journal of Southeast Asian Economies (JSEAE)*, *41*(2), 89–105.

Yamin, M., Atmaja, J. P., & Ikra. (2023). Dampak Mobilitas Buruh Migran Terhadap Peningkatan Ekonomi Keluarga dan Pendidikan Anak: Studi Kasus Buruh Migran di Bima. *PENDIKDAS: Jurnal Pendidikan Sekolah Dasar*, *4*(1), 35–45. https://doi.org/10.56842/pendikdas.v4i1.181.

Zuhra., Safeer, A. K., & Abbas, S. (2024). Analyzing the Theme of Forced Migration in Amit Majmudar's Partitions through the Lens of Everett Lee's Pull-Push Theory. *Panacea Journal of Linguistics & Literature*, *2*(2), 367–376. https://doi.org/10.59075/pjll.v2i2.356


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# Determinants of International Migration: A Panel Data Evidence from Indonesia

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## ABSTRACT

**Research Originality**: This research is original in integrating education, unemployment, minimum wages, and poverty into a panel-data framework to analyze international labor migration across Indonesian provinces.

**Research Objectives**: This study aims to investigate the impact of average educational attainment, the open unemployment rate, provincial minimum wage, and poverty rate on international migration of Indonesian workers.

**Research Methods**: This study uses panel data from 32 provinces in Indonesia for the period 2010 to 2025 and applies a panel regression approach with a Fixed Effects Model.

**Empirical Results**: The findings indicate significant influences from both dependent and independent variables. Average years of education, open unemployment rate, provincial minimum wage, and poverty are shown to have a negative and significant influence on the international migration patterns of Indonesian migrant workers.

**Implications**: Policymakers should focus on affordable migration financing schemes to address poverty constraints, vocational training relevant to the international labor market, and strengthening the migration ecosystem in areas with high unemployment rates.

**Keywords:**
international migration; education; unemployment; minimum wage; poverty

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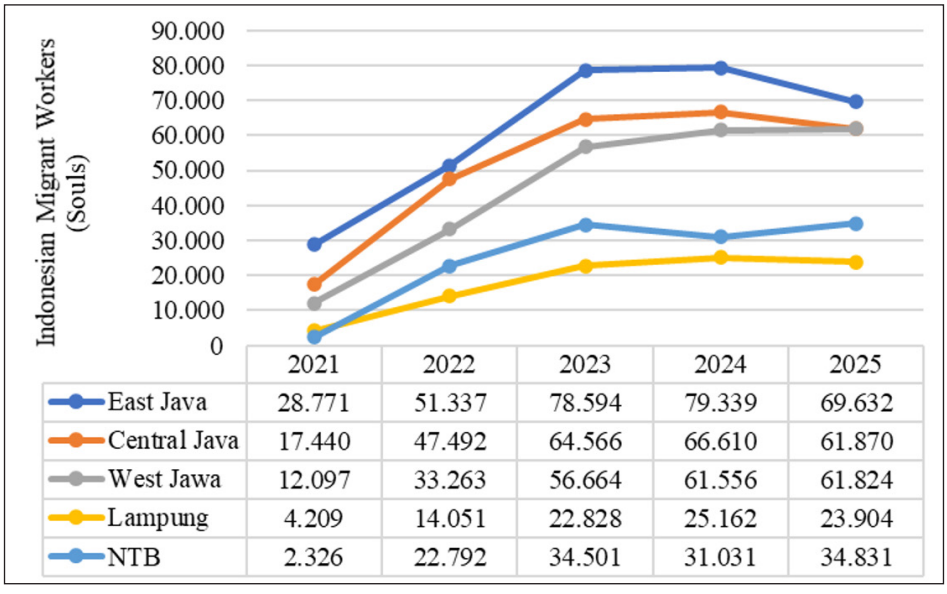
## INTRODUCTION

Advances in transportation, communication, and information flows have reduced the costs of migration and expanded mobility in almost all regions of the world (Al-Dalahmeh et al., 2021; Liu et al., 2025; Tolesh & Biloshchytska, 2024). The number of international migrants worldwide increased from 275 million in 2020 to 304 million in 2024, a 10.5 percent increase (United Nations, 2024). Migration is generally undertaken by workers seeking employment abroad to earn higher incomes and support their families through remittances (Atiyatna et al., 2024; Baite & Panda, 2025; Khan et al., 2023). Therefore, international labor migration is understood as cross-border mobility in search of employment that generates economic benefits for migrants, their countries of origin, and the economies of their destination countries (Mitterbacher et al., 2024).

In this global context, Indonesia is one of the largest labor-sending countries in Southeast Asia. Data from the Indonesian Migrant Workers Protection Agency (BP2MI) shows that the number of Indonesian migrant workers increased by 27.6 percent, from 233,029 in 2010 to 296,948 in 2025 (KP2MI/BP2MI, 2026). Figure 1 shows that the highest migration originated from East Java, Central Java, West Java, Lampung, and West Nusa Tenggara. East Java is recorded as the largest contributor, with a sharp increase from 28,771 people in 2021 to 79,339 people in 2024, before declining to 69,632 people in 2025. Migrant workers contributed approximately USD 15.7 billion in remittances to the Indonesian economy throughout 2024 (KP2MI/BP2MI, 2026).

**Figure 1. Migration trends based on the five provinces with the highest number of migrant workers during 2021-2025**




| | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|
| East Java | 28.771 | 51.337 | 78.594 | 79.339 | 69.632 |
| Central Java | 17.440 | 47.492 | 64.566 | 66.610 | 61.870 |
| West Jawa | 12.097 | 33.263 | 56.664 | 61.556 | 61.824 |
| Lampung | 4.209 | 14.051 | 22.828 | 25.162 | 23.904 |
| NTB | 2.326 | 22.792 | 34.501 | 31.031 | 34.831 |

Source: KP2MI/BP2MI (2026)

Most Indonesian migrants work in the informal sector and low-skilled jobs, such as domestic work, agriculture, and nursing, because these sectors offer higher wages than in Indonesia, even for those without specialized skills (Shahiri et al., 2021). This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migration flow primarily originates in low- and middle-income countries and flows to developed countries (Schäfer & Henn, 2023). The dominance of Indonesian migrants in unskilled jobs reflects the state of the national education system. Despite showing gradual improvement, the Indonesian education system has not yet achieved the target of twelve years of compulsory education.

According to the Central Statistics Agency (BPS), in 2025, the average national education level will be only nine years, with significant variations between provinces, ranging from 8.07 years in West Kalimantan to 11.59 years in DKI Jakarta. BPS data for 2025 shows socio-economic differences between regions reflected in open unemployment rates varying from 1.49 percent in Bali to 6.77 percent in West Java, provincial minimum wages that vary significantly from Rp 2,036,947 in Central Java to Rp 5,067,381 in DKI Jakarta, and poverty rates ranging from 3.72 percent in Bali to 19.16 percent in East Nusa Tenggara. These conditions indicate that provincial socio-economic characteristics can systematically influence migration decisions. However, the interaction between average years of schooling, open unemployment rates, provincial minimum wages, and poverty in shaping migration patterns over time remains inadequately understood.

The existing literature identifies education, unemployment, minimum wages, and poverty as key determinants of international migration, yet empirical findings remain inconsistent. Education exhibits a nonlinear relationship with migration: higher education increases permanent migration among skilled workers, while lower education is associated with temporary labor migration (Popescu & Pudelko, 2024). Park et al. (2024) show that higher education increases the propensity to migrate, while Fenoll & Kuehn (2017) found that increasing primary education actually reduces the likelihood of migration because higher education creates better domestic job opportunities. Conversely, Atiyatna et al. (2024) and Puspitasari (2017) found no significant effect of education levels on labor migration in Indonesia.

Unemployment also shows varying effects in various empirical studies. Unemployment occurs when the number of job seekers exceeds the number of available job vacancies and can hinder a country's economic progress (Grecu et al., 2024). Komariyah & Sutantio (2020) and Muslihatinningsih et al. (2020) found that higher unemployment rates positively affect migration flows in Indonesia, consistent with evidence from Europe, Mihi-Ramírez et al. (2014), which shows that increasing unemployment is positively associated with emigration, and Dritsaki & Dritsaki (2024), which found that rising unemployment correlates with higher immigration rates. The growing number of immigrant workers helps fill labor shortages in certain sectors, thereby reducing unemployment rates in the destination countries (Lakshmanasamy, 2021; Tomohara, 2022).

Regarding wages, findings indicate that significant wage differences between the home and host countries are a major factor driving migration. (Lakshmanasamy, 2021; Martin & Termos, 2015; Shahiri et al., 2021). According to neoclassical theory (Massey et al., 1993; Park et al., 2024). Research from Indonesia by Atiyatna et al. (2024) and Muslihatinningsih et al. (2020) found that increasing domestic wages reduces the

propensity to migrate. However, the minimum wage policy in Indonesia applies only to permanent formal-sector workers, leaving most informal-sector workers with wages below the minimum standard (Siregar, 2022). This structural inequality can encourage workers to migrate internationally in search of higher incomes and better job protection.

The relationship between poverty and migration is among the most theoretically debated. The New Economic Labor Migration (NELM) approach views migration as a household strategy for income diversification and risk management (Massey et al., 1993; Stark & Bloom, 1985), supported by Muslihatinningsih et al. (2020), who found that poverty was positively associated with international migration from Java. However, Hagen-Zanker et al. (2025), based on a survey of 13,000 young respondents in 10 countries using multilevel mixed logistic regression, confirm that extreme poverty tends to reduce the desire and ability to migrate due to limited resources, social networks, and access. These findings suggest a nonlinear relationship between poverty and migration, where moderate poverty may encourage migration. In contrast, extreme poverty may actually constrain it, a dynamic that has not been fully explored in studies in Indonesia, especially given the large variation in poverty levels across regions.

This study differs from previous research in terms of data coverage, time span, and methodology. Atiyatna et al. (2024) focused on 10 provinces in Sumatra during 2017-2021, while Muslihatinningsih et al. (2020) analyzed six provinces in Java during 2010-2019. In contrast, this study uses a national panel dataset covering 32 provinces in Indonesia over a longer period, 2010-2025, allowing for a more comprehensive analysis of regional and temporal dynamics. Furthermore, unlike Komariyah & Sutantio (2020), who use time-series data with an OLS approach, this study employs panel-data regression, which better captures cross-sectoral and temporal variations in the determinants of labor migration.

Although research on international labor migration in Indonesia continues to grow, significant gaps remain in the literature. Existing studies are generally limited to specific regions, use national aggregate data, or analyze the determinants of migration separately over relatively short periods, thus failing to capture interprovincial heterogeneity and the simultaneous interaction of key socio-economic factors. No study has systematically analyzed the combined and long-term effects of average years of education, open unemployment rates, provincial minimum wages, and poverty across all provinces in Indonesia. This study fills this gap by presenting a comprehensive panel analysis of international labor migration across 32 provinces from 2010 to 2025. It analyzes the individual and combined effects of education, unemployment, minimum wages, and poverty on outbound migration flows from provinces. It evaluates variations in their impacts across regions and changes over time. Thus, the outcomes of this research are expected to serve as an evidence-based policy foundation for provincial and national governments in designing more targeted interventions, while also supporting the formulation of national strategies for migrant worker protection, international labor cooperation, and remittance management to support regional and national economic development.


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## METHODS

This study uses secondary panel data that combines time-series observations with cross-sectional information. The cross-sectional component comprises 32 provinces in Indonesia, and the time dimension spans 2010-2025. The selection of the research period is based on the availability and consistency of data that are relatively more complete and reliable across all provinces since 2010, thereby supporting the validity of the panel data regression analysis. The total sample size in this study is 480 observations, deemed sufficient to support strong statistical inferences while maintaining data quality and comparability across provinces. It should be noted that although Indonesia currently has 38 provinces, this study covers only 32 of them. The other six provinces are excluded due to limited data availability on several research variables during the observation period.

This study positions international labor migration as the dependent variable, operationalized through the total number of Indonesian Migrant Workers (PMI). The independent variables include average length of schooling (RLS), unemployment rate (TPT), provincial minimum wage (UMP), and poverty rate (KE). Data collection was conducted by searching for, gathering, and downloading information from official websites (Syafitri et al., 2025), namely the Central Statistics Agency (BPS), the Indonesian Migrant Workers Protection Agency (BP2MI), and the Ministry of Manpower's One Data portal (Kemnaker). All data were obtained from the official websites of these institutions to ensure authenticity and accuracy. The description of the variables used in this analysis is presented in Table 1.

**Table 1. Definition of Variables**

| Variables | Definitions | Symbol | Sources | References |
|---|---|---|---|---|
| Indonesian migrant workers (People) | Every Indonesian citizen who works or has worked and received wages outside the territory of the Republic of Indonesia. | PMI | KP2MI/ BP2MI | (Muslihatinningsih et al., 2020) |
| average length of schooling (Years) | The mean duration of formal schooling attained by the population aged 25 years and older. | RLS | BPS | (Puspitasari, 2017) |
| Open unemployment rate (%) | The ratio of the number of unemployed people to the total labor force in a particular region and period of time. | TPT | BPS | (Amri et al., 2025) |
| Provincial minimum wage (IDR) | The minimum wage applicable to workers in all districts/cities within a province. | UMP | Library DPR RI | (Atiyatna et al., 2024; Muslihatinningsih et al., 2020) |
| Poverty rate (%) | The percentage of the population with a mean monthly per capita expenditure below the poverty threshold is measured. | KE | BAPPENAS | (Amri et al., 2022) |

Source: Author calculation

Data analysis was performed using panel data regression, as this method captures cross-sectional and time-series variation simultaneously, controls for unobserved heterogeneity across provinces, and produces more efficient and consistent estimates compared to pure time-series or cross-sectional approaches (Amri et al., 2022). The panel data regression method is used to analyze the relationship between these independent variables and international migration in 32 provinces in Indonesia from 2010 to 2025. This model is specified based on neoclassical migration theory (Massey et al., 1993) and the New Economics of Labor Migration (Stark & Bloom, 1985), which state that differences in wages, job opportunities, and household economic conditions influence migration decisions. The econometric model employed in this study can be articulated as such:

$$LPMI_{it} = \beta_0 + \beta_1 LRLS_{it} + \beta_2\ LTPT_{it} + \beta_3\ LUMP_{it} + \beta_4 LKE_{it} + \varepsilon_{it} \qquad (1)$$

Where $LPMI_{it}$ is the logarithm logarithm of the number of Indonesian migrant workers from province *i* during period *t*. $LRLS_{it}$ is the logarithm of the average length of schooling in province *i* in period *t*. $LTPT_{it}$ is the logarithm of the open unemployment rate in province *i* in period *t*. $LUMP_{it}$ is the logarithm of the provincial minimum wage in province *i* in period *t*. $LKE_{it}$ is the logarithm of the poverty rate in province *i* in period *t*. Furthermore, $\beta_0$ is a constant, while $\beta_1$-$\beta_4$ are the estimated coefficients for the independent variables LRLS, LTPT, LUMP, and LKE. The index *i* indicates the province unit (1, 2, …, 32) and *t* indicates the observation period (2010, 2011, …, 2025). Lastly, $\varepsilon$ is the error term in the model.

In the context of panel data regression, the analysis begins with data preparation, including data cleaning, checking for missing values, handling outliers, and transforming all variables to logarithms. All research variables are transformed to natural logarithms to standardize the data scale, reduce potential heteroskedasticity, and facilitate the interpretation of regression coefficients as elasticities, thereby making the estimation results more statistically stable and economically relevant. Next, descriptive statistical analysis is conducted to characterize the research variables (Amri et al., 2022).

In panel data regression, there are three main approaches, namely the Joint Effects Model, the Fixed Effects Model, and the Random Effects Model (Amri, 2020). Selecting the right regression model is crucial for obtaining accurate estimates of the relationships between the variables under study. Therefore, to determine the most appropriate panel regression model, model specification tests are performed, namely the Chow test and the Hausman test (Amri, 2020). The Chow test is used to select between CEM and FEM; a p-value > 0.05 indicates CEM, while a p-value < 0.05 indicates FEM. Next, the Hausman test is performed to determine whether the fixed-effects or random-effects model should be used; if the p-value is> 0.05, this supports the random-effects model. Conversely, if the p-value < 0.05, this indicates that the fixed-effects model is appropriate.

After determining the most appropriate panel regression model, classical assumption tests are performed. In panel data regression, classical assumption tests include tests


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for multicollinearity and heteroscedasticity, where the multicollinearity test assesses the correlation among independent variables. The multicollinearity test used in panel data regression is the Pairwise Correlation method, with a correlation coefficient value < 0.85. Next, a heteroscedasticity test is conducted to examine the consistency of the residual variance. Then, panel data regression is estimated using the selected model, and statistical conclusions are drawn from the interpretation of regression coefficients and hypothesis testing at $\alpha = 0.05$.

## RESULTS AND DISCUSSION

Table 2 presents descriptive statistics for the research variables based on panel data from 32 provinces in Indonesia during 2010-2025, yielding a total of 512 observations. Indonesian migrant workers (PMI) number a maximum of 149,936 in West Java Province (2011), a minimum of 1 in North Maluku Province (2020-2021), and an average of 9,911. The substantial standard deviation of 23,332 indicates significant regional disparities in population movements. Average Years of Schooling (RLS) ranges from 5.59 years in Papua Province (2010) to 11.59 years in DKI Jakarta Province (2024), with an average of 8.37 years, suggesting uneven educational attainment across regions. The Open Unemployment Rate (TPT) ranges from 1.40 percent in Bali Province (2018) to 13.74 percent in Banten Province (2011), averaging 5.29 percent, reflecting diverse labor market conditions across regions. Provincial Minimum Wage (UMP) demonstrates considerable variation, ranging from IDR 630,000 in East Java Province (2010) to IDR 5,396,761 in DKI Jakarta Province (2025), with an average of IDR 2,071,588. Finally, Poverty (KE) ranges from 3.47 percent in DKI Jakarta (2019) to 34.10 percent in Papua (2010), with an average of 10.86 percent during the 2010-2025 period, indicating considerable variation across provinces over the study period.

**Table 2. Summary Statistics**

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Indonesian migrant workers (PMI) | 512 | 9,911 | 23,332 | 1 | 149,936 |
| average length of schooling (RLS) | 512 | 8.37 | 1.07 | 5.59 | 11.59 |
| Open unemployment rate (TPT) | 512 | 5.29 | 2.05 | 1.40 | 13.74 |
| Provincial minimum wage (UMP) | 512 | 2,071,588 | 872,496 | 630,000 | 5,396,761 |
| Poverty rate (KE) | 512 | 10.86 | 5.52 | 3.47 | 34.10 |

Source: The author's calculations using Eviews, 2026

Before estimating a panel data regression, we first selected the best model among the Common Effects Model, Fixed Effects Model, and Random Effects Model using the Chow and Hausman Tests. The test results are presented in Table 3 below. Based on the Chow Test results, a probability value of 0.00 (< 0.05) was obtained, indicating that the Fixed Effect Model is more appropriate. Furthermore, the Hausman test showed a p-value of 0.00 (< 0.05), indicating that the Fixed Effects Model was more appropriate

than the Random Effects Model. Therefore, it was decided to use the Fixed Effects Model in this study.

**Table 3. Chow and Hausman Test Results**

| Effect Test | Chi-Squared | df | P-Value |
|---|---|---|---|
| Chow | 1,091 | 31 | 0.00 |
| Hausman | 24.53 | 4 | 0.00 |

Source: The author's calculations using Eviews, 2026

We conducted multicollinearity tests for the selected model, with the results shown in Table 4. From Table 4, the results of the multicollinearity test using the Pairwise Correlation method indicate that all correlation coefficients between independent variables are less than 0.85. This indicates that there is no multicollinearity in the panel data regression specification used.

**Table 4. Multicollinearity Test Results: Pair Wise Correlation**

| Variable | LRLS | LTPT | LUMP | LKE |
|---|---|---|---|---|
| LRLS | 1 | | | |
| LTPT | 0.32 | 1 | | |
| LUMP | 0.55 | -0.08 | 1 | |
| LKE | -0.48 | -0.16 | -0.30 | 1 |

Source: The author's calculations using Eviews, 2026

Furthermore, a heteroscedasticity test was conducted to examine the consistency of residual variance. Figure 2 shows the LPMI residual plot, where the residuals are randomly scattered around zero and have relatively constant variance across all observations. The absence of systematic patterns or funnel shapes indicates that the model satisfies the homoscedasticity assumption. From the residual plot (blue), it can be observed that the values remain within the bounds (500 and -500), indicating that the residual variance is constant. Therefore, it can be concluded that this study does not exhibit heteroscedasticity or passes the heteroscedasticity test, and is worthy of estimation.

The regression model used meets the classical assumptions because it passes the heteroscedasticity and multicollinearity tests; thus, the estimation results are statistically valid and reliable (Table 5). The results of the fixed-effects panel-data estimation across 32 provinces for 2010-2025 showed an adjusted R-squared of 0.89. This indicates that 89 percent of the variation in international migration of Indonesian workers is explained by the independent variables included in the model, while the remaining 11 percent is explained by other factors outside the model. The Prob value (F-statistic) of 0.00 indicates that the model is jointly significant.

The coefficient of average years of education (LRLS) is -1.56 with a p-value of 0.22. This means that a 1 percentage point increase in the growth rate of average years


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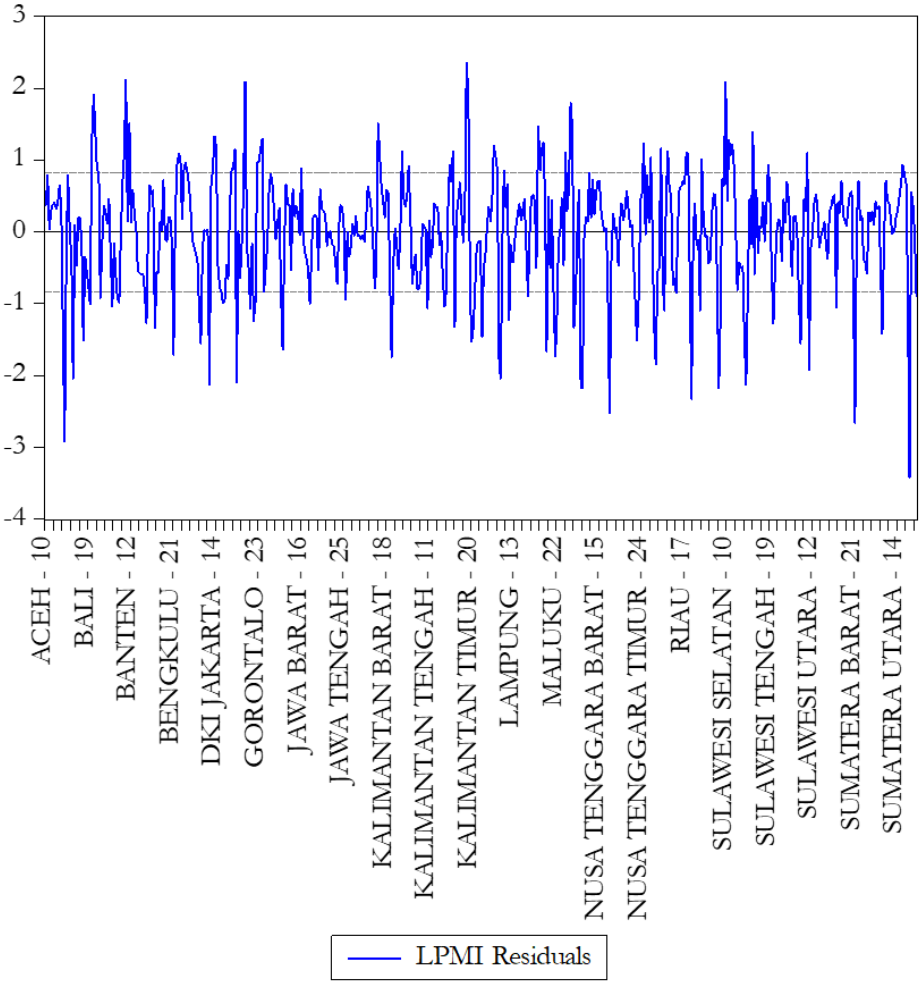
**Figure 2. Residual Heteroscedasticity Test**




Source: The author's calculations using Eviews, 2026

of education tends to reduce the number of Indonesian migrant workers by approximately 1.56 percentage points, ceteris paribus. However, because the p-value (0.22) is greater than the significance levels (1%, 5%, and 10%), this effect is not statistically significant. The coefficient of the log of the open unemployment rate (LTPT) is -0.71 with a p-value of 0.00. This means that if the unemployment growth rate increases by 1 percentage point, it will reduce the number of Indonesian migrant workers by approximately 0.71 percentage points, ceteris paribus. The coefficient of the logarithmic provincial minimum wage (LUMP) is -1.57 with a p-value of 0.00. This means that every 1 percent increase in the provincial minimum wage will reduce the number of Indonesian migrant workers by approximately 1.57 percent, ceteris paribus. Finally, the log coefficient of the poverty rate (LKE) is -3.14 with a p-value of 0.00. This means that if the poverty rate growth rate increases by 1 percent, it will reduce the number of Indonesian migrant workers by 3.14 percent, ceteris paribus.

**Table 5. Panel Regression Estimation Results**

| Variables | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| C | 40.94 | 12.67 | 0.00*** |
| LRLS | -1.56 | -1.23 | 0.22 |
| LTPT | -0.71 | -3.42 | 0.00*** |
| LUMP | -1.57 | -7.89 | 0.00*** |
| LKE | -3.14 | -5.73 | 0.00*** |
| R-square | 0.90 | | |
| Adjusted R-squared | 0.89 | | |
| F-statistic | 120.79 | | |
| Prob(F-statistic) | 0.00 | | |
| Durbin-Watson Stat | 1.10 | | |

Note:*** significant at 1%, ** significant at 5%, * significant at 10%

Source: The author's calculations using Eviews, 2026

Table 3 shows that the panel regression model between education, unemployment rate, provincial minimum wage, poverty rate, and international labor migration in 32 Indonesian provinces from 2010 to 2025 can be expressed in the following equation:

$$LPMI_{it} = 40.94_{it} - 1.56LRLS_{it} - 0.71LTPT_{it} - 1.57LUMP_{it} - 3.14LKE_{it} + \varepsilon_{it} \quad (2)$$

The average length of schooling does not have a significant effect on international labor migration in Indonesia. This finding is consistent with research by Atiyatna et al. (2024) and Puspitasari (2017), which also shows that education level does not significantly influence labor migration decisions in Indonesia. The structure of Indonesia's international labor migration explains this insignificance. According to BP2MI (2025) data, of the 296,948 Indonesian migrant workers placed in 2025, 52.3 percent, or 155,302, worked in the informal sector, with domestic workers being the largest category. Informal sector jobs, such as domestic work, care work, and manual labor, do not require higher education. Furthermore, there are no provisions regarding the minimum education level for prospective Indonesian workers placed abroad (Puspitasari, 2017), provided they have the basic reading and writing skills necessary to follow the pre-departure briefing process (Puspitasari, 2017). Employers in destination countries place greater emphasis on work experience and job readiness than on formal educational qualifications. Therefore, increasing the average length of schooling, for example, from elementary school to junior high school or from junior high school to senior high school, does not improve migrant workers' competitiveness in these types of jobs.

In addition, structural barriers in destination countries, such as diploma recognition, administrative costs, and language requirements, limit the utilization of basic educational qualifications (Fenoll & Kuehn, 2017). This finding does not fully support the human capital theory (Park et al., 2024; Popescu & Pudelko, 2024), which found a positive relationship between education and migration. However, this theory generally applies when education represents upper secondary or higher qualifications for skilled jobs in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the formal sector. Nevertheless, education remains important for integration into the domestic labor market, but it is not a primary factor in international migration because job opportunities abroad are still dominated by the informal sector.

The unemployment rate shows a negative impact on international migration, contrary to the push-pull migration theory and several previous studies. This finding is in contrast to Komariyah & Sutantio (2020), Mihi-Ramírez et al. (2014), and Muslihatinningsih et al. (2020), who found a positive correlation between unemployment and emigration. However, our results do not completely contradict Atiyatna et al. (2024), who found that unemployment does not significantly drive migration when other economic factors dominate. Empirical evidence from Indonesia provides strong support for this counterintuitive relationship. BP2MI (2025) data shows that East Java, with an unemployment rate of 3.88 percent, sent 69,632 migrant workers abroad, while Banten Province, with a higher unemployment rate of 6.69 percent, sent only 3,609. The pattern suggests that provinces with lower unemployment rates have stronger economic capacity, better institutional support systems, and more established migration networks to facilitate large-scale international migration.

This study contributes to the development of migration theory by highlighting the importance of liquidity constraints. International migration requires substantial initial investments in administrative costs, training, transportation, and documentation. Unemployed individuals generally lack sufficient financial resources to cover these costs (Liu et al., 2025). Therefore, our findings extend dual labor market theory and world-systems theory by showing that unemployment pressure alone is insufficient to drive migration without minimal economic capacity and regional-level institutional structures.

The provincial minimum wage (UMP) also negatively affected international labor migration. This result strongly supports the research Atiyatna et al. (2024) and Muslihatinningsih et al. (2020), and is consistent with neoclassical economic theory, which views migration as a response to wage differences (Massey et al., 1993). Therefore, this study strengthens the wage differential hypothesis in the Indonesian context. In Indonesia, where minimum wage policies primarily apply to the formal sector (Siregar, 2022). Rising wages signal increased well-being and income stability in the domestic labor market. As domestic wages rise, international migration becomes less attractive, especially considering job insecurity, cultural adjustment challenges, and family separation in the destination country.

Building on the findings of Sy & Hosoe (2023), this study shows that minimum wage increases do not completely stop migration, but rather make it more selective. Workers with specialized skills or strong migration networks continue to migrate, while others choose to remain in the domestic labor market. This explains why migration flows continue despite wage increases, albeit at lower levels. This selectivity effect is an important contribution to understanding the relationship between wages and migration in developing countries.

Finally, the poverty level shows a negative effect on international labor migration. This result is in line with research by Hagen-Zanker et al. (2025), which states that extreme poverty hinders households' ability to migrate because when all income is allocated to basic needs, households lack the financial resources to cover the significant initial costs of migration (Liu et al., 2025). Empirical evidence from Indonesia strongly supports this relationship. BP2MI (2025) reports that West Nusa Tenggara (NTB), with a poverty rate of 11.78 percent, sent 34,831 migrant workers abroad, while East Nusa Tenggara (NTT), with a poverty rate of 18.60 percent, sent only 4,128. East Java, with a lower poverty rate of 9.50 percent, sent more migrants, a total of 69,632 people. Communities with relatively better economic conditions have a greater capacity to finance international labor migration.

However, our findings differ from those of Muslihatinningsih et al. (2020), which found a positive relationship between poverty and migration. This difference is theoretically significant because it demonstrates a threshold effect. Moderate levels of poverty may increase motivation to migrate, but at severe levels, it creates binding financial constraints that prevent migration. Migration is not a rational choice for the poorest households, but rather a strategy available only to groups with minimal economic capacity (Massey et al., 1993). Furthermore, this study reexamines the dominant narrative regarding remittances as a poverty-reduction mechanism. Although remittances are often considered an effective tool for poverty reduction, migration does not always guarantee improved household welfare. Vulnerabilities arising from pre-migration debt, labor exploitation in the destination country, and high living costs abroad can actually create new conditions of poverty for migrant workers and their families (Ghimire & Neupane, 2025; Hornung et al., 2025). Therefore, our research contributes to reconceptualizing poverty not as the primary driver of migration, but as a structural barrier that hinders access to international migration opportunities.

## CONCLUSION

This study aims to analyze the influence of education, the open unemployment rate, provincial minimum wage, and poverty on international migration of Indonesian workers across 32 provinces during 2010-2025 using a Fixed Effects Model. The results indicate that regional economic conditions play a significant role in determining migration. Average years of education do not have a significant effect, indicating that primary and secondary education are not yet relevant to migration patterns dominated by the informal sector. In contrast, the unemployment rate and provincial minimum wage have a negative impact, as financial constraints stemming from unemployment and increased domestic welfare reduce the incentive to migrate. The poverty rate also has a negative impact and is the most dominant factor, strengthening the poverty trap hypothesis because poor households cannot afford the initial costs of migration. Overall, migration requires minimal economic capacity and is not simply a response to economic pressure.


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Based on the study's findings, the central government, regional governments, and the Indonesian Migrant Workers Association (BP2MI) need to design a more integrated migration policy. This effort includes strengthening vocational training and skills certification to prevent migration from being concentrated solely in the informal sector. In provinces with high unemployment rates but low migration rates, strengthening the migration ecosystem through training and credible placement agencies is crucial to expanding access to international employment. Furthermore, the government needs to provide affordable migration financing schemes, such as subsidies for administrative and transportation costs, to assist poor households who wish to migrate but are constrained by costs. Furthermore, the government and BP2MI need to ensure legal protection and access to decent work for migrant workers so that migration effectively reduces poverty and unemployment and improves the welfare of the Indonesian people. For future research, we recommend using individual microdata and analyzing by occupation and destination country to gain a more comprehensive understanding of the factors influencing Indonesia's international labor migration.

## REFERENCES

Al-Dalahmeh, M., Sarihasan, I., & Dajnoki, K. (2021). The Influence of Gender and Educational Attainment Differences on International Migrants' Occupational Status in OECD Countries. *Economies*, *9*(3), 126. https://doi.org/10.3390/economies9030126.

Amri, K. (2020). Pengaruh Zakat dan Kesempatan Kerja terhadap Tingkat Kemiskinan di Aceh. *Al-Muzara'Ah*, *7*(2), 57–70. https://doi.org/10.29244/jam.7.2.57-70.

Amri, K., Adnan, M., & Fitri, C. D. (2022). Does Poverty Affect Divorce Rates? The Role of Women's Income as a Moderating Variable. *Cogent Social Sciences*, *8*(1), 2069908. https://doi.org/10.1080/23311886.2022.2069908.

Amri, K., Fitri, C. D., & Lubis, I. T. (2025). Sumber Daya Manusia Terhadap Tingkat Pengangguran: Bukti Data Panel Di Provinsi Riau. *Jurnal Selodang Mayang*, *11*(1), 57–66.

Atiyatna, D. P., Hamira, & Yunisvita. (2024). Determinants of Labor Migration to International Labor Markets: A Study of Sumatra Island. *Sriwijaya International Journal of Dynamic Economics and Business, 8*(3), 291–302. https://doi.org/10.29259/sijdeb.v8i3.291-302.

Baite, L., & Panda, B. (2025). Social and Economic Determinants of International Migration: A Study of Kuki Migrants in Singapore. *International Journal of Sociology and Social Policy*, *45*(9–10), 806–820. https://doi.org/10.1108/IJSSP-02-2025-0087.

Dritsaki, M., & Dritsaki, C. (2024). Immigration, Growth, and Unemployment: Panel VAR Evidence from E.U. Countries. *Journal of the Knowledge Economy, 15*, 19928–19963. https://doi.org/10.1007/s13132-024-01909-w.

Fenoll, A. A., & Kuehn, Z. (2017). Compulsory Schooling Laws and Migration across European Countries. *Demography*, *54*(6), 2181–2200. https://doi.org/10.1007/s13524-017-0615-x.

Ghimire, A., & Neupane, M. S. (2025). Induced Poverty, Increased Remittances: Unveiling the Lived Realities of Nepali Migrant Workers. *BMC Public Health*, *25*, 4178. https://doi.org/10.1186/s12889-025-25503-0.

Grecu, I. M., Noja, G. G., Cristea, M., Grima, S., Thalassinos, E., & Dorożyński, T. (2024). Migrants' Role In Shaping Unemployment Duration and Labour Market Performance inaA Sustainable Perspective: Empirical Evidence from Romania. *International Journal of Sustainable Development and Planning*, *19*(8), 2893–2905. https://doi.org/10.18280/ijsdp.190808.

Hagen-Zanker, J., Carling, J., Caso, N., & Rubio, M. G. (2025). The Multi-Level Determinants of International Migration Aspirations in 25 Communities in Africa, Asia and the Middle East. *World Development*, *185,* 106774. https://doi.org/10.1016/j.worlddev.2024.106774.

Hornung, M., Stuffolino, E., & Zagel, H. (2025). Poverty among Migrant, Mixed, and Non-Migrant Households: The Role of Non-Teleworkability and Single-Earnership in Germany. *Journal of Ethnic and Migration Studies*, *51*(5), 1294–1321. https://doi.org/10.1080/1369183X.2024.2404219.

Khan, M. I., Alharthi, M., Haque, A., & Illiyan, A. (2023). Statistical Analysis of Push and Pull Factors of Migration: A Case Study of India. *Journal of King Saud University - Science*, *35*(8), 102859. https://doi.org/10.1016/j.jksus.2023.102859.

Komariyah, S., & Sutantio, R. A. (2020). The Relationship Between International Migration, Income Per Capita, and Unemployment Rate in Indonesia. *Jurnal Perspektif Pembiayaan dan Pembangunan Daerah*, *8*(4), 387–396. https://doi.org/10.22437/ppd.v8i4.9863.

KP2MI/BP2MI. (2026). *Statistik Layanan Penempatan Pekerja Migran Indonesia*. Retrieved from: https://kp2mi.go.id/dashboard-publik

Lakshmanasamy, T. (2021). The Causal Effect of International Migration on Native-Born and Foreign-Born Unemployment, Wages and Economic Growth: Panel VAR Estimation. *Studies in Economics and International Finance*, *1*(2), 121–136.

Liu, D., Zhang, S., Feng, Y., Zhang, X., & Zhang, Z. (2025). How Does Inflow Areas' Fiscal Pressure Affect the Employment of Migrant Labor in China? *International Review of Financial Analysis*, *108,* 104717. https://doi.org/10.1016/j.irfa.2025.104717.

Martin, D., & Termos, A. (2015). Does a High Minimum Wage Spur Low-Skilled Emigration? *Economics Letters*, *137*, 200–202. https://doi.org/10.1016/j.econlet.2015.10.027.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50209

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., & Taylor, J. E. (1993). Theories of International Migration: A Review and Appraisal. *Population and Development Review*, *19*(3), 431. https://doi.org/10.2307/2938462.

Mihi-Ramírez, A., Rudžionis, A., & Kumpikaitė, V. (2014). European Economic Migration Flow, Earnings, and Unemployment in Decade of 2000. *Procedia - Social and Behavioral Sciences*, *110*, 122–129. https://doi.org/10.1016/j.sbspro.2013.12.854.

Mitterbacher, K., Fleiß, J., & Palan, S. (2024). Reciprocity in Migration Policy and Labor Market Integration: A Lab Experiment. *Economic Analysis and Policy*, *81*, 1–16. https://doi.org/10.1016/j.eap.2023.11.008.

Muslihatinningsih, F., Sinaga, J. P., & Istiyani, N. (2020). Migrasi Internasional Penduduk Pulau Jawa menjadi Pekerja Migran Indonesia di Luar Negeri. *Jurnal Ekonomi Pembangunan*, *9*(2), 106–115. https://doi.org/10.23960/jep.v9i2.100.

Park, J., Lee, S., & Park, J. (2024). The Economic Decision of International Migration: Two Empirical Evidences from the United States and Canada. *Economies*, *12*(8), 214. https://doi.org/10.3390/economies12080214.

Popescu, C., & Pudelko, M. (2024). The Impact of Cultural Identity on the Cultural and Language Bridging Skills of First- and Second-Generation Highly Qualified Migrants. *Journal of World Business*, *59*(6), 101571. https://doi.org/10.1016/j.jwb.2024.101571.

Puspitasari, W. I. (2017). Faktor-Faktor yang Mempengaruhi Migrasi Tenaga Kerja ke Luar Negeri Berdasarkan Provinsi di Indonesia. *Jurnal Ilmu Ekonomi Terapan*, *2*(1), 44–55. https://doi.org/10.20473/jiet.v2i1.5505.

Schäfer, S., & Henn, S. (2023). Recruiting and Integrating International High-Skilled Migrants – Towards a Typology of Firms in Rural Regions in Germany. *Journal of Rural Studies*, *103,* 103094. https://doi.org/10.1016/j.jrurstud.2023.103094.

Shahiri, H., Cheng, Z., & Al-Hadi, A. A. (2021). Why Do Low-Skilled Foreign Workers Have a Wage Advantage? Evidence from the Palm Oil Plantation Sector in Malaysia. *Population, Space and Place*, *27*(3), 2404. https://doi.org/10.1002/psp.2404.

Siregar, T. H. (2022). Investigating the Effects of Minimum Wages on Employment, Unemployment, and Labour Participation in Java: A Dynamic Spatial Panel Approach. *Bulletin of Indonesian Economic Studies*, *58*(2), 195–227. https://doi.org/10.1080/00074918.2021.1914817.

Stark, O., & Bloom, D. E. (1985). The New Economics of Labor Migration. *The American Economic Review*, *75*(2), 173–178.

Sy, D. K., & Hosoe, N. (2023). Consequences of a Minimum Wage Increase in a Migrant-Sending Country. *Economic Analysis and Policy*, *80*, 1057–1066. https://doi.org/10.1016/j.eap.2023.09.020.

Syafitri, A. E., Endang, E., & Susilo, J. H. (2025). Dynamic Panel Data Analysis of Income Inequality in Indonesia. *Signifikan: Jurnal Ilmu Ekonomi*, *14*(1), 149–162. https://doi.org/10.15408/sjie.v14i1.44943.

Tolesh, F., & Biloshchytska, S. (2024). Forecasting International Migration in Kazakhstan using ARIMA Models. *Procedia Computer Science*, *231*, 176–183. https://doi.org/10.1016/j.procs.2023.12.190.

Tomohara, A. (2022). Does an Increase in the Number of Immigrant Workers Reduce Unemployment Rates? An Industry Sector Unit Level Analysis in Japan. *Economic Analysis and Policy*, *74*, 464–476. https://doi.org/10.1016/j.eap.2022.03.002.

United Nations. (2024). *International Migrant Stock - Population Division*. Retrieved from: https://www.un.org/development/desa/pd/content/international-migrant-stock.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Regional Heterogeneity in Employment Determinants: Evidence from Indonesia

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**ABSTRACT**

**Research Originality**: This study contributes to the literature by examining regional heterogeneity in employment determinants across Indonesia and underscoring the limitations of models relying solely on national aggregates.

**Research Objectives**: This study investigates the differential impacts of foreign direct investment, economic growth, education, and health on employment at the national level and across distinct regional clusters in Indonesia.

**Research Methods**: The study utilizes panel data regression covering 33 Indonesian provinces from 2011 to 2024, categorized into four regional clusters. Fixed- and random-effects models with robust standard errors are applied, with model selection based on formal specification tests.

**Empirical Results**: The findings reveal substantial regional variation regarding the magnitude and statistical significance of employment determinants. While specific variables show significant associations within certain regions, these relationships remain obscured in national aggregate data.

**Implications**: The results indicate that employment dynamics in Indonesia are inherently regional. Policymakers should prioritize regionally calibrated socioeconomic strategies over uniform national policies to effectively support employment expansion.

**Keywords:**

employment; foreign direct investment; economic growth, human capital; regional development

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## INTRODUCTION

Employment conditions are widely regarded as an important element of overall economic performance. Achieving full employment generally requires consistent, effective national-level policies. Failure to implement these policies risks high unemployment rates, which pose a severe threat to both national stability and individual welfare. Grounded in Okun's Law, high unemployment directly restricts economic growth and can leave a prolonged negative impact on the economy (Porras-Arena & Martín-Román, 2023). These consequences extend beyond fiscal metrics and include the depreciation of human capital (Doppelt, 2019), weakened social cohesion (Pohlan, 2024), and a decline in public trust in government institutions (Popova et al., 2026).

In recent years, Indonesia has undergone substantial transformations, including shifts in production structures, uneven patterns of industrial development, and differing magnitudes of foreign investment across regions (Andriyani & Irawan, 2018; ASEAN Secretariat, 2024; Halim et al., 2025). These developments may impact the effectiveness of existing economic policies in driving employment expansion (Mulya, 2024). Such structural changes necessitate a re-evaluation of employment determinants, as traditional economic drivers may no longer yield the same labor-absorption outcomes in a changing industrial landscape. Consequently, further research using the most recent empirical data is essential to identify the evolving factors influencing job creation and to ensure that national policy frameworks remain responsive to these contemporary regional dynamics. Drawing from neoclassical growth theory and Okun's Law, economic output is fundamentally determined by the interplay of capital, labor, human capital, and technological progress. The existing literature suggests a positive elasticity among these variables, implying that labor absorption is not an isolated metric but is functionally dependent on the accumulation of other production factors (Ferrara, 2025; Porras-Arena & Martín-Román, 2023; Wang & Wang, 2025). Therefore, expanding employment opportunities can be fostered strategically by enhancing capital investment and the quality of human capital.

Economic growth is widely viewed as a primary driver for supporting employment expansion. Within classical frameworks, rising output generates capital surpluses that can be reinvested into the economy. This increase in investment expands overall economic activity, which naturally requires more labor to meet the new production demands. Consequently, higher output levels tend to drive employment by increasing the total number of workers needed to sustain an expanded economy (Ferrara, 2025). Empirical studies have reported findings that are broadly consistent with this expected relationship (Astuti & Gunawan, 2024; Irshad & Hasan, 2022; Taqiyyuddin, 2023). Furthermore, foreign capital inflows represent another key channel through which employment expansion may occur (Nguyen et al., 2024). One mechanism operates through the expansion of production capacity and economic activity associated with incoming foreign capital (Hakim et al., 2023).

Additionally, foreign firms may introduce new technologies, managerial practices, and skills that generate spillover effects for the domestic labor market (Zhao et al., 2024). These benefits are not automatic, however, as the extent to which the local workforce


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can absorb technological and knowledge spillovers depends on the availability of adequate human capital, particularly education (Badinger et al., 2019). From a broader theoretical perspective, growth frameworks emphasize that increases in capital accumulation and technological capability can support sustained output growth and, under certain conditions, lead to higher labor demand (Diebolt & Hippe, 2019). However, research in this area is far from uniform. Several studies report that foreign direct investment is positively associated with employment in certain contexts (Aderemi et al., 2022; Hakim et al., 2023; Nguyen et al., 2024; Tanaya & Suyanto, 2023), while others find insignificant or even negative relationships under different settings (Astuti & Gunawan, 2024; Irshad & Hasan, 2022; Jude & Silaghi, 2016; Taqiyyuddin, 2023).

Human capital represents another critical socioeconomic factor in the analysis of employment outcomes, as the emergence of human capital theory, research, and policy attention to education and health has become increasingly prominent. Classical theory emphasizes that education and health contribute to employment by enhancing productivity, employability, and workers' ability to adapt to technological change. Empirical evidence, however, does not provide uniform conclusions. Several studies find that education is positively associated with employment in certain contexts (Adejumo et al., 2021; Astuti & Gunawan, 2024; Raza et al., 2023), while others report insignificant or negative relationships depending on the settings of the analysis (Pinna et al., 2024; Raza et al., 2023). In contrast, improvements in health are more consistently linked to favorable employment outcomes across different studies (Pinna et al., 2024; Raza et al., 2023).

While a substantial body of literature has examined the relationship between socioeconomic factors and employment, the evidence remains insufficient to provide clear guidance for policy formulation in countries characterized by pronounced regional diversity, such as Indonesia (Black et al., 2025; Chen et al., 2021; Halim et al., 2025; Hill & Vidyattama, 2016). Most existing studies rely on national-level data, which implicitly assume that the effects of foreign investment, economic growth, education, and health on employment are homogeneous across regions (Irshad & Hasan, 2022; Nguyen et al., 2024; Pinna et al., 2024; Tanaya & Suyanto, 2023). This assumption is particularly restrictive in the Indonesian context, where regions differ markedly in economic structure, development stage, and labor market conditions (Halim et al., 2025).

Although several studies employ provincial-level data, many continue to estimate a single national model that treats provinces as a uniform analytical unit (Hafidz & Aida, 2025; Saraswati et al., 2022; Silvia et al., 2025; Tantra & Anandari, 2025). As a result, these studies do not test whether national-level estimates remain valid once regional heterogeneity is explicitly considered. In this setting, the use of provincial data does not substantially differ from national aggregation, as differences in regional employment responses are not directly modeled. Other studies focus on specific regions or selected provinces, which limits the generalizability of their findings to the broader national context (Astuti & Gunawan, 2024; Purwantoro et al., 2022; Santosa & Aisyah, 2025).

Moreover, much of the existing literature relies on earlier datasets, leaving employment dynamics up to 2024 largely unexplored. This gap is important because failing to account for regional heterogeneity may lead to aggregation bias and misleading empirical inference. National-level estimates may mask substantial differences in how employment responds to key socioeconomic factors across regions, increasing the risk that policy conclusions drawn from aggregate models are ineffective or poorly targeted. Without explicitly examining whether a single national model is sufficient, it remains unclear whether observed relationships reflect general patterns or region-specific dynamics. This study addresses these limitations by examining employment determinants in Indonesia using recent provincial data and by explicitly comparing national-level estimations with regional models.

The objective of this study is to assess and contrast how foreign direct investment, economic growth, education, and health are associated with employment at the national level and across regional clusters in Indonesia, and further to determine whether a single national model is sufficient to explain employment dynamics in a country characterized by substantial regional diversity. The novelty of this study lies in its explicit comparison of national and regional estimations, which enables an evaluation of whether a single national-level model adequately represents employment dynamics in a regionally diverse economy. By doing so, the study moves beyond treating Indonesia as a homogeneous unit. It provides empirical evidence on how the relationships between key socioeconomic factors and employment vary across regions with different economic and social characteristics.

## METHOD

This study utilizes panel data regression employing fixed or random effects models, where the selection is determined through formal specification tests for each regional cluster. The dataset covers the period from 2011 to 2024. The analysis comprises 33 provinces selected based on the completeness of data availability throughout the observation period. Furthermore, this temporal scope was chosen specifically to ensure the completeness and consistency of the socioeconomic indicators.

To deepen the analysis, these provinces are further divided into four regional clusters: Sumatra, Java-Bali, Kalimantan-Sulawesi, and Eastern Indonesia. This study adopts a regional classification adapted from Akita (2003), with the primary modification being the consolidation of Kalimantan and Sulawesi into one regional grouping. Kalimantan and Sulawesi are combined due to their relatively small number of provinces and their economic structure dependent on commodities. The details regarding these shared commodity-based profiles are explicitly outlined in Presidential Regulation (Perpres) Number 12 of 2025, which identifies the primary sector dependencies common to both regions (Perpres No. 12/2025, 2025, Annex IV).

All variables and their definitions are presented in detail in Table 1. Employment (EMP) refers to the number of employed individuals within the working-age population. Foreign direct investment (FDI) is measured as the ratio of foreign investment inflows


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to provincial GRDP. This measure is used to ensure comparability across provinces with different economic sizes. Economic growth is captured by the annual GRDP growth rate (GRDPG). Education is represented through two indicators: APK, which measures school participation at the basic and secondary levels, and RLS, which reflects the average duration of schooling and serves as a proxy for educational quality. Health capital is measured by life expectancy at birth (AHH).

To address differences in scale and variance, EMP and FDI are transformed into natural logarithms. Logarithmic transformations are commonly used in applied econometrics to reduce skewness and stabilize variance, particularly for variables with wide value ranges. GRDPG is not transformed because some observations take negative values. APK, RLS, and AHH remain in their original forms to preserve interpretability, as their scales do not require transformation. The empirical analysis relies on a panel regression framework.

**Table 1. Operational Variables**

| Variables | Proxy | Code | Unit | Description | Data Source |
|---|---|---|---|---|---|
| Employment | Number of employed individuals | LNEMP | Persons (logged) | Represents the number of individuals who are employed within each province in a given year. This variable reflects the region's employment level. | Statistics Indonesia (BPS) |
| Foreign Investment | Ratio of realized FDI on economic growth | LNFDI | Ratio (logged) | Measures the ratio of realized foreign direct investment to provincial nominal GRDP. It indicates the extent to which provincial economic activity is supported by foreign capital inflows. | Statistics Indonesia (BPS) & Indonesia Investment Coordinating Board (BKPM) |
| Economic Growth | Gross Regional Domestic Product Growth | GRDPG | Percent (%) | Captures the annual growth rate of provincial real Gross Regional Domestic Product. This variable reflects the expansion of production activities and overall economic performance within a province. | Statistics Indonesia (BPS) |
| Education | Average Years of Schooling | RLS | Years | Indicates the average number of completed years of formal education among residents aged 15 and above. It is used as a proxy for education quality and accumulated human capital within a province. | |
| | Gross Enrollment Rate | APK | Percent (%) | Represents the average gross enrollment rate across primary and secondary education levels. It measures the extent of educational participation and access among the school-age population. | |
| Health | Life expectancy | AHH | Years | Reflects the average number of years a newborn is expected to live under prevailing mortality conditions. It serves as a key indicator of population health and overall human development. | |

The general model estimated in this study is written as:

$$LNEMP_{it} = \alpha + \beta_1 LNFDI_{it} + \beta_2 GRDPG_{it} + \beta_3 RLS_{it} + \beta_4 APK_{it} + \beta_5 AHH_{it} + \varepsilon_{it}$$

Description:

$LNEMP_{it}$ : Natural logarithm of employed individuals in province i at time t

$\alpha$ : Model intercept

$LNFDI_{it}$ : Natural logarithm of foreign direct investment in province i at time t

$GRDPG_{it}$ : Growth rate of Gross Regional Domestic Product in province i at time t

$RLS_{it}$ : Average years of schooling in province i at time t

$APK_{it}$ : Average Gross enrollment rate at the primary, junior secondary, and senior secondary levels in province i at time t

$AHH_{it}$ : Average life expectancy at birth for both men and women in province i at time t

$\beta_{it}$ : Slope coefficients of each explanatory variable on employment

$\varepsilon_{it}$ : Error term

The empirical analysis is conducted using Stata. To determine the most appropriate model for the national data and each regional cluster, we employ the Chow test and the Hausman specification test. The Breusch and Pagan Lagrange Multiplier (LM) test is also applied where necessary to distinguish between common and random effects models. This allows the estimation strategy to vary (either FEM or REM) depending on the specific data characteristics of each region. To ensure the validity of our results, we use cluster-robust standard errors at the provincial level. This approach addresses potential heteroskedasticity and serial correlation, reducing the need for separate diagnostic tests for these assumptions (Abadie et al., 2022). The primary classical diagnostic retained is the Variance Inflation Factor (VIF) test, which we use to ensure that multicollinearity does not bias our estimates.

This study adopts one-tailed hypothesis testing, consistent with theoretical expectations regarding the directional relationship of the coefficients. Since statistical software reports two-tailed p-values, the probabilities are divided by 2 when the estimated sign aligns with the hypothesized relationship. Conversely, when the estimated sign contradicts the theoretical expectation, the null hypothesis is rejected regardless of the adjusted probability value. Descriptive analysis is conducted prior to the estimation stage to support the interpretation of the regression results. The analysis is presented using two primary indicators: the mean value of each variable by region and the coefficient of variation. These indicators are selected because they allow straightforward comparison and provide a clear overview of the data distribution and variability. Both measures are calculated using regional panel data covering the period from 2011 to 2024. No data transformation is applied in the descriptive analysis, as the purpose of descriptive statistics is to present the behavior of the variables in their original measurement scale and to offer a basic overview of the data structure. This descriptive assessment provides contextual


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support for examining the determinants of employment and for highlighting differences in their relationships at the national and regional levels.

## RESULTS AND DISCUSSION

The panel regression analysis yields several key findings that highlight substantial variation across national and regional models. Overall, the results show limited uniformity between the national estimate and regional clusters for most variables, except for school participation (APK), which does not exhibit a statistically significant relationship with employment at either the national or regional levels. Foreign direct investment shows a positive association with employment at the national level, with weak significance, whereas a stronger, statistically significant positive effect is observed in Sumatra. In contrast, the relationship between FDI and employment is not statistically significant in the remaining regions. Economic growth shows a weak but negative association with employment at the national level.

In contrast, positive, statistically significant effects are found in Java–Bali and Kalimantan–Sulawesi, with no significant relationship in other regions. Education quality, measured by average years of schooling (RLS), is not significant in the national model, shows a weakly significant negative relationship in Eastern Indonesia, and exhibits positive and significant effects in the other regional clusters. Health, proxied by life expectancy (AHH), demonstrates a positive, statistically significant association with employment at the national level, with significant positive effects also observed in Java–Bali and Eastern Indonesia, but remaining insignificant elsewhere. Taken together, these findings indicate pronounced regional heterogeneity and suggest that national-level models alone do not adequately capture the variation in employment determinants across Indonesia.

Model selection is conducted using a sequence of specification tests, namely the Chow test, the Hausman test, and the Breusch–Pagan Lagrange Multiplier (LM) test, with the results summarized in Table 2. The Chow test is first applied to determine whether the common effect is appropriate or whether unobserved heterogeneity across provinces should be accounted for through panel estimators. The consistently significant Chow test results across all models indicate that panel-based estimations are required. Subsequently, the Hausman test is employed to assess whether the fixed effects or random effects specification is more suitable by testing the consistency of the random effects estimator. Based on the Hausman test results, the random effects model is selected for the national, Sumatra, and Kalimantan–Sulawesi samples, while the fixed effects model is preferred for the Java–Bali and Eastern Indonesia clusters. The LM test is applied only when the Chow test indicates panel effects and the Hausman test fails to reject the random effects specification, to confirm the relevance of random effects relative to common effects. This sequential procedure ensures that each model specification is selected according to the underlying data structure of each regional cluster, rather than imposing a uniform estimation approach across regions.

**Table 2. Model Specification Test**

| Test | National | Sumatra | Java - Bali | Kalimantan - Sulawesi | Eastern Indonesia |
|---|---|---|---|---|---|
| Chow Test (p-value) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hausman Test (p-value) | 0.6559 | 1.00 | 0.0010 | 0.9688 | 0.00 |
| LM Test (p-value) | 0.00 | 0.00 | - | 0.00 | - |
| Selected Model | REM | REM | FEM | REM | FEM |

Next, multicollinearity was assessed using the Variance Inflation Factor (VIF). The results in Table 3 indicate that all explanatory variables have VIF values well below commonly used thresholds, with none exceeding 3. This suggests that the explanatory variables are not strongly correlated with one another and that the degree of linear association among the regressors is relatively low. Consequently, the estimated coefficients are unlikely to be substantially distorted by multicollinearity, and each variable can be interpreted without concern that its effect is being masked or inflated by other predictors. Although VIF does not imply the complete absence of correlation among regressors, the consistently low values observed for both the national sample and all regional clusters indicate that multicollinearity is not a substantive issue in this study.

**Table 3. Variance Inflation Factor (VIF) Test Results**

| VIF | National | Sumatra | Java - Bali | Kalimantan - Sulawesi | Eastern Indonesia |
|---|---|---|---|---|---|
| LNFDI | 1.08 | 1.16 | 1.63 | 1.22 | 1.31 |
| PDRBG | 1.08 | 1.32 | 1.07 | 1.24 | 1.28 |
| RLS | 1.74 | 2.24 | 1.11 | 2.94 | 2.09 |
| APK | 1.47 | 2.33 | 1.34 | 2.30 | 2.02 |
| AHH | 1.32 | 1.15 | 1.88 | 2.40 | 1.70 |
| Mean VIF | 1.34 | 1.64 | 1.41 | 2.02 | 1.68 |

The descriptive statistics in Table 4 report the mean values and coefficients of variation for each variable within each regional cluster. The results indicate regional heterogeneity in Indonesia. A comparison of mean values shows that employment (EMP), foreign direct investment (FDI), and economic growth (GRDPG) exhibit noticeable variation across regions. This range of variation suggests that regional disparities are more pronounced for population and economic indicators. In contrast, differences in human capital indicators appear to be relatively more limited.

Furthermore, the coefficients of variation reveal substantial differences within and between regions. These patterns suggest that heterogeneity in socioeconomic conditions exists not only across regions but also within regions themselves. This finding underscores the relevance of adopting a regional clustering approach, as treating Indonesia as a single


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national unit may obscure important variations in both the levels and relationships of the variables under study.

Proceeding to the estimation stage, this study examines the effects of the explanatory variables on employment at both the national and regional levels. For clarity and conciseness, the regression results are summarized in Table 5. For each specification, Wald or F tests are conducted, and the results indicate that all estimated models are statistically valid for interpretation. The discussion that follows interprets the estimated coefficients sequentially by variable. Descriptive statistics provide additional context on regional characteristics, helping clarify differences observed across regions. The estimation results reveal notable differences in the relationship between foreign direct investment and employment across models. At the national level, FDI is positively associated with employment, though the statistical significance is relatively weak. In contrast, the Sumatra cluster shows a stronger, positive association between FDI and employment, whereas no significant association is detected in the Java–Bali, Kalimantan–Sulawesi, and Eastern Indonesia clusters.

**Table 4. Regional Comparison of Mean Values and Coefficient of Variation, 2011–2024**

| Variables | Measurement | National | Sumatra | Java - Bali | Kalimantan - Sulawesi | Eastern Indonesia |
|---|---|---|---|---|---|---|
| EMP | Coefficient of Variation | 1.4063 | 0.6775 | 0.7792 | 0.5898 | 0.6632 |
| | Mean | 3,745,292 | 2,611,529 | 10,461,393 | 1,604,425 | 1,367,557 |
| FDI | Coefficient of Variation | 2.0596 | 0.9507 | 0.8369 | 1.2810 | 1.8608 |
| | Mean | 4.7% | 2.03% | 3.25% | 4.84% | 10.63% |
| GRDPG | Coefficient of Variation | 0.6813 | 0.4849 | 0.5532 | 0.5610 | 1.0398 |
| | Mean | 5.02% | 4.31% | 4.79% | 5.74% | 5.28% |
| RLS | Coefficient of Variation | 0.1250 | 0.0883 | 0.1414 | 0.1050 | 0.1552 |
| | Mean | 8.320 | 8.610 | 8.630 | 8.190 | 7.730 |
| APK | Coefficient of Variation | 0.0528 | 0.0403 | 0.0392 | 0.0445 | 0.0845 |
| | Mean | 0.929 | 0.942 | 0.926 | 0.918 | 0.928 |
| AHH | Coefficient of Variation | 0.0379 | 0.0150 | 0.0242 | 0.0367 | 0.0183 |
| | Mean | 69.65 | 69.87 | 72.45 | 69.50 | 66.24 |

The positive association observed at the national level and in Sumatra is broadly consistent with classical and endogenous growth frameworks, which suggest that additional investment can expand productive capacity and, under certain conditions, support

employment growth (Ferrara, 2025). Although indirect channels, such as technology or knowledge spillovers, are often discussed in the literature, they are not explicitly examined in this study. Therefore, the results should be interpreted as evidence of association rather than causal transmission. Comparing this result with the descriptive analysis, the significant positive effect in Sumatra may be attributed to the region having the lowest average FDI-to-GRDP ratio. This result might indicate that many of its provinces are still at an earlier stage of foreign investment absorption. Under such conditions, investment may generally flow towards expansion of production rather than efficiency improvements, consequently expanding employment (Jude & Silaghi, 2016). Sumatra also has relatively high mean values of RLS and APK, which may indicate a higher level of education that would enable local firms and stakeholders to benefit from spillover effects (Badinger et al., 2019; Jude & Silaghi, 2016).

**Table 5. Summary of Estimation Results for National and All Regions**

| | National (REM Robust SE) | Sumatra (REM Robust SE) | Java-Bali (FEM Robust SE) | Kalimantan-Sulawesi (REM Robust SE) | Eastern Indonesia (FEM Robust SE) |
|---|---|---|---|---|---|
| *C* | 5.082641 | 11.98551 | 13.0624 | 11.93376 | -11.97771 |
| *Std. Err* | 3.980326 | 0.6434185 | 0.9771843 | 1.107184 | 9.364818 |
| *t/z stat* | (1.28) | (18.63) | (13.37) | (10.78) | (-1.28) |
| *LNFDI* | 0.0196361 | 0.0114359 | -0.0065086 | 0.004641 | 0.0074227 |
| *Std. Err* | 0.146102 | 0.0042896 | 0.0063257 | 0.0046772 | 0.0273173 |
| *t/z stat* | (1.34)* | (2.67)*** | (-1.03) | (0.99) | (0.27) |
| *GRDPG* | -0.0043389 | -0.0006244 | 0.0034017 | 0.0023267 | -0.0074007 |
| *Std. Err* | 0.0027703 | 0.0021201 | 0.0006883 | 0.0006872 | 0.0055489 |
| *t/z stat* | (-1.57)* | (-0.29) | (4.94)*** | (3.39)*** | (-1.33) |
| *RLS* | -0.0764033 | 0.2329648 | 0.1185925 | 0.1820665 | -0.6506913 |
| *Std. Err* | 0.1566321 | 0.026671 | 0.0187446 | 0.0258466 | 0.3636104 |
| *t/z stat* | (-0.49) | (8.73)*** | (6.33)*** | (7.04)*** | (-1.79)* |
| *APK* | 0.0016009 | 0.0022324 | 0.0004573 | 0.0012267 | 0.0097034 |
| *Std. Err* | 0.0020425 | 0.0020612 | 0.00034957 | 0.0023686 | 0.0108283 |
| *t/z stat* | (0.78) | (1.08) | (0.13) | (0.52) | (0.90) |
| *AHH* | 0.144421 | 0.0056091 | 0.0221601 | 0.0085734 | 0.4535228 |
| *Std. Err* | 0.763363 | 0.0108085 | 0.015157 | 0.0189628 | 0.1695865 |
| *t/z stat* | (1.89)** | (0.52) | (1.46)* | (0.45) | (2.67)** |
| *R-Square* | 0.3022 | 0.0049 | 0.8203 | 0.0476 | 0.4219 |

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively, based on one-tailed tests. Because the estimations use both fixed- and random-effects specifications, the reported test statistics differ by model: t-statistics are shown for FEM results, while z-statistics are shown for REM results. For model fit, the table reports the overall R-squared for REM and the within R-squared for FEM.

These findings partially align with previous studies that document a positive relationship between FDI and employment in specific contexts (Hakim et al., 2023; Nguyen et al., 2024; Rudatin et al., 2024; Tanaya & Suyanto, 2023). However, the


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absence of significant effects in several regional clusters indicates that this relationship is not uniform across regions. The lack of statistical significance in these regions likely stems from differences in regional factor endowments, particularly in labor skill sets and urbanization levels. Evidence suggests that FDI location decisions in Indonesia are influenced by the availability of high-skilled human capital, leading to a 'skill-biased' labor demand (Halim et al., 2025; Ramdhan, 2025).

This result implies that the labor-absorptive capacity of FDI is not automatic but may depend on how well the investment requirements align with the existing local human capital stock and regional industry characteristics. This pattern is consistent with other empirical studies reporting insignificant or mixed effects of FDI on employment (Irshad & Hasan, 2022; Misnahwati, 2024; Simanora, 2025; Wulandari & Sishadiyati, 2023). Taken together, the contrast between the weakly significant national result, the stronger association in Sumatra, and the insignificant outcomes in other regions highlights substantial regional heterogeneity. These differences suggest that national-level estimations may not fully capture region-specific employment dynamics, supporting the view that a single national model is insufficient to explain the relationship between FDI and employment across Indonesia.

The estimated effect of GRDP growth on employment is mixed across the national and regional models. At the national level, the GRDPG coefficient is negative and only weakly statistically significant. This pattern does not align with the initial hypothesis or the standard growth expectation that higher output expansion is accompanied by greater use of production inputs, including labor (Ferrara, 2025). In practice, however, output can increase without a proportional rise in employment when growth is driven mainly by efficiency gains. When firms expand production through technological upgrading or highly capital-intensive processes, labor demand may remain unchanged or even decline, consistent with prior arguments that growth driven by efficiency can have limited employment effects (Hötte et al., 2023; Jude & Silaghi, 2016).

The negative national estimate is consistent with Tantra & Anandari (2025), who also report a negative association using Indonesian provincial panel data. Nevertheless, this national result should not be interpreted as a single dominant pattern, given that the regional estimations indicate heterogeneous relationships. In Java, Bali, and Kalimantan–Sulawesi, GRDP growth is positively associated with employment and statistically significant, whereas the estimates for Sumatra and Eastern Indonesia are not statistically significant. The lack of significance in certain regions may also be explained by the composition effect of regional growth, in which differences in factor endowment shape the characteristics of industries and how their labor markets respond to growth (Halim et al., 2025; Perpres No. 12/2025, 2025, Annex IV). The positive coefficients in some clusters align closely with studies documenting a positive growth–employment relationship in certain contexts (Astuti & Gunawan, 2024; Irshad & Hasan, 2022; Saraswati et al., 2022; Taqiyyuddin, 2023). Meanwhile, the insignificant results in other clusters are also consistent with evidence that does not find a robust relationship in some settings (Hamzah & Fitriyah, 2025; Ruslan & Pratomo, 2025). Overall, differences in coefficient direction and statistical significance across clusters indicate regional heterogeneity in the

relationship between GRDP growth and employment. This result further supports the interpretation that a single national model may not fully represent employment dynamics across Indonesia's regions, since aggregation can mask variation across clusters.

This study uses two education indicators: the gross enrollment rate (APK) and the average years of schooling (RLS). APK captures participation in basic and secondary education, while RLS reflects the accumulated duration of formal education completed by the population. These indicators represent different dimensions of education: APK focuses on enrollment coverage, and RLS captures educational attainment. The estimation results indicate that APK does not exhibit a statistically significant relationship with employment at either the national or regional levels. This finding is consistent with previous studies that employ similar measures and also report insignificant results for APK (Asmawati et al., 2025; Wulandari & Astuti, 2023). A plausible interpretation is that enrollment at the basic and secondary levels, while important for general access to education, may not be sufficient to directly influence employment outcomes, particularly when participation rates are already relatively high and exhibit limited variation.

In contrast, the results for RLS demonstrate a more heterogeneous pattern across regions. At the national level, RLS is not statistically significant, consistent with findings from several earlier studies (Sari & Setyowati, 2023). At the regional level, RLS shows a weakly negative and significant association with employment in Eastern Indonesia, a result also documented in recent empirical work (Amarta & Setiawati, 2025). Meanwhile, in Sumatra, Java, Bali, and Kalimantan–Sulawesi, RLS exhibits a positive, statistically significant relationship with employment. This positive association is consistent with a large body of empirical literature suggesting that higher educational attainment supports employment through improved productivity and employability (Hafidz & Aida, 2025; Romawati & Setiawati, 2025; Ruslan & Pratomo, 2025; Saraswati et al., 2022). The variation in these results suggests that the impact of educational attainment is closely tied to the regional labor market's characteristics. Improvement in educational attainment, particularly in regions with adequate job opportunities, may correspond to better alignment with formal labor-market requirements.

Moreover, additional schooling may increase the population's readiness to enter a sector that values higher qualifications (Munawaroh, 2021). Taken together, these findings indicate that the relationship between education and employment differs markedly across regions. While most regions show a positive association between educational attainment and employment, the contrasting result observed in Eastern Indonesia contributes to the absence of a significant relationship at the national level. This pattern illustrates the limitation of relying solely on national estimations, as aggregation may conceal important regional differences. The variation in both the sign and significance of the education coefficients across regions provides further evidence of regional heterogeneity and reinforces the argument that a single national model is insufficient to fully capture the role of education in shaping employment outcomes in Indonesia.

Health is proxied in this study by life expectancy at birth (AHH). The estimation results indicate a generally positive association between health and employment, although


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the strength and statistical significance of this relationship vary across models. At the national level, AHH shows a positive and statistically significant relationship with employment. Similar positive effects are observed in the Java–Bali and Eastern Indonesia clusters, with the coefficient in Java–Bali being positive but only weakly significant. In contrast, the relationship between AHH and employment is not statistically significant in Sumatra and Kalimantan–Sulawesi.

The significant association in Java-Bali aligns with the region's relatively higher AHH in the dataset. AHH is often viewed as a broad indicator of socioeconomic development. Regions with more advanced development may possess labor markets that can better absorb improvements in the quality of labor supply (OECD, 2019). A similar pattern is observed in Eastern Indonesia, although the region has a lower AHH. In this scenario, improvements in health conditions may be more discernible in the data because they occur from a lower baseline.

The positive association between health and employment across several models is consistent with previous studies that document that improvements in population health tend to support labor productivity and labor market participation (Handayani et al., 2025; Pinna et al., 2024; Raza et al., 2023; Sajati & Pujiati, 2025). These studies suggest that healthier individuals are generally better able to participate in economic activity and sustain employment, findings that align with the significant results observed at the national level and in selected regions. Simultaneously, the absence of statistical significance in some regional models is also supported by earlier findings. A limited number of studies report insignificant relationships between health indicators and employment under certain regional or sectoral conditions (Sutrisna & Suasih, 2025). This result suggests that improvements in health do not always translate uniformly into employment gains, particularly when labor demand or economic structure differs across regions.

Overall, while the positive direction of the health coefficient appears relatively consistent across most models, the variation in statistical significance indicates that the magnitude and effectiveness of health improvements in supporting employment are not uniform across regions. This pattern highlights regional heterogeneity in the health–employment relationship. Consequently, the national-level result should be interpreted with caution, as it may not fully reflect how employment responds to health improvements across regions. These findings further reinforce the inadequacy of relying solely on a national model and underscore the importance of region-specific analysis when assessing the role of health in employment outcomes.

The results of this study consistently indicate regional heterogeneity in the determinants of employment. Across all variables examined, the magnitude, direction, and statistical significance of the relationships with employment differ across regions. No single determinant exhibits a uniform pattern that applies equally to all regional clusters, except APK. This variation suggests that employment dynamics in Indonesia are shaped by regional-specific economic and social conditions rather than by a single national mechanism. These variations may suggest that the unique factor endowments of

each region shape how socioeconomic factors relate to employment. For determinants such as FDI, economic growth, and human capital (education and health), the capacity for labor absorption may depend on the sectoral composition of the local economy. In clusters with high labor-intensity economic structures, these factors may show a stronger association with employment. Conversely, in clusters dominated by capital-intensive or resource-based sectors, the impact of these variables might be limited by the nature of the industries themselves. As the specific sectoral mechanisms were not empirically tested in this study, these observations remain theoretical and point to the importance of region-specific conditions in shaping employment outcomes.

The presence of such heterogeneity implies that models based on national aggregates, widely employed in previous research, may be insufficient to fully explain employment determinants in a country with substantial regional diversity. When relationships between key socioeconomic factors and employment differ across regions, national estimates risk masking important local dynamics. As a result, findings derived solely from national models should be interpreted with caution and may not be directly applicable as a basis for regional decision-making or policy formulation. By extension, employment policies designed using a uniform national approach may be less effective in addressing regional labor market conditions. Differences in how employment responds to investment, growth, education, and health across regions suggest that policy effectiveness is likely to vary spatially. This study highlights the limitations of analytical frameworks that apply a single standard across contexts and emphasizes the need for approaches in both empirical research and policy design that are calibrated to regional contexts. Through this contribution, the study encourages a more nuanced understanding of employment determinants that accounts for regional diversity rather than relying exclusively on aggregate national models.

## CONCLUSION

This study analyzes the relationships among foreign direct investment, economic growth, education, health, and employment at both the national and regional levels in Indonesia, using provincial panel data from 2011 to 2024. The empirical findings demonstrate that these relationships vary substantially across regional clusters, exhibiting differences in both statistical significance and magnitude. In several instances, national-level estimations mask relationships that are clearly observed at the regional level, indicating that a single national model is insufficient to capture employment dynamics in a country with pronounced regional diversity. By contrasting national and regional results, this study confirms regional heterogeneity in employment determinants, thereby addressing the core research objective. These variations may reflect differences in factor endowments and sectoral composition specific to the region, although such mechanisms were not explicitly examined. Future research should therefore incorporate sectoral data to better identify the structural factors underlying labor absorption capacity within regions.

From a policy perspective, the results suggest that employment strategies based solely on national-level evidence may be ineffective. When the responsiveness of employment to investment, growth, education, and health differs across regions, uniform policy


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interventions risk generating uneven outcomes. Employment and socioeconomic policies should thus be calibrated regionally, taking into account local economic structures, labor market conditions, and human capital characteristics. Such differentiated approaches are more likely to translate improvements in key development indicators into sustainable employment gains across Indonesia.

## REFERENCES

Abadie, A., Athey, S., Imbens, G. W., & Wooldridge, J. M. (2022). When Should You Adjust Standard Errors for Clustering? *The Quarterly Journal of Economics*, *138*(1), 1–35. https://doi.org/10.1093/qje/qjac038.

Adejumo, O. O., Asongu, S. A., & Adejumo, A. V. (2021). Education Enrolment Rate vs. Employment Rate: Implications for Sustainable Human Capital Development in Nigeria *International Journal of Educational Development*, *83*, 102385. https://doi.org/10.1016/j.ijedudev.2021.102385.

Aderemi, T., Omitogun, O., & Osisanwo, B. (2022). Effect of FDI Inflows on Employment Generation in Selected ECOWAS Countries: Heterogeneous Panel Analysis. *Central Bank of Nigeria Journal of Applied Statistics*, *13*(1), 22-30. https://doi.org/10.33429/Cjas.13122.8/9.

Akita, T. (2003). Decomposing Regional Income Inequality in China and Indonesia Using Two-Stage Nested Theil Decomposition Method. *The Annals of Regional Science*, *37*(1), 55–77. https://doi.org/10.1007/s001680200107.

Amarta, P. C., & Setiawati, R. I. S. (2025). Analysis of the Effect of Population, Education Level, and Minimum Wage on Open Unemployment Rate in West Java Province. *International Journal of Business and Applied Economics*, *4*(5), 2567–2576. https://doi.org/10.55927/ijbae.v4i5.214.

Andriyani, V. E., & Irawan, T. (2018). Identification of Premature Deindustrialization and Its Acceleration in Indonesia (Period 1986-2015). *Jurnal Ekonomi dan Kebijakan Pembangunan*, *7*(1), 78–101. https://doi.org/10.29244/jekp.7.1.2018.78-101.

ASEAN Secretariat. (2024). *ASEAN Investment Report 2024 - ASEAN Economic Community 2025 and Foreign Direct Investment*. Jakarta: ASEAN Secretariat.

Asmawati, T., Hidayat, M., & Murialti, N. (2025). Analysis of Government Expenditure and Investment in Reducing Unemployment Between Regions of the Island of Sumatra with FD-GMM and SYS-GMM Methods. *Jurnal Ilmiah Akuntansi, Manajemen dan Ekonomi Islam*, *8*(2), 756–768. https://doi.org/10.36085/jamekis.v8i2.7800.

Astuti, R. D., & Gunawan, G. (2024). Penanaman Modal Asing dan Penyerapan Tenaga Kerja di Provinsi Jawa Barat. *Jurnal Kebijakan Ekonomi dan Keuangan, 2*(2), 151–160. https://doi.org/10.20885/jkek.vol2.iss2.art10.

Badinger, H., Egger, P. H., & von Ehrlich, M. (2019). Productivity Growth, Human Capital and Technology Spillovers: Nonparametric Evidence for EU Regions. *Oxford Bulletin of Economics and Statistics*, *81*(4), 768–779. https://doi.org/10.1111/obes.12285.

Black, J., Connolly, K., Davidson, S. N., & Spowage, M. (2025). The Use and Misuse of Regional Data: Perspectives, Challenges and Policy Implications from Across the UK. *Regional Studies*, *59*(1), 2464102. https://doi.org/10.1080/00343404.2025.2464102.

Chen, Y., Liu, Y., & Fang, X. (2021). The New Evidence of China's Economic Downturn: from Structural Bonus to Structural Imbalance. *PLOS ONE*, *16*(9), e0257456. https://doi.org/10.1371/journal.pone.0257456.

Diebolt, C., & Hippe, R. (2019). The Long-Run Impact of Human Capital on Innovation And Economic Development in The Regions of Europe. *Applied Economics*, *51*(5), 542–563. https://doi.org/10.1080/00036846.2018.1495820.

Doppelt, R. (2019). Skill Flows: A Theory of Human Capital and Unemployment. *Review of Economic Dynamics*, *31*, 84–122. https://doi.org/10.1016/j.red.2018.12.004.

Ferrara, M. (2025). Solow-Swan Model and Growth Dynamics: Moving Forward. *Decisions in Economics and Finance*. https://doi.org/10.1007/s10203-025-00543-8

Hafidz, M., & Aida, N. (2025). Determinants of Labor Absorption in the Creative Economy Sector: A Case Study of 34 Provinces in Indonesia . *International Journal of Economics, Business and Innovation Research*, *4*(04), 1884–1901. https://doi.org/10.63922/ijebir.v4i04.2168.

Hakim, D. R., Ahman, E., & Kusnendi, K. (2023). The Effect of FDI on the Host Countries' Employment: A Meta-Regression Analysis. *Russian Journal of Economics*, *9*(2), 158–182. https://doi.org/10.32609/j.ruje.9.98252.

Halim, P. R., Yusuf, A. A., Sumner, A., & Purnagunawan, R. M. (2025). Structural Transformation and Regional Inequality Differential in Indonesia. *Regional Studies, Regional Science*, *12*(1), 790–815. https://doi.org/10.1080/21681376.2025.2565318.

Hamzah, M., & Fitriyah. (2025). Causality Between Economic Growth and Unemployment in Indonesia. *E-Jurnal Ekonomi Dan Bisnis Universitas Udayana*, 1155–1167. https://doi.org/10.24843/EEB.2025.v14.i08.p06.

Handayani, T. S., Azimi, A., & Kalbarini, R. Y. (2025). Determinan Partisipasi Angkatan Kerja: Pengaruh Penetapan Upah Minimum dan Tingkat Kesehatan di Kalimantan Barat Tahun 2014–2023. *Economic and Education Journal (Ecoducation)*, *7*(2), 513–529. https://doi.org/10.33503/ecoducation.v7i2.1523.

Hill, H., & Vidyattama, Y. (2016). Regional Development Dynamics in Indonesia Before and After the 'Big Bang' Decentralization. *The Singapore Economic Review*, *61*(02), 1640027. https://doi.org/10.1142/S0217590816400270.

Hötte, K., Somers, M., & Theodorakopoulos, A. (2023). Technology and Jobs: A Systematic Literature Review. *Technological Forecasting and Social Change*, *194*, 122750. https://doi.org/10.1016/j.techfore.2023.122750.

Irshad, M., & Hasan, S. (2022). Causal Nexus between Economic Growth, FDI, and Employment: An Inquiry into BRICS and ASEAN. *Theoretical and Applied Economics*, *XXIV*(2(631)), 107–124.

Jude, C., & Silaghi, M. I. P. (2016). Employment Effects of Foreign Direct Investment: New Evidence from Central and Eastern European Countries. *International Economics*, *145*, 32–49. https://doi.org/10.1016/j.inteco.2015.02.003.

Misnahwati. (2024). The Effect of FDI and GRDP on Industrial Labor Absorption in West Java. *Efficient: Indonesian Journal of Development Economics*, *7*(2), 158–168. https://doi.org/10.15294/efficient.v7i2.1096.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.49655

Mulya, N. P. (2024). Navigating the Tides of Change: Analyzing Indonesia's Employment and Unemployment Dynamics from 2011 to 2023. *Indonesian Journal of Innovation Multidisciplinary Research*, *2*(3), 356–364. https://doi.org/10.69693/ijim.v2i3.189.

Munawaroh, S. (2021). Decision to Work in the Formal and Informal Sector: Empirical Evidence from East Java Province. *East Java Economic Journal*, *5*(1), 47–57. https://doi.org/10.53572/ejavec.v5i1.59.

Nguyen, H. T., Le, A. N. N., Le, H. V., & Duong, K. D. (2024). Foreign Direct Investment and Employment in Asia Pacific Nations: The Moderating Role of Labor Quality. *Heliyon*, *10*(9), e30133. https://doi.org/10.1016/j.heliyon.2024.e30133.

Pinna, P. M., Fumagalli, E., & Suhrcke, M. (2024). The Impact of Health on Labour Market Outcomes: A Rapid Systematic Review. *Health Policy*, *143*, 105057. https://doi.org/10.1016/j.healthpol.2024.105057.

Pohlan, L. (2024). Unemployment's Long Shadow: The Persistent Impact on Social Exclusion. *Journal for Labour Market Research*, *58*(1), 12. https://doi.org/10.1186/s12651-024-00369-8.

Popova, O., Nikolova, M., See, S. G., & Otrachshenko, V. (2026). Inflation, Unemployment, and Institutional Trust: The Global Evidence. *Oxford Economic Papers, 78*(1), 157–178. https://doi.org/10.1093/oep/gpaf026.

Porras-Arena, M. S., & Martín-Román, Á. L. (2023). The Heterogeneity of Okun's law: A Metaregression Analysis. *Economic Modelling*, *128*, 106490. https://doi.org/10.1016/j.econmod.2023.106490.

Purwantoro, P., Rahayu, H. C., Rahman, A., & Hidayat, H. (2022). Determinants Of Sectoral Labor Absorption. *Jurnal Ekonomi*, *11*(03), 1319–1327.

Ramdhan, D. (2025). The Determinants of FDI Inflows in the Indonesian Manufacturing Sector: Some Evidence from Spatial Dependency Measurements. *Bulletin of Monetary Economics and Banking*, *28*(1), 36–56. https://doi.org/10.59091/2460-9196.1709.

Raza, A., Fahad Ali Shah, S., & Mujahid Shah, S. U. (2023). Analyzing the Effect of Infant Mortality, Life Expectancy, and Health Expenses on Labor Force Participation in Pakistan. *Global Economics Review*, *VIII*(IV), 40–50. https://doi.org/10.31703/ger.2023(VIII-IV).04.

Romawati, A., & Setiawati, R. I. S. (2025). The Effect of Provincial Minimum Wage, Open Unemployment Rate, and Average Years of Schooling on Labor Force Participation Rate in East Java Province. *Indonesian Interdisciplinary Journal of Sharia Economics*, *9*(1), 392–404. https://doi.org/10.31538/iijse.v9i1.7510.

Rudatin, A., Haq, A. G. F., & Perdana, A. R. A. (2024). Determinants of Labour Absorption in ASEAN. *Jurnal Kebijakan Ekonomi dan Keuangan*, *3*(2), 174–181. https://doi.org/10.20885/JKEK.vol3.iss2.art7.

Ruslan, W. D. A. P., & Pratomo, D. S. (2025). The Effect of GRDP, Minimum Wages, and Education on Workforce Absorption in Regencies and Cities in East Java. *Journal of Development Economic and Social Studies*, *4*(1), 91–109. https://doi.org/10.21776/jdess.2025.04.1.08.

Sajati, W. K., & Pujiati, A. (2025). Determinan Tingkat Partisipasi Angkatan Kerja Perempuan di Provinsi Jawa Barat. *El-Mal: Jurnal Kajian Ekonomi & Bisnis Islam*, *6*(4), 7568. https://doi.org/10.47467/elmal.v6i4.7568.

Santosa, A. H., & Aisyah, S. (2025). Analysis of Factors Affecting the Absorption of Female Labor in Central Java. *Journal of Management: Small and Medium Enterprises (SMEs)*, *18*(2), 1503–1513. https://doi.org/10.35508/jom.v18i2.24371.

Saraswati, B. D., Krisnawati, Y. D., & Adhitya, D. (2022). Determinan Penyerapan Tenaga Kerja 34 Provinsi di Indonesia: Pendekatan Fixed Effect Model. *Jurnal Ilmiah Manajemen, Ekonomi, & Akuntansi (MEA)*, *6*(3), 1139–1156. https://doi.org/10.31955/mea.v6i3.2218

Sari, D. W., & Setyowati, E. (2023). Determinants of Open Unemployment Rate in East Java Regencies and Cities from 2017-2021. *Entrepreneurship on Global Economic Development in the Era of Society 5.0*, 374–383. https://doi.org/10.30596/miceb.v1i0.140.

Silvia, V., Agustina, M., & Zulfa, D. (2025). What Drives Household Labor Absorption in Indonesia? A Provincial-Level Analysis using Panel ARDL Modeling. *Cogent Economics & Finance*, *13*(1), 2485398. https://doi.org/10.1080/23322039.2025.2485398.

Simanora, D. (2025). Does Investment Reduce Unemployment? An Empirical Study of FDI and DDI Impacts in Bandung Regency. *Quantitative Economics and Management Studies*, *6*(5), 729-737. https://doi.org/10.35877/454RI.qems4109.

Sutrisna, I. B. A., & Suasih, N. N. R. (2025). Pengaruh Tingkat Pendidikan, Upah, Kesehatan, dan Investasi terhadap Penyerapan Tenaga Kerja di Provinsi Bali. *E-Jurnal Ekonomi Pembangunan Universitas Udayana*, *12*(12), 798–810.

Tanaya, O., & Suyanto, S. (2023). Investigating the Role of Foreign Direct Investment on Youth Unemployment Rate in Indonesia. *Binus Business Review*, *14*(2), 121–131. https://doi.org/10.21512/bbr.v14i2.8486.

Tantra, G. A. A. D., & Anandari, I. G. A. A. A. (2025). Analisis Faktor-Faktor yang Mempengaruhi Penyerapan Tenaga Kerja di Provinsi-Provinsi di Indonesia. *E-Jurnal Ekonomi Pembangunan Universitas Udayana*, *14*(2), 135.

Taqiyyuddin, F. (2023). Analisis Pengaruh Investasi Terhadap Penyerapan Tenaga Kerja Melalui Variabel Produk Domestik Regional Bruto di Indonesia. *Jurnal Ilmu Ekonomi JIE*, *7*(01), 95–105. https://doi.org/10.22219/jie.v7i01.23006.

Wang, W., & Wang, Q. (2025). Does the Digital Economy Boost Enterprise Labor Demand? An Empirical Analysis of Typical Listed Firms in China. *Economic Analysis and Policy*, *88*, 1112–1130. https://doi.org/10.1016/j.eap.2025.10.021.

Wulandari, A. T., & Sishadiyati. (2023). The Effect of Foreign Investment, Employment Rates, and Total Population on Educated Unemployment in Indonesia. *International Journal of Economics (IJEC)*, *2*(2), 679–687. https://doi.org/10.55299/ijec.v2i2.557.

Wulandari, D. L., & Astuti, I. P. (2023). Determinan Tingkat Pengangguran di Jawa Tengah. *Jurnal Ekonomi-Qu*, *13*(1), 44-60. https://doi.org/10.35448/jequ.v13i1.20530.

Zhao, M., Chen, Q., Dai, D., Fan, Y., & Xie, J. (2024). The Spillover Effect of Foreign Direct Investment on China's High-Tech Industry Based on Interprovincial Panel Data. *Sustainability*, *16*(4), 1660. https://doi.org/10.3390/su16041660.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.49655

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# Urban-Rural Differences in Sustainable Energy Consumption Behavior: Evidence from Indonesia

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## ABSTRACT

**Research Originality**: This study offers a novel contribution by integrating micro-level spatial comparison and behavioral analysis. Unlike previous studies that highlight income or education as key drivers, this research finds that structural factors have a stronger influence on energy-saving behavior.

**Research Objectives**: This study aims to examine household energy consumption patterns and identify the socioeconomic and structural determinants of energy-saving behavior in urban and rural settings.

**Research Methods**: A mixed-methods approach is employed. Qualitative analysis using ATLAS.ti explores household energy-use practices and perceptions, while binary logit regression is applied to identify factors influencing energy-efficient behavior.

**Empirical Results**: The results indicate significant differences in energy consumption between urban and rural households. Urban households tend to consume more energy due to lifestyle characteristics and appliance ownership. Regression results show that household size, dwelling area, installed electrical capacity, and residential location significantly affect the likelihood of adopting energy-saving behavior. Rural households exhibit a higher propensity for energy-efficient practices, mainly due to limited electricity access and reliance on traditional energy sources.

**Implications**: Energy policies should incorporate spatial and socioeconomic dimensions, reduce subsidy-induced price distortions, and promote incentives for energy-efficient behavior and renewable energy adoption.

**Keywords:**

Energy; consumption; behavior; residential setting; energy accessibility

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## INTRODUCTION

Energy is one of the inputs in industrial, service, transportation, and household activities. Stable and affordable energy availability is a key pillar for driving economic growth, maintaining industrial competitiveness, and ensuring public welfare. However, Indonesia faces serious challenges to energy security due to its high dependence on fossil fuels, as its oil and natural gas reserves are dwindling (Li et al., 2024). The depletion of petroleum reserves and other energy sources, coupled with the continuing rise in energy consumption, means Indonesia must begin conserving energy. Energy subsidies in Indonesia remain substantial. In 2025, the government will continue to provide subsidies of 19.41 million kiloliters (KL) for fuel, while for LPG, it will be 8.2 million metric tons. Additionally, the government will allocate IDR 90.22 trillion in electricity subsidies, higher than the 2024 level. If this situation persists, the Indonesian government will face difficulties in maintaining its foreign exchange reserves, which could threaten national energy security.

Household energy consumption accounts for a significant share of total energy consumption worldwide (Zhou & Yang, 2016). Household energy consumption in Indonesia accounted for approximately 42% of total electricity consumption in 2023 (Ministry of Energy and Mineral Resources, Republic of Indonesia, 2023), underscoring its significant impact on environmental issues. Indonesian households contribute 3.8% of direct carbon emissions and 20.7% of indirect carbon emissions (Pangestu & Ayuningsasi, 2024). Several factors influence household energy consumption patterns, and there is potential for savings. Based on research, household energy use can be reduced by up to 27% (Lesic et al., 2018). Households can save energy through a combination of technological advances and changes in energy consumption behavior (Frederiks et al., 2015).

High levels of urbanization have led to increased energy demand (Dong et al., 2018) due to lifestyle changes (Novianto et al., 2022). The standard of living in cities, which offer more opportunities, affects income, leading to increased use of household appliances and, consequently, higher energy demand (Olatunde & Okwandu, 2024). Energy consumption among rural residents is lower than in urban areas, as they rely more on straw, biogas, solar energy, and wood (G. Li et al., 2016). Unfortunately, energy sources in rural areas are only sufficient to meet basic needs but are not yet able to improve their standard of living.

Increased household income is associated with higher energy consumption (Nazer & Handra, 2016). Increased income also reduces traditional energy consumption as people shift to modern energy sources. The positive relationship between income and modern energy consumption indicates that modern energy is a normal good (Marzban et al., 2023). The energy ladder theory holds that households will increase their energy consumption and seek higher-quality energy as their income rises (Van Der Kroon et al., 2013; Waleed & Mirza, 2023). The theory of increased energy consumption up to the last rung of the energy ladder is more commonly found in urban areas than in rural areas. In addition to income, wealth also affects energy consumption, which, in turn, impacts the environment and health (Xiong & Xu, 2021; Piao & Managi, 2023).


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In addition to income, other economic variables influence energy consumption, including energy prices and the prices of household appliances that use energy (Zhang & Tao, 2020). In addition to economic factors, there are non-economic factors that influence shifts in energy consumption, namely household size (Romero-Jordán & del Río, 2022), urbanization (Zhao & Zhang, 2018), household demographic characteristics (Soltani et al., 2020; Chavda et al., 2023), access to energy (Gashaye et al., 2025; Zhang & Khan, 2024), sociocultural factors (Ravindra et al., 2019; Bhattacharjee & Reichard, 2011), and education (Benlaria, 2025; Endriana et al., 2025).

Several international studies emphasize the importance of a multidimensional approach to energy consumption behavior, including the influence of demographics, energy literacy, and social norms (Van Der Kroon et al., 2013; Frederiks et al., 2015). These studies also show that although there is potential for energy savings of up to 27% from household use (Lesic et al., 2018), its implementation is highly dependent on the local context and non-economic factors, which have not been widely discussed in Indonesia-based studies.

The development of renewable energy shows a gap between urban and rural areas. Cities play a crucial role in reducing greenhouse gas emissions and leading the transition to renewable energy that can be used across all sectors; however, they are not yet able to generate as much renewable energy as rural areas. Urban residents are becoming increasingly aware of the benefits of using more energy-efficient technologies, while rural residents are playing a greater role in generating renewable energy. Therefore, this study will examine differences in people's energy consumption behavior patterns.

This study is novel in that it uses a comparative spatial approach at the micro level to examine energy consumption patterns between urban and rural households. It also integrates mixed methods, combining quantitative and qualitative approaches. ATLAS.ti was used to map the determinants of energy behavior based on interviews and FGDs, while logit regression analysis empirically tested the influence of socioeconomic variables on energy-saving behavior.

Despite extensive international studies on multidimensional energy behavior, a significant research gap remains in the Indonesian context. Most local studies focus on macro-level energy demand or purely economic determinants, often overlooking how spatial disparities and psychological perceptions simultaneously shape energy-saving propensity. There is a lack of integrated evidence on how structural constraints across different residential settings, ranging from high-capacity urban hubs to resource-limited areas, shape behavioral adoption. Furthermore, the interplay between qualitative household perceptions and quantitative socioeconomic indicators remains underexplored.

To address this gap, this study aims to examine household energy consumption patterns and identify the socioeconomic and structural determinants of energy-saving behavior across diverse spatial contexts. This research is novel in its application of a micro-level comparative spatial approach, integrating a mixed-methods design. By combining qualitative mapping using ATLAS.ti to capture lived experiences of energy with binary logit regression to test socioeconomic variables empirically, this study provides a holistic

framework for understanding energy behavior that is often overlooked by single-method approaches.

## METHODS

This study was conducted in two regions with distinct characteristics: Surakarta City, representing urban areas, and Magelang Regency, representing resource-dependent peripheral areas. The research employed a mixed-methods approach, combining quantitative and qualitative methodologies. Primary data were collected through a survey of 120 households. Respondents were selected using a proportional sampling method, with the sample size determined by the Slovin formula to ensure representativeness and statistical validity. Data were collected through structured questionnaires, in-depth interviews, and focus group discussions (FGDs). The questionnaires focused on socioeconomic characteristics, energy use patterns, and behavioral aspects of energy conservation. Secondary data were collected from the Central Bureau of Statistics (BPS) for demographic and economic indicators; the Ministry of Energy and Mineral Resources (ESDM) for national energy consumption, pricing, and subsidy trends; and Official reports and policy documents related to Indonesia's energy sector.

**Table 1. Operational Variables**

| Variable | Definition | Measurement | Source | References |
|---|---|---|---|---|
| Energy Consumption Patterns | Household energy consumption patterns refer to the form, type, and amount of various energy sources used by households in their daily activities to meet their needs, such as cooking, lighting, cooling, entertainment, and personal transportation. | 0 = Households have not yet made any savings in their energy consumption.<br>1 = Households have already made savings in their energy consumption. | Interview | (Shim & Song, 2025) |
| Income (Inc) | An amount of money or income obtained by respondents from various sources | Rupiah | Interview | (Zhou & Yang, 2016)<br>(Marzban et al., 2023)<br>(Van Der Kroon et al., 2013) |
| Education (Edu) | Highest level of education completed by respondents | Years | Interview | (Endriana et al., 2025) |
| House area (House_area) | Total floor area of the building used as a residence by households | Total square meters ($m^2$) of all rooms used | Interview | (Stephan & Crawford, 2016) |
| Installed electrical power (Elec_power) | The maximum electrical capacity connected to the household as stated in the contract or on the electricity meter. | Power rating in Volt-Amperes (VA) – for example, 450 VA, 900 VA, 1300 VA, 2200 VA, 3500 VA, etc. | Interview | (Spunei & Martin, 2024)<br>(Permana et al., 2015) |
| Number of electrical appliances (Home_tech) | Total number of electrical appliances owned and used in households | Unit | Interview | (Firth et al., 2018) |
| Location (Loc) | Respondents' place of residence | 0 = respondents living in urban areas<br>1 = respondents living in rural areas | Interview | (Zhou & Yang, 2016)<br>(Chimbo, 2020)<br>(Guo et al., 2023) |


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This study has two main objectives. First, to map and analyze energy consumption patterns using ATLAS.ti software to assist in organizing and mapping data based on the results of literature studies, documentation, focus group discussions, and in-depth interviews. ATLAS.ti facilitates an understanding of the meaning and motivation behind consumption behavior. Second, to analyze the influence of socioeconomic variables on energy consumption patterns across rural and urban communities using logit regression. This model enables researchers to estimate the likelihood that a household will adopt energy-efficient practices, based on various socioeconomic and environmental factors (e.g., income, education, household size, dwelling area, electricity capacity, number of appliances, and residential location).

The model used in this research is as follows:

$$L_i = L_n = \frac{P_i}{(1 - P_i)} = \alpha_0 + \alpha_1\, Inc + \alpha_2\, Edu + \alpha_3\, Fam_{number} + \alpha_4\, House_{area} + \alpha_5\, Elec_{power} + \alpha_6\, Home_{tech} + \alpha_7\, Loc + \varepsilon_i$$

This study uses binary logit regression to analyze the factors influencing household energy conservation behavior. Logit regression is used because the dependent variable is dichotomous. The $\alpha_n$ coefficient is estimated using the Maximum Likelihood Estimation (MLE) method. The coefficient indicates the direction of each variable's influence on the logarithm of households' energy-saving probability. To facilitate interpretation, the coefficient can be converted to an odds ratio ($e\beta k$), which describes the likelihood of a change in saving behavior for a one-unit change in the independent variable.

## RESULTS AND DISCUSSION

The results of this study indicate that household energy-saving behavior differs significantly between urban and rural areas. Based on the mixed-method analysis, both structural and behavioral factors play a decisive role in shaping household energy consumption patterns. Qualitative findings from ATLAS.ti highlight variations in daily energy-use practices, transportation choices, and perceptions of renewable energy, while the binary logit regression results show that household size, dwelling area, installed electrical capacity, and residential location significantly influence the likelihood of adopting energy-saving behavior. Notably, rural households exhibit a higher propensity for energy-saving practices than urban households.

To provide a clearer context for these findings, Table 2 presents descriptive statistics summarizing the socioeconomic characteristics and energy-use profiles of respondents in both urban and rural areas. Demographic characteristics also differed substantially between locations. Rural respondents were predominantly aged 60–69 years, while urban respondents were mainly in the 40–59 age group. Previous studies suggest that age influences energy consumption through lifestyle and activity patterns, with productive-age households tending to consume more energy, while younger cohorts show greater awareness of energy conservation (Mills & Schleich, 2012; Khulaemi, 2022). Household

size varied across respondents and was found to affect energy use by increasing demand for electricity, cooking fuel, and transportation, supporting earlier findings on the relationship between household composition and energy consumption (Dupont, 2004).

**Table 2. Descriptive Statistic**

| No | Descriptive | Mean |
|---|---|---|
| 1 | Income | |
| | Urban | 3.466.666,167 |
| | Rural | 1.533.333 |
| 2 | Age | |
| | Urban | 40 – 59 |
| | Rural | 60 – 69 |
| 3 | Family Members | |
| | Urban | 7 |
| | Rural | 8 |
| 4 | House Size | |
| | Urban | 30 – 79 m2 |
| | Rural | 30 – 79 m2 |
| 5 | Installed Electrical Power | |
| | Urban | 900 VA |
| | Rural | 450 VA |
| 6 | Elecreical Bills | |
| | Urban | 150.000 – 299.000 |
| | Rural | 0 – 149.000 |
| 7 | Vehicle Owned | |
| | Urban | Motorcycle |
| | Rural | Motorcycle |

Source: Data Processed (2025)

Housing characteristics further explain variations in energy consumption. Larger dwelling areas and higher installed electrical capacity were more prevalent in urban households, leading to greater electricity demand for lighting and cooling. This result aligns with prior research indicating that building size and appliance ownership significantly influence household energy use (Oh et al., 2021; Peng et al., 2024). Most respondents consumed electricity in the range of 100–300 VA per month, although urban households exhibited higher consumption levels and more diverse appliance use, including air conditioners and washing machines.

Electricity expenditure patterns also differed spatially. Rural households generally paid less than IDR 149,000 per month, while urban households showed higher and more varied electricity bills, reflecting differences in installed power and appliance intensity. Despite these differences, respondents in both areas demonstrated relatively high awareness of electricity conservation, particularly in switching off unused appliances, which is consistent with findings on household energy management behavior (Permana et al., 2015; Shrestha et al., 2021).

In terms of cooking energy, urban households predominantly relied on LPG, whereas rural households continued to use firewood either exclusively or in combination


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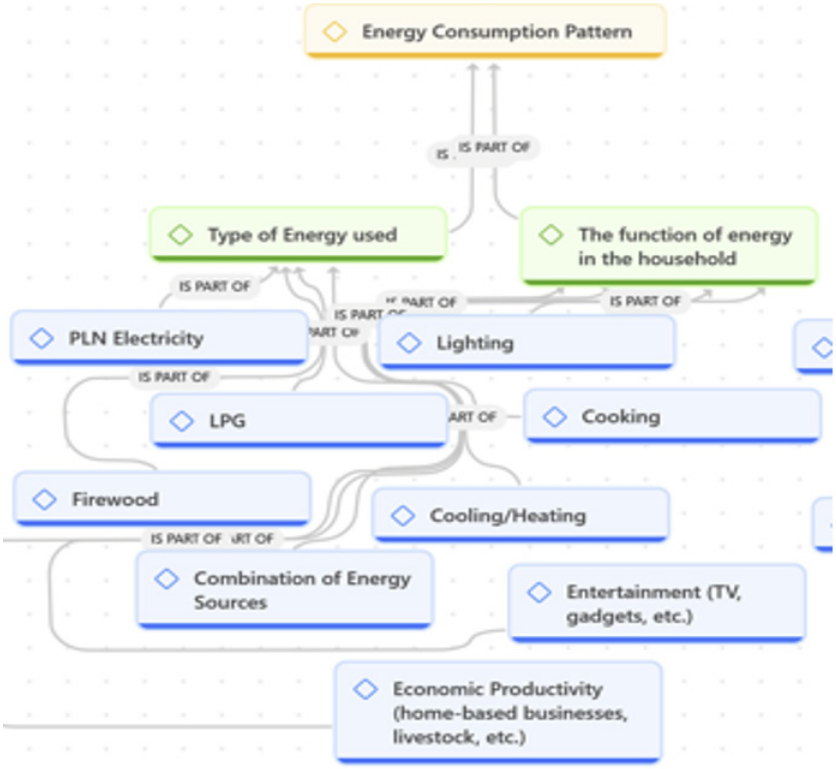
with LPG. This pattern supports the Energy Ladder Theory, which explains the gradual transition from traditional to modern fuels as income and access to modern fuels improve. Finally, energy consumption related to mobility was higher in urban areas, where vehicle ownership was more diverse, while motorcycles dominated rural transportation. Limited public transportation in both areas highlights structural constraints on promoting low-carbon mobility (Brown et al., 2016).

Energy conservation at the household level is crucial to supporting sustainable development. The ATLAS.ti analysis shows that household energy consumption behavior is shaped by socioeconomic conditions, education, infrastructure availability, and energy conservation awareness. These behaviors are reflected in several key dimensions, including energy consumption patterns, energy-saving practices, transportation-related energy use, knowledge and acceptance of renewable energy, and public expectations and recommendations. Figure 1 presents findings related to household energy consumption patterns.

**Figure 1. Energy Consumption Patterns**




Households primarily rely on three energy sources: PLN electricity for electronic appliances, LPG for cooking, and firewood, mainly in rural areas, for large-scale or alternative uses (see Figure 1). Differences in LPG and firewood utilization indicate a clear urban–rural energy transition gap, where rural households remain more dependent on traditional energy sources. These findings highlight the importance of promoting energy-saving behavior in daily household activities.

**Figure 2. Energy-Saving Behavior**

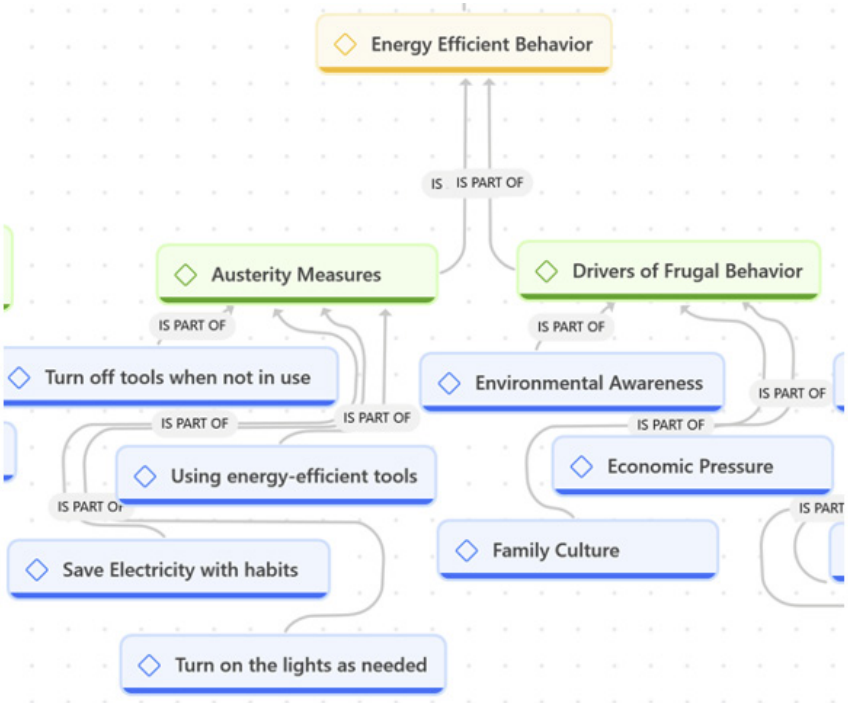
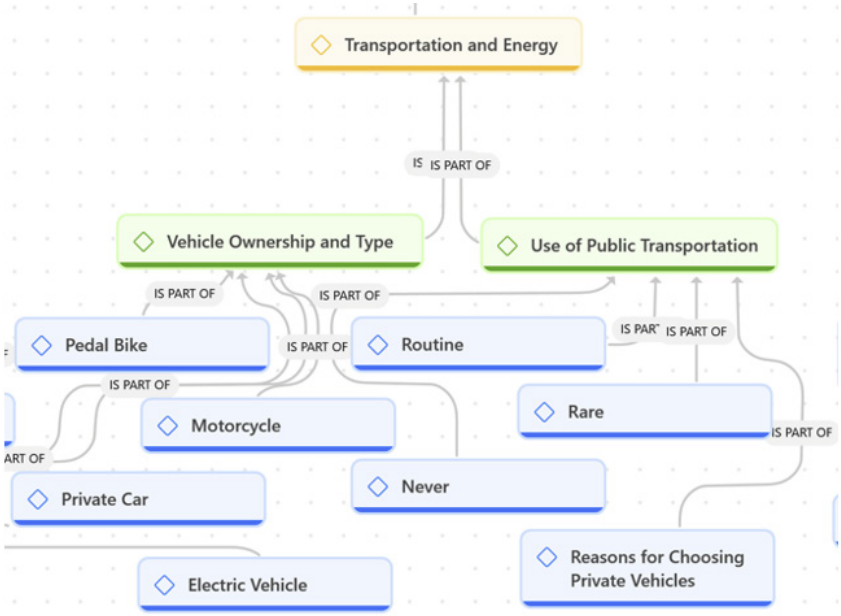



**Figure 3. Transportation and Energy**




Energy-saving behavior is mainly reflected in habits such as turning off unused appliances, limiting lighting use, and adopting energy-efficient devices. These practices are influenced by environmental awareness, economic considerations, education, and family values (see Figure 2). Education and household role models emerge as important drivers in shaping sustainable energy-saving habits. Transportation-related energy use is also identified as a key area for household-level energy conservation, as illustrated in the ATLAS.ti coding results.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Transportation patterns reflect household economic conditions and significantly contribute to energy consumption. Motorcycles and cars dominate daily mobility, while electric vehicles are increasingly appearing in urban areas. In contrast, limited access to public transportation remains a major challenge in rural areas. Low public transport utilization increases fuel consumption, suggesting that improvements in transportation services and supportive energy transition policies are necessary to encourage behavioral change (see Figure 3).

**Figure 4. Knowledge and Acceptance of Renewable Energy**

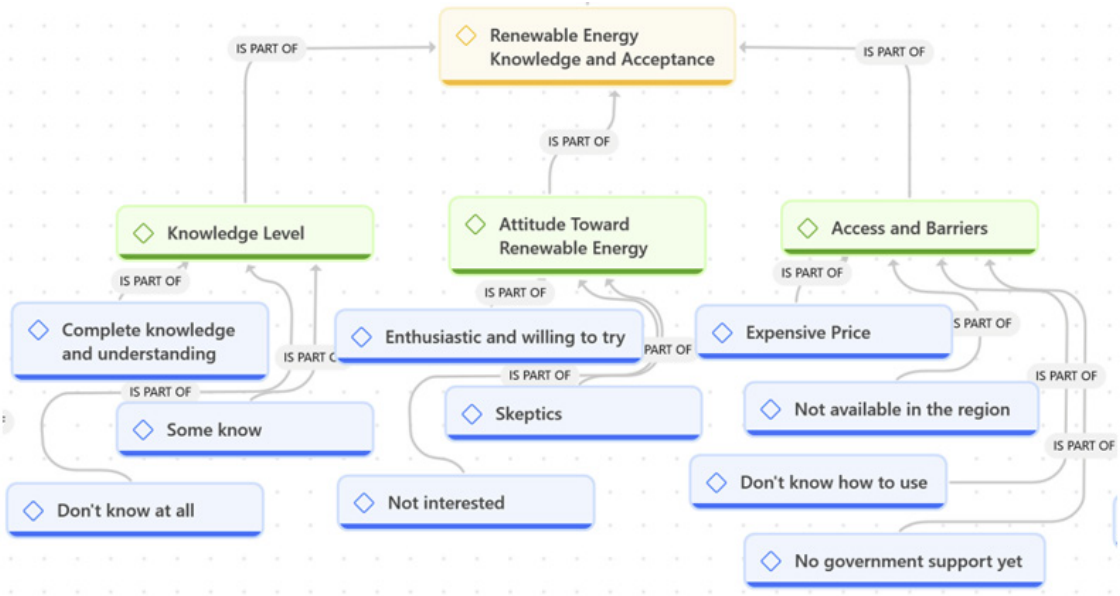
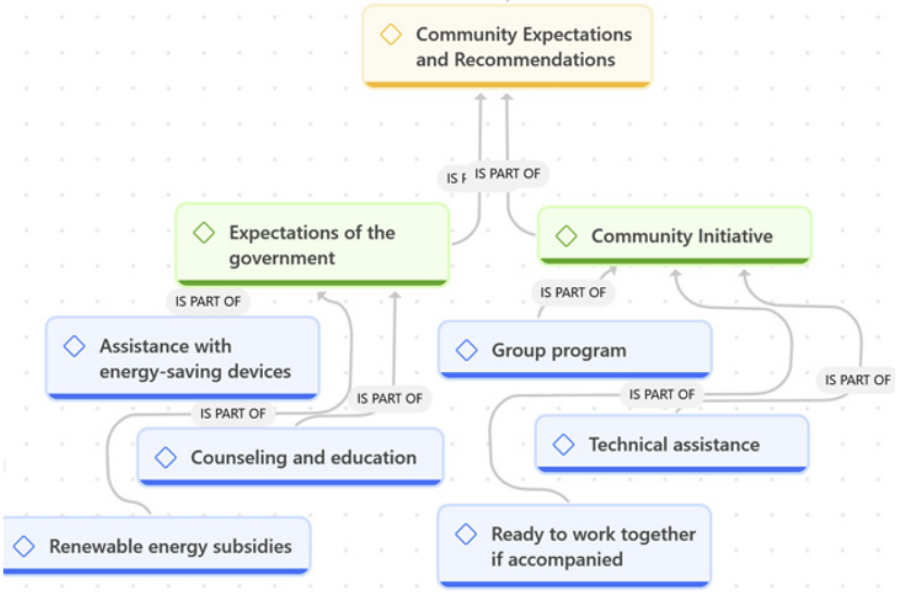



Figure 4 describes public knowledge and acceptance of renewable energy. Knowledge of renewable energy varies substantially, ranging from full understanding to complete lack of awareness. Renewable energy literacy is notably higher in urban areas, where 57% of respondents recognize the concept, compared to 27% in rural areas. In rural areas, 32% of respondents are unaware of renewable energy, and 17% have never heard of it. Willingness to adopt renewable energy is also higher among urban households (59%) than rural households (17%), reflecting disparities in information access and infrastructure. Barriers to adoption include high technology costs, limited infrastructure, and uneven policy support. Indonesia's continued dependence on fossil fuels, reinforced by rising fuel, LPG, and electricity subsidies, further constrains the adoption of renewable energy despite growing public awareness.

Public enthusiasm for energy conservation is relatively high, as reflected in expectations for stronger government involvement through education, technical assistance, and support programs for energy-saving technologies such as LED lighting. Energy-saving behavior is expressed through daily habits and decisions to adopt energy-efficient technologies, both of which are influenced by psychological motivations, economic considerations, and the availability of incentives and accessible information (see Figure 5).

**Figure 5. Public Expectations and Recommendations**




An analysis of energy consumption patterns is explained in the data processing output in Table 3. The binary logistic regression analysis reveals that socioeconomic variables do not uniformly influence household energy-saving behavior. Specifically, income level is not a statistically significant predictor of energy conservation. This result suggests that higher financial capacity does not automatically translate into a stronger commitment to sustainable energy practices. One major contributing factor to this phenomenon in Indonesia is the extensive energy subsidy system, which significantly reduces the actual cost of electricity and fuel. As a result, financial incentives to conserve energy are diminished, particularly for higher-income households, who may not perceive energy costs as a substantial burden.

**Table 3. Binary Logistic Regression Test**

| Variable | Coefficient | z-stat | Prob | Odd ratio |
|---|---|---|---|---|
| C | -3,0239 | -0,5705 | 0,5684 | 0,0486 |
| Inc | 0,8087 | 0,8512 | 0,3947 | 2,2450 |
| Edu | -0,0083 | -0.1093 | 0,9129 | 0,9917 |
| Fam_number | -0,3571 | -2,3922 | 0,0167 | 0,6997 |
| House_area | -0,0097 | -2,4484 | 0,0143 | 0,9903 |
| Elec_power | 0,0012 | 2,2178 | 0,026 | 1,0012 |
| Home_tech | -0,1190 | -0,8012 | 0,423 | 0,8878 |
| Loc | 1,1115 | 2,2428 | 0,0249 | 3,0389 |
| McFadden R-squared | 0,1254 | | | |
| LR Statistic | 20,0415 | | | |
| Prob(LR Statistic) | 0,0055 | | | |

Sources: Data Processed (2025)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This result aligns with Ameli and Brandt (2015), who found that in markets where energy prices are heavily subsidized or regulated, income elasticity of energy efficiency behavior tends to weaken. Households across income levels may exhibit similar patterns of energy use. Likewise, Romero-Jordán et al. (2022) demonstrated that in low-price environments, non-economic factors such as housing characteristics and appliance usage patterns often play a more prominent role than income in determining energy efficiency outcomes. Additionally, higher-income households may prioritize comfort and convenience, leading to increased energy consumption regardless of cost. In contrast, lower-income groups, although potentially more financially constrained, may also lack access to the information, technology, or infrastructure needed to adopt energy-efficient practices (González-González & Moro, 2020).

Similarly, formal education shows no significant relationship with energy-efficient consumption. This finding aligns with prior research suggesting that formal education alone does not guarantee more sustainable energy behavior (Endriana et al., 2025). The presence of a rebound effect may explain this, as individuals with higher levels of education often have higher appliance ownership, potentially offsetting their environmental awareness. These results support the argument that household habits and social environments play a more critical role than formal education in shaping energy-saving actions (Grilli & Curtis, 2021), especially when reinforced by community norms and collective motivation (Abrahamse et al., 2005).

In contrast, household size emerged as a significant determinant, where an increase in the number of family members reduces the likelihood of practicing energy-efficient behavior. Larger households face structural challenges, such as intensified daily activities and more frequent use of shared appliances, making systemic conservation harder to maintain. This finding is consistent with previous studies emphasizing household composition as a key driver of residential energy consumption. Physical housing characteristics also play a crucial role; larger dwelling areas are associated with a lower probability of energy efficiency. Larger homes inherently demand more energy for lighting and cooling. However, prior studies note that lifestyle choices, adequate ventilation, and access to natural lighting can mitigate energy consumption even in larger homes (Sardianou, 2007).

Interestingly, installed electrical capacity has a positive and significant effect on energy-efficient behavior. Households with higher capacity are more likely to adopt energy-saving practices, reflecting a technological transition in which higher-capacity homes tend to use newer, more efficient appliances. Similar patterns have been observed in previous studies, which emphasize the role of appliance efficiency and technological upgrading in reducing energy intensity (Romero-Jordán & del Río, 2022).

Although the number of electronic appliances owned by a household is often assumed to increase energy consumption, this study finds that appliance ownership is not a statistically significant determinant of energy efficiency behavior. This result suggests that energy-saving behavior is influenced more by usage patterns and behavioral self-

regulation than by the mere quantity of appliances. In other words, households with many appliances may still exhibit efficient energy use if they maintain strong behavioral control, awareness, or apply usage restrictions. This finding is consistent with recent studies that emphasize the importance of behavioral factors over structural ownership. For instance, Qiao et al. (2024) found that the energy-saving potential of appliances depends more on user behavior than on the number or technical specifications of the devices themselves. Similarly, Sardianou (2020) highlights that attitudes, perceived behavioral control, and routine practices are better predictors of household energy use than asset ownership alone.

Ultimately, residential location remains a primary determinant of energy behavior. Households in resource-dependent peripheral settings are significantly more likely to practice energy-efficient consumption compared to those in high-density spatial contexts. This disparity is attributed to increased appliance ownership and lifestyle modernization in developed areas (IEA, 2022). In contrast, higher efficiency in peripheral areas is often a result of structural and environmental constraints, such as reliance on traditional energy sources (Our World in Data, 2023) and better access to natural cooling and daylighting (OECD, 2021), which differ significantly from developed contexts.

## CONCLUSIONS

This study reveals that household energy consumption behavior is strongly influenced by spatial disparities, where structural and behavioral factors outweigh conventional economic determinants. Empirical findings indicate that household size, dwelling area, installed electrical capacity, and residential location significantly affect the likelihood of adopting energy-saving practices. In contrast, income and education have a limited statistical influence. These outcomes suggest that Indonesia's long-standing energy subsidy policies have weakened price signals, reducing the role of economic motivation in promoting conservation. Instead, housing characteristics, access to electricity, and appliance usage patterns emerge as key drivers of energy behavior.

Several policy recommendations based on these findings concern subsidy reform, namely, readjusting subsidies to minimize price distortions and align them with energy conservation goals. One such recommendation is conditional subsidies for those who practice energy conservation. Strengthening public programs that focus on energy literacy, behavioral change, and awareness campaigns, especially in urban areas with high energy consumption. In addition, providing incentives in the form of financial assistance, tax rebates, or microfinance for households to adopt energy-efficient appliances and small-scale renewable energy systems can motivate them to improve energy efficiency or begin adopting renewable energy use.


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## REFERENCES

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A Review of Intervention Studies Aimed at Household Energy Conservation. *Journal of Environmental Psychology*, *25*(3), 273–291. https://doi.org/10.1016/j.jenvp.2005.08.002.

Ameli, N., & Brandt, N. (2015). What Impedes Household Investment in Energy Efficiency and Renewable Energy? *International Review of Environmental and Resource Economics*, *8*(1), 101–138. https://doi.org/10.1561/101.00000067.

Benlaria, H. (2025). Does Education Spending Affect Energy Consumption in Saudi Arabia? A Bootstrap Causality Test. *International Journal of Energy Economics and Policy*, *15*(1), 36–46. https://doi.org/10.32479/ijeep.17481.

Bhattacharjee, S., & Reichard, G. (2011). Socio-Economic Factors Affecting Individual Household Energy Consumption: A Systematic Review. *ASME 2011 5th International Conference on Energy Sustainability.*

Brown, A. E., Blumenberg, E., Taylor, B. D., Ralph, K., & Voulgaris, C. T. (2016). A Taste for Transit? Analyzing Public Transit Use Trends Among Youth. *Journal of Public Transportation*, *19*(1), 49–67. https://doi.org/10.5038/2375-0901.19.1.4.

Chavda, R., Pandya, S., & Kotwal, C. (2023). Influence of Demographic-Household Features on Electricity Consumption to generate Consumption Patterns and Profiles. *Indian Journal of Science and Technology*, 16(35), 2879–2888. https://doi.org/10.17485/ijst/v16i35.685.

Chica-Olmo, J., Gachs-Sánchez, H., & Lizarraga, C. (2018). Route Effect on the Perception of Public Transport Services Quality. *Transport Policy*, *67*, 40–48. https://doi.org/10.1016/j.tranpol.2017.03.024.

Chung, Y. M., Chung, B. J., & Kim, D. S. (2024). Electricity Bill Savings from Reduced Household Energy Consumption in Apartment Complexes. *Energies*, *17*(21), 1–19. https://doi.org/10.3390/en17215488.

Dong, F., Yu, B., Hua, Y., Zhang, S., & Wang, Y. (2018). A Comparative Analysis of Residential Energy Consumption in Urban and Rural China: Determinants and Regional Disparities. *International Journal of Environmental Research and Public Health*, *15*(11), 2507. https://doi.org/10.3390/ijerph15112507.

Dupont, D. P. (2004). Do Children Matter? An Examination of Gender Differences in Environmental Valuation. *Ecological Economics*, *49*(3), 273–286. https://doi.org/10.1016/j.ecolecon.2004.01.013.

Endriana, L., Hartono, D., Khoirunurrofik, & Muzayanah, I. F. U. (2025). Does Education Affect Energy Behavior? Investigating The Influence of Educational Attainment in Indonesia. *Social Sciences and Humanities Open*, *11*, 101612. https://doi.org/10.1016/j.ssaho.2025.101612.

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household Energy Use: Applying Behavioural Economics to Understand Consumer Decision-Making and Behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385–1394. https://doi.org/10.1016/j.rser.2014.09.026.

Gashaye, A. T., Liu, H., & Li, J. (2025). The Effect of Access to Electricity on Rural Households of Underdeveloped Countries: Evidence from Ethiopia. *Energy Policy*, *199*, 114531. https://doi.org/10.1016/j.enpol.2025.114531.

Grilli, G., & Curtis, J. (2021). Encouraging Pro-Environmental Behaviours: A Review of Methods and Approaches. *Renewable and Sustainable Energy Reviews*, *135*, 110039. https://doi.org/10.1016/j.rser.2020.110039.

Guo, J., Xu, Y., Qu, Y., Wang, Y., & Wu, X. (2023). Exploring Factors Affecting Household Energy Consumption in the Internet Era: Empirical Evidence from Chinese households. *Energy Policy*, *183*, 113810. https://doi.org/10.1016/j.enpol.2023.113810.

Haque, A. N., Lemanski, C., & de Groot, J. (2021). Why Do Low-Income Urban Dwellers Reject Energy Technologies? Exploring the Socio-Cultural Acceptance of Solar Adoption in Mumbai and Cape Town. *Energy Research and Social Science*, *74*, 101954. https://doi.org/10.1016/j.erss.2021.101954.

Harnphattananusorn, S., & Puttitanun, T. (2022). Energy Consumption and Generation Diversity. *International Journal of Energy Economics and Policy*, *12*(6), 481–485. https://doi.org/10.32479/ijeep.13523.

Khulaemi, A. (2022). Perilaku Hemat Energi pada Generasi Milenial. *Jurnal Widyaiswara Indonesia*, *3*(2), 107–118. https://doi.org/10.56259/jwi.v3i2.111.

Lesic, V., De Bruin, W. B., Davis, M. C., Krishnamurti, T., & Azevedo, I. M. L. (2018). Consumers' Perceptions of Energy Use and Energy Savings: A Literature Review. *Environmental Research Letters*, *13*(3). https://doi.org/10.1088/1748-9326/aaab92.

Li, G., Sun, J., & Dai, A. (2016). Village Differences in Rural Household Energy Consumption within The Loess Hilly Region of China. *Energy, Sustainability and Society*, *6*, 33. https://doi.org/10.1186/s13705-016-0099-3.

Li, Z., Zhao, Q., Guo, H., & Huang, R. (2024). Impact of Fossil Fuel Subsidies on Energy-Saving Technological Change in China. *Energy*, *286*, 129265. https://doi.org/10.1016/j.energy.2023.129265.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46868

Lindgren, S. (2024). Sociocultural Determinants of Electric Cooking in Rural Namibia: Recommendations for Youth and Educational Approaches to Implementation Strategy and Policy. *Energy Policy*, *187*, 114015. https://doi.org/10.1016/j.enpol.2024.114015.

Lundberg, D. C., Tang, J. A., & Attari, S. Z. (2019). Easy but not Effective: Why "Turning off the Lights" Remains a Salient Energy Conserving Behaviour in the United States. *Energy Research and Social Science*, *58*, 101257. https://doi.org/10.1016/j.erss.2019.101257.

Ly, H., & Irwin, J. D. (2017). The Relationship Between Perceptions of Discounted Public Transit and Physical Activity: Cross-Sectional Online Survey in Canada. *Case Studies on Transport Policy*, *5*(2), 279–285. https://doi.org/10.1016/j.cstp.2017.01.002.

Mahmoud, M., & Hine, J. (2016). Measuring the Influence of Bus Service Quality on the Perception of Users. *Transportation Planning and Technology*, *39*(3), 284–299. https://doi.org/10.1080/03081060.2016.1142224.

Marzban, E., Firoozpour, A., & Marzban, M. (2023). Electricity as a Common Good/Resource: a Scenario-based Approach. *International Journal of Energy Sector Management*, *17*(3), 510–530. https://doi.org/10.1108/IJESM-08-2021-0020.

Mills, B., & Schleich, J. (2012). Residential Energy-Efficient Technology Adoption, Energy Conservation, Knowledge, And Attitudes: An Analysis of European Countries. *Energy Policy*, *49*, 616–628. https://doi.org/10.1016/j.enpol.2012.07.008.

Ministry of Energy and Mineral Resources. (2023). *Handbook Of Energy & Economic Statistics Of Indonesia 2023*. Jakarta: Ministry of Energy and Mineral Resources.

Nazer, M., & Handra, H. (2016). Analisis Konsumsi Energi Rumah Tangga Perkotaan di Indonesia: Periode Tahun 2008 dan 2011. *Jurnal Ekonomi dan Pembangunan Indonesia*, *16*(2), 141–153. https://doi.org/10.21002/jepi.v16i2.04.

Novianto, D., Koerniawan, M. D., Munawir, M., & Sekartaji, D. (2022). Impact of Lifestyle Changes on Home Energy Consumption during Pandemic COVID-19 in Indonesia. *Sustainable Cities and Society*, *83*, 103930. https://doi.org/10.1016/j.scs.2022.103930.

Nugroho, S. B., Fujiwara, a, Zhang, J., Kanemoto, K., Moersidik, S. S., & Abbas, S. (2010). Development of a Household Energy Consumption. *International Sustainable Development Research Conference 2010*.

Oh, M., Jang, K. M., & Kim, Y. (2021). Empirical Analysis of Building Energy Consumption and Urban Form in a Large City: A Case of Seoul, South Korea. *Energy and Buildings*, *245*, 111046. https://doi.org/10.1016/j.enbuild.2021.111046.

Olatunde, T. M., & Okwandu, A. C. (2024). Reviewing the Impact of Energy-Efficient Appliances on Household Consumption. *International Journal of Science and Technology Research Archive*, *6*(2), 1–11. https://doi.org/10.53771/ijstra.2024.6.2.0038.

Pangestu, R. C. K., & Ayuningsasi, A. A. K. (2024). Pengaruh Konsumsi Energi Sektor Industri, Rumah Tangga, dan Transportasi terhadap Emisi Karbon di Indonesia. Inisiatif: *Jurnal Ekonomi, Akuntansi dan Manajemen*, *3*(4), 297–311.

Peng, Y., Gaspari, J., & Marchi, L. (2024). Exploring Residential Energy Behaviour of the Younger Generation for Sustainable Living: A Systematic Review. *Energies*, *17*(12), 3043. https://doi.org/10.3390/en17123043.

Permana, A. S., Aziz, N. A., & Siong, H. C. (2015). Is Mom Energy Efficient? A Study of Gender, Household Energy Consumption, and Family Decision Making in Indonesia. *Energy Research and Social Science*, *6*, 78–86. https://doi.org/10.1016/j.erss.2014.12.007.

Piao, X., & Managi, S. (2023). Household Energy-Saving Behavior, Its Consumption, and Life Satisfaction in 37 Countries. *Scientific Reports, 13*, 1382. https://doi.org/10.1038/s41598-023-28368-8.

Qiao, L., Bai, X., Liang, X., Cheng, J., & Xia, Y. (2024). User Behavior and Energy-Saving Potential of Electric Washing Machines. *Energy Informatics*, *7*, 137. https://doi.org/10.1186/s42162-024-00444-x.

Ravindra, K., Kaur-Sidhu, M., Mor, S., & John, S. (2019). Trend in Household Energy Consumption Pattern in India: A Case Study on the Influence of Socio-Cultural Factors for the Choice of Clean Fuel Use. *Journal of Cleaner Production*, *213*, 1024–1034. https://doi.org/10.1016/j.jclepro.2018.12.092.

Romero-Jordán, D., & del Río, P. (2022a). Analysing the Drivers of the Efficiency of Households in Electricity Consumption. *Energy Policy*, *164,* 112828. https://doi.org/10.1016/j.enpol.2022.112828.

Rustanto., Djati, A. P., Gymnastiar, A. A., Widiyanto, S., Putra, D. S., Aziz, M. Y. A., & Afifi, A. A. (2024). Peningkatan Efisiensi Energi pada Peralatan Rumah Tangga Berbasis Mekanik oleh Mahasiswa Universitas Negeri Semarang di Kawasan Cempaka Sari. *Jurnal Potensial*, *3*(1), 38–55.

Sardianou, E. (2007). Estimating Energy Conservation Patterns of Greek Households. *Energy Policy*, *35*(7), 3778–3791. https://doi.org/10.1016/j.enpol.2007.01.020.

Shrestha, B., Tiwari, S. R., Bajracharya, S. B., Keitsch, M. M., & Rijal, H. B. (2021). Review on the Importance of Gender Perspective in Household Energy-Saving Behavior and Energy Transition for Sustainability. *Energies*, *14*(22), 7571. https://doi.org/10.3390/en14227571.

Soltani, M., Rahmani, O., Ghasimi, D. S. M., Ghaderpour, Y., Pour, A. B., Misnan, S. H., & Ngah, I. (2020). Impact of Household Demographic Characteristics on Energy Conservation and Carbon Dioxide Emission: Case from Mahabad city, Iran. *Energy*, *194*, 116916. https://doi.org/10.1016/j.energy.2020.116916.

Sovacool, B. K. (2009). The Cultural Barriers to Renewable Energy and Energy Efficiency in the United States. *Technology in Society*, *31*(4), 365–373. https://doi.org/10.1016/j.techsoc.2009.10.009.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46868

Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017). New Frontiers and Conceptual Frameworks for Energy Justice. *Energy Policy*, *105*, 677–691. https://doi.org/10.1016/j.enpol.2017.03.005.

Steg, L., & Vlek, C. (2009). Encouraging Pro-Environmental Behaviour: An Integrative Review and Research Agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004.

Sütterlin, B., & Siegrist, M. (2017). Public Acceptance of Renewable Energy Technologies from an Abstract Versus Concrete Perspective and the Positive Imagery of Solar Power. *Energy Policy*, *106*, 356–366. https://doi.org/10.1016/j.enpol.2017.03.061.

Taufikurahman, M. R., Holis, A., Mirdad, A. J., Wibowo, D. H., & Ahmad, T. (2023). Dampak Subsidi BBM dan LPG 3Kg Terhadap Kemiskinan Nelayan. *Indef Policy Brief*, 3, 1–9.

Van Der Kroon, B., Brouwer, R., & Van Beukering, P. J. H. (2013). The Energy Ladder: Theoretical Myth or Empirical Truth? Results from a Meta-Analysis. *Renewable and Sustainable Energy Reviews*, *20*, 504–513. https://doi.org/10.1016/j.rser.2012.11.045.

Waleed, K., & Mirza, F. M. (2023). Examining Fuel Choice Patterns Through Household Energy Transition Index: An Alternative to Traditional Energy Ladder and Stacking Models. *Environment, Development and Sustainability*, *25*, 6449–6501. https://doi.org/10.1007/s10668-022-02312-8.

Wang, B., Wang, X., Guo, D., Zhang, B., & Wang, Z. (2018). Analysis of Factors Influencing Residents' Habitual Energy-Saving Behaviour Based on NAM and TPB Models: Egoism or Altruism? *Energy Policy*, *116*, 68–77. https://doi.org/10.1016/j.enpol.2018.01.055.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social Acceptance of Renewable Energy Innovation: An Introduction to the Concept. *Energy Policy*, 35(5), 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001.

Xiong, J., & Xu, D. (2021). Relationship between Energy Consumption, Economic Growth, and Environmental Pollution in China. *Environmental Research*, *194*, 110718. https://doi.org/10.1016/j.envres.2021.110718.

Yu, M., Wang, C., Liu, Y., Olsson, G., & Bai, H. (2018). Water and Related Electrical Energy Use in Urban Households—Influence of Individual Attributes in Beijing, China. *Resources, Conservation and Recycling*, *130*, 190–199. https://doi.org/10.1016/j.resconrec.2017.11.004.

Yumita, F. R., Irawan, M. Z., & Malkhamah, S. (2020). Faktor Keengganan Pelajar Menggunakan Angkutan Umum dalam Perjalanan Ke Sekolah. *Jurnal Aplikasi Teknik Sipil*, *18*(2), 239–248.

Zhang, J., & Khan, I. (2024). Energy Use, Energy Access, and Oil Price Fluctuations as New Determinants of Environmental Quality in APEC Countries. *Gondwana Research*, *132*, 309–322. https://doi.org/10.1016/j.gr.2024.04.015.

Zhang, Y., & Tao, W. (2020). Will Energy Efficiency Affect Appliance Price? An Empirical Analysis of Refrigerators in China based on the Hedonic Price Model. *Energy Policy*, *147*, 111818. https://doi.org/10.1016/j.enpol.2020.111818.

Zhao, P., & Zhang, M. (2018). The Impact of Urbanisation on Energy Consumption: A 30-Year Review in China. *Urban Climate*, *24*, 940–953. https://doi.org/10.1016/j.uclim.2017.11.005.

Zhou, K., & Yang, S. (2016). Understanding Household Energy Consumption Behavior: The Contribution of Energy Big Data Analytics. *Renewable and Sustainable Energy Reviews*, *56*, 810–819. https://doi.org/10.1016/j.rser.2015.12.001.


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# Forecasting Coal Consumption Reduction for Climate Change

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## ABSTRACT

**Research Originality**: This study uniquely examines how reducing coal consumption could mitigate climate change and help achieve the Sustainable Development Goals by 2030.

**Research Objectives**: This study investigates the impact of reducing coal consumption on climate change and on achieving the Sustainable Development Goals in Indonesia, a major coal exporter, as well as in China and India, which are expected to become major coal importers by 2030.

**Research Methods**: This study employs a basic panel regression model to analyze data from 2015 to 2024, and uses an ARIMA method to forecast progress toward the Sustainable Development Goals by 2030.

**Empirical Results**: The findings highlight the urgent need for Indonesia, China, and India to shift to clean, renewable energy to meet the Sustainable Development Goals by 2030, which aim to reduce emissions.

**Implications**: This study recommends that the governments of Indonesia, China, and India should increase their use of renewable energy sources more consistently.

**Keywords:**

global warming; emission reduction; renewable energy; clean energy; energy transition

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## INTRODUCTION

The energy transition plays a crucial role in achieving Sustainable Development Goals 7 and 13. In the National Long-Term Development Plan, policies supporting a fair transition to new and renewable energy sources are part of efforts to promote low-carbon growth. This transition ensures that the benefits and risks of moving toward a more sustainable energy future are shared fairly among all affected communities. Previous studies have shown mixed results on how to achieve these development goals. Successfully achieving them will require adopting new methods that promote environmental protection and sustainable practices (Ansell et al., 2022; Küfeoğlu, 2022).

Development Goals suggest a country-led implementation process. However, the success of these initiatives depends on setting sustainability targets that are compatible across different sectors and levels (Moallemi et al., 2020; Shrivastava et al., 2020). It is important to recognize that Sustainable Development Goals 7 and 13 focus on urgent actions needed to fight climate change and its harmful impacts: Clean and Affordable Energy, which aims to ensure universal access to affordable, reliable, sustainable, and modern energy services for everyone.

The literature on climate change has demonstrated an increasing awareness of the need to connect climate change with sustainable development. The findings of this study emphasize the effectiveness of nature-based solutions (NBS) in tackling global challenges. It analyzed 132 documents from Scopus and Web of Science (WoS). The study observed a significant rise in research output, indicating that NBS are becoming more important. The analysis also found that India, Italy, and the UK are among the top countries conducting research. However, there are notable differences in the level of contribution across countries, with African nations contributing less than others (Okolie et al., 2025).

Another study found that transitioning to a renewable energy economy involves more than just shutting down coal-fired power plants; it also requires implementing strategies to reduce the economic and social risks inherent in the supply chain. However, the new regulation remains focused on technology, primarily using metrics such as coal use, power generation, and emissions reductions to measure success. It does not address what will happen to workers who lose their jobs when coal plants close, nor does it provide a way for local communities to participate in decision-making. Climate change is a complex and urgent global issue that has gained significant attention in recent years (Brady, 2020).

Over the years, climate change has significantly affected both the natural environment and society, with both positive and negative impacts. Studies in other countries show that low-carbon transitions are especially difficult in coal regions. There are not only technological and economic challenges but also deep socio-political and cultural barriers to breaking free from carbon lock-in. Changing these regions involves destabilizing and reshaping high-carbon systems, often requiring structural shifts across technological, socioeconomic, political, and cultural areas (Mangalagiu et al., 2025). Those involved find adding capacity to be a significant challenge. Recent studies in India and China,


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two major coal importers, indicate that coal consumption and trade openness greatly affect $CO_2$ emissions in both the short and long term. An analysis of India's and China's plans shows that each country aims to reduce $CO_2$ emissions from its power sector by adopting clean coal technology. The analysis indicates that clean technology has substantial potential in this area, as it can accelerate the development of coal technology (Pan et al., 2024; Xu et al., 2024).

This study uses Indonesia, a major coal exporter, as a case study to explore ways to reduce carbon emissions and assess the impact of phasing out coal in the power and upstream sectors of developing coal-producing countries. As one of the fastest-growing economies in Southeast Asia, Indonesia faces a significant challenge in balancing its energy needs with efforts to lower greenhouse gas emissions. Energy has become an increasingly strategic commodity, and supply uncertainty could threaten economic independence and security (Gulagi et al., 2025; Li et al., 2025; Massagony et al., 2025).

Indonesia was selected for this study because it is an emerging country experiencing rapid growth in electricity generation, with coal-fired power plants responsible for 60% of this increase. It is also the world's fifth-largest coal producer and holds a significant share of global coal reserves. Additionally, Indonesia must recognize the importance of the coal sector to the mining industry's income. It has contributed 80% of the total income over the past decade. Furthermore, the coal sector has added 1.5–2% to the national income (Handayani et al., 2025; Munawir et al., 2025; Reyseliani et al., 2024a; Wollff, 2023). Coal revenues account for about 35% of East Kalimantan's income and between 19% and 26% of South Kalimantan's income.

In 2020, the power generation sector remained the largest consumer of coal. Indonesia's total power capacity was 72.8 GW that year, with coal (50.4%), natural gas (24.2%), and oil (11%) accounting for the majority of installed capacity. Additionally, approximately 33 GW of coal-fired power plant capacity was under construction and in active development (Gulagi et al., 2025; Jermain & Pilcher, 2023; Reyseliani et al., 2024b). According to the National Energy Policy (NEP) roadmap, coal is expected to account for about 30 percent of the national energy mix by 2025, decreasing to around 25 percent by 2050. Since 2023, Indonesia has implemented a series of energy transition policies that are expected to affect domestic coal consumption. The government aims to gradually reduce the capacity and electricity generation from coal-fired power plants. Indonesia is actively working to cut coal consumption through various strategies, including transitioning to renewable energy sources and boosting energy efficiency (Ali & Kim, 2024; Massagony et al., 2025; Shah et al., 2024).

Moreover, this study focuses on China and India, as recent research shows that these countries' coal use and openness to trade significantly influence their $CO_2$ emissions both in the short and long term. Both nations are major importers of coal from Indonesia (Li & Haneklaus, 2022; Li et al., 2012). An analysis of India's and China's plans indicates that both countries aim to reduce $CO_2$ emissions from their power sectors by adopting clean coal technology. The analysis suggests that clean technology plays a key role in

accelerating the development of coal technology in India and China (Agrawal et al., 2024; Chen et al., 2022; Sun & Zuo, 2025; Wu et al., 2024; Zhang et al., 2024). This idea is interesting and could be practiced in Indonesia.

The originality of this research lies in its examination of the potential impact of reducing coal use on climate change and helping achieve Sustainable Development Goals 7 and 13 by 2030. It focuses on Indonesia, a key coal exporter, along with China and India, major coal importers. The study fills a gap in existing research by predicting how shifting from coal to renewable energy could influence climate change and progress toward SDGs 7 and 13, especially in Indonesia, China, and India. Its goal is to analyze how reducing coal use might affect climate change and progress on the SDGs in these countries by 2030. The results are expected to identify ways to lower carbon emissions while boosting renewable energy use, offering policymakers valuable insights.

## METHODS

This study forecasts a decrease in carbon emissions using a projection method that combines two complementary analytical techniques: panel regression and ARIMA models. First, panel regression was used to analyze the respective impacts of coal and renewable energy consumption on climate change from 2015 to 2024. The study utilizes panel data from Indonesia, China, and India spanning 2015 to 2024, marking the start of the Sustainable Development Goals period, to assess current conditions. The panel regression model uses longitudinal data to capture temporal and spatial variations in carbon emissions across countries. A second data set covers the years 2025 to 2030, indicating the end of the Sustainable Development Goals period, for predicting future conditions.

Renewable energy, mainly from solar, wind, and hydro sources, is crucial for fighting climate change by replacing fossil fuels, which are the primary source of greenhouse gases that trap heat. Switching to these clean sources cuts carbon emissions because renewables produce minimal emissions during operation. This helps limit global warming, improve air quality, and promote sustainability, with over 90% of new power capacity in 2024 coming from renewable sources (Babaremu et al., 2025; Nwagu, Ujah, Kallon, & Aigbodion, 2025; Okolie, Danso-Abbeam, Ogundeji, Owolabi, & Kunguma, 2025). Because of this, the study focuses on two variables—coal energy consumption and renewable energy sources—to analyze how reducing coal use and increasing renewable energy sources, such as solar and wind power, affect carbon emission forecasts in Indonesia, China, and India. The study also emphasizes the need for more accurate climate modeling to meet the research objectives (see Table 1).

Forecasting is a technique for predicting the future. This research examines forecasting conditions in Indonesia, China, and India, focusing on how reducing coal consumption and increasing renewable energy use will affect carbon emissions forecasts for 2025-2030. The Autoregressive Integrated Moving Average (ARIMA) method is employed to analyze time series data. This medium-term forecasting approach generally yields more accurate results than other methods. The ARIMA model is one example of a technique suitable for analyzing time series data.


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**Table 1. Operational Variables**

| Variables | Definitions | Measurements | Sources |
|---|---|---|---|
| Climate Change | Total carbon emissions from energy, in million tons of carbon dioxide | Million tons of carbon dioxide | The Energy Institute |
| Coal Energy Consumption | The total amount of energy consumed from coal in one year | Exajoules | The Energy Institute |
| Renewable Energy Consumption | The total amount of renewable energy consumed in one year | Exajoules | The Energy Institute |

The above method aims to analyze the impact of reducing coal consumption and increasing renewable energy sources, such as solar and wind power, on carbon emission forecasts. This will help us predict whether the Sustainable Development Goals will be achieved by 2030 and address the research objectives of this study. This approach offers different perspectives on how changes in energy substitution might influence future emissions. It is expected to produce more precise estimates of potential emission reductions, thereby aiding policymakers in developing effective climate change strategies for 2025–2030. The formation of the existing condition analysis model in this research is defined as follows:

$$Y_{it} = \alpha_0 + \alpha_1 X_{1it} + \alpha_2 X_{2it} + \varepsilon_{it}$$

Where, α: parameter, i: cross section (Indonesia, China, and India), t: time series (2015-2023), ε: error term.

When estimating panel data regression models, three approaches are typically used: the common effect model (CEM), the fixed effects model (FEM), and the random effects model (REM). If the p-values of the cross-section F-test and the cross-section chi-square test are both greater than or equal to 0.05, the chosen model is the CEM. Conversely, if the p-value is less than 0.05, the FEM is selected. Then, the Hausman test is performed after the Chow test shows the FEM model is better. Also, careful testing is necessary to choose the best model between FEM and REM. The decision depends on the p-value of the random cross-section: if it is above 0.05, REM is used; if it is below, FEM is used. The purpose of the Lagrange Multiplier test is to select the best between the CEM and REM models. If the Breusch-Pagan (BP) cross-sectional value is 0.05 or higher, the CEM is chosen. If it is less than 0.05, the REM is preferred (Ospina, Gondim, Leiva, & Castro, 2023; Pereira da Veiga, Pereira da Veiga, Girotto, Marconatto, & Su, 2024).

The ARIMA model was developed by George E. P. Box and Gwilym M. Jenkins. Model identification relies on the ACF and PACF results from the time series. The ARIMA model works well for short-term forecasting but is less accurate for long-term predictions. It does not consider independent variables when making forecasts and assumes data is stationary. ARIMA uses past and present values of the dependent variable to produce accurate forecasts. Short-term forecasting involves multiple stages.

ARIMA assumes the existence of a combination (p, d, q), where p is the number of AR variables, d is the differencing process that makes the data stationary, and q is the number of MA variables. The first step in analyzing a time series with an ARIMA model is to identify the model. ARIMA models can only be applied to stationary time series. Therefore, the first step is to determine whether the data is stationary. If it is not, determine the order of differencing (d) required to make the data stationary. The next step is to determine the orders p and q of the ARIMA model by interpreting the correlogram of the stationary data. The graph should reveal patterns indicating the presence of these elements. Use the ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) coefficients to guide this process. Third, estimate the AR and MA parameters. The ARIMA forecasting method is most effective when it includes both AR and MA parameters. Fourth, perform diagnostic checks to confirm the model specifications, paying close attention to the residual correlogram. The fifth step is to forecast and select the best model. This combined approach of panel regression and ARIMA models enables more precise estimation of carbon emission reductions based on predicted changes in energy use, thereby providing a more accurate means to meet the research objectives.

## RESULTS AND DISCUSSION

A series of regression analyses was conducted to assess current conditions in Indonesia, China, and India for this research. A Chow test should be conducted to identify the best model, as shown in Table 2. The FEM model is clearly better than the CEM model (Table 2). The next step to find the best model is to perform a Hausman test. A detailed analysis of the Hausman test results (Table 3) showed that the fixed-effects model (FEM) performs better than the random-effects model (REM). It should be noted that the Lagrange Multiplier test was not performed because the FEM is the most suitable model for interpretation.

**Table 2. Chow Test Result**

| Effect Test | Statistic | d.f | Probability |
|---|---|---|---|
| Cross-Section F | 17.582000 | 2,25 | 0.0000 |
| Cross-section Chi-Square | 26.345950 | 2 | 0.0000 |

Source: Output Eviews

According to Table 3, the Hausman test indicates that the REM model is the best fit. Therefore, we can use the Lagrange Multiplier test to verify that the FEM model is the most suitable panel regression model (Table 4).

**Table 3. Hausman Test Result**

| Test Summary | Chi-Sq. Statistic | Chi-Sq d.f | Probability |
|---|---|---|---|
| Cross-section random | 35.163999 | 35.163999 | 0.0000 |

Source: Output Eviews


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The results in Table 4 show that energy consumption in Indonesia, China, and India between 2015 and 2024 significantly influenced climate change. It is clear that these countries are shifting toward renewable energy sources, marking a major change in their energy profiles. This study focused on coal energy use in these nations, which accounts for 96.06609% of the climate change impact. The results of this study are interesting and support those of a previous study. Earlier research found that China's imports of large quantities of coal from Indonesia were contributing to climate change. Since most air pollutants in China originate from coal combustion, it is important to limit coal use to improve the environment. This study uses data from 29 Chinese provinces between 1995 and 2012 to forecast China's coal consumption in 2020. It is believed that China's coal use will continue to grow, but at a slower pace. It is estimated that China will consume around 4.43 billion tonnes of coal by 2020. However, if China's growth rate stays at approximately 7.8% annually, the tipping point for total coal consumption will be reached in 2019, with usage expected to peak at 4.16 billion tonnes (Gosens et al., 2022; Liu et al., 2022).

**Table 4. Fixed Effect Model Interpretation**

| Variable | Coeff. | Std Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 559.4204 | 278.0616 | 2.011858 | 0.0551 |
| X1 | 96.06609 | 9.741093 | 9.861941 | 0.0000 |
| X2 | -104.4093 | 19.71771 | 5.295203 | 0.0000 |

Source: Output Eviews

Moreover, this research offers additional evidence supporting the findings of a previous study conducted in India. That study revealed that India's large-scale coal imports from Indonesia contributed to climate change. It showed that India's expansion of coal power could be linked to several factors. First, the power sector was opened to competition to ensure a reliable supply. This allowed big companies to invest in coal and make long-term profits, especially given the limited support for renewable energy. Second, planned public investments in new coal capacity aim to guarantee long-term electricity availability. Third, coal's importance to the economy in eastern India and the influence of local groups are major reasons why ending coal use is so challenging. Fourth, regulations meant to cut pollution and coal use are ineffective because coal supporters hold significant political influence (Montrone et al., 2021).

This study provides information on the impact of coal consumption in Indonesia, the world's largest coal exporter, as well as in China and India, which are major coal importers. However, because few studies have assessed the environmental effects of the coal industry, this research supports the idea that Indonesia causes environmental damage from coal use. Specifically, the carbon emissions from a 1% increase in coal consumption in developed countries are roughly 6 times higher than those in developing countries. Therefore, the study recommends a gradual, rather than abrupt, phase-out of coal, prioritizing developed countries. The coal phase-out and the removal of fossil fuel subsidies

should be implemented first in developed nations or be made more stringent there than in developing economies. Developed nations should reduce their coal consumption by a larger share than developing countries (Alhassan et al., 2024).

The debate over phasing out or reducing coal use is ongoing across the world's economies. Each country has its own views and commitments based on its socioeconomic priorities. Another study found that, in a globalized world, strategies to limit China's total coal consumption should be considered to reduce its coal use. Improving energy efficiency would be an effective way for China (Adebayo, 2023; Orhan et al., 2021). The harmful effects of climate change on the environment require us to accelerate the transition to low-carbon energy sources. The most important step is reducing our dependence on coal since it is the main source of carbon emissions and a key driver of global warming. However, the coal sector is deeply rooted in the country's social and political landscape, making it challenging to reduce reliance on coal (Pandey & Kumar, 2025).

This study also found that increased use of renewable energy can help reduce climate change by (-104.4093%). It supports the findings of another study, which reported that the average cost of solar power in India is now cheaper than the variable cost of many coal-fired power plants (Shrimali, 2020). Renewable energy is a type of energy source that does not emit carbon. The findings show that renewable energy can effectively replace coal, leading to substantial environmental benefits and economic savings. The research confirms previous studies that estimate the effects of switching from coal to renewable energy in China. The results reveal that the reduction in $CO_2$ emissions from decreased coal use exceeds the increase in $CO_2$ emissions from renewable energy use (Kocak & Alnour, 2025).

These findings also support the conclusions of a recent study suggesting that the global community is currently pursuing two different strategies to phase out coal. The first strategy involves using gas as a temporary solution during the shift to renewable energy sources. The second strategy involves moving directly from coal to renewable energy. This study also supports earlier research on the transition from coal to clean energy sources. This is crucial because reducing carbon emissions is vital for all countries. Some of these studies have explored ways to cut coal consumption. All of these studies agree that, to lower greenhouse gas emissions, the world must decrease its dependence on coal for electricity. Greenhouse gases are a primary driver of global warming. Achieving this could help the world become carbon-neutral by 2050 (Do & Burke, 2023; Hyun et al., 2023; Jermain & Pilcher, 2023; Moon et al., 2025).

This study also examined forecasting conditions using a series of ARIMA tests, including the ADF test in Table 5, to assess data stationarity. As shown in Table 5, the data-stationarity analysis indicates that the orders are 1 for coal energy consumption and 2 for climate change and renewable energy consumption. Once data stationarity has been established, the next step is to determine the ARIMA model orders p and q using the correlogram, as illustrated in Table 6. As shown in Table 6, this information can serve as the basis for ARIMA forecasting via the automatic method in the review processing application. At this stage, it is concluded that the data are stationary in first differences


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for coal energy consumption and in second differences for climate change and renewable energy consumption.

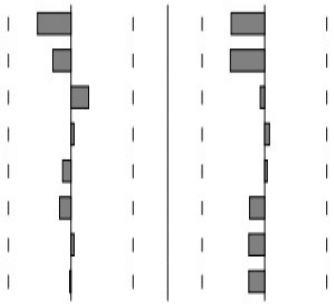
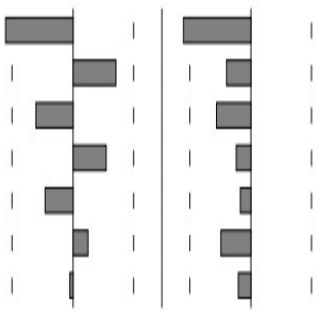
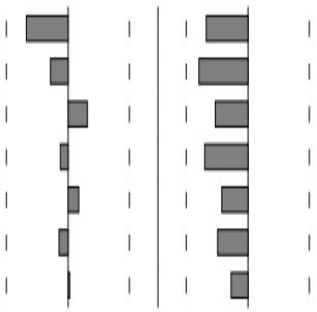
**Table 5. Stationery Test Result**

| Variable | ADF Test | | | | Decision |
|---|---|---|---|---|---|
| | First Difference | Prob. | Second Difference | Prob. | |
| Y | -3.218275 | 0.0573 | -3.505575 | 0.0507 | Stationer |
| X1 | -3.621467 | 0.0338 | - | - | Stationer |
| X2 | -5.035982 | 0.0059 | -7.022003 | 0.0012 | Stationer |

Source: Output Eviews

Therefore, the d element in the ARIMA (p, d, q) model is 1 for coal energy consumption and 2 for climate change and renewable energy consumption. Consequently, the analysis will use the ARIMA (p, 1, q) model for coal energy consumption and the ARIMA (p, 2, q) model for climate change and renewable energy consumption. The next step is to determine the values of p and q.

**Table 6. Correlogram Test Results**

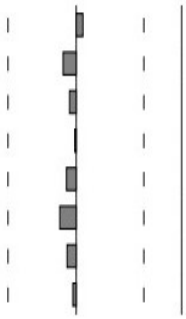
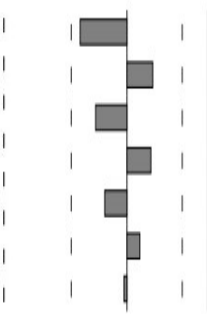
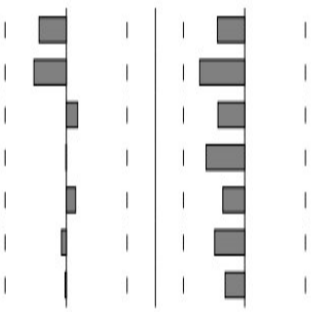
| Y | | X1 | | X2 | |
|---|---|---|---|---|---|
| Auto Corr. | Partial Corr. | Auto Corr. | Partial Corr. | Auto Corr. | Partial Corr. |
|  | |  | |  | |

Source: Output Eviews 13

**Table 7. Selection of the best ARIMA model**

| Variable | ARIMA Model | AIC | SC | HC | Adjusted R2 | Significant Variable | Result |
|---|---|---|---|---|---|---|---|
| **Y** | **(0,2,1)** | 11.93700 | 11.96679 | 11.73607 | -0.473062 | 0 | Best Model |
| | **(1,2,1)** | 12.13413 | 12.17385 | 11.86623 | 0.406934 | 0 | AR(0) MA(1) |
| | **(1,2,0)** | 12.38848 | 12.41827 | 12.18756 | -0.058177 | 0 | |
| **X1** | **(1,1,0)** | 2.032859 | 2.098600 | 1.890989 | -0.159603 | 0 | Best Model |
| | **(1,1,1)** | 2.045466 | 2.133121 | 1.856306 | 0.084667 | 0 | AR(0) MA(1) |
| | **(0,1,1)** | 1.846263 | 1.912004 | 1.704393 | 0.245250 | 1 | |
| **X2** | **(0,2,1)** | -2.180462 | -2.150671 | -2.150671 | 0.565104 | 0 | Best Model |
| | **(1,2,1)** | -2.284765 | -2.245044 | -2.552666 | 0.668471 | 0 | AR(0)MA(1) |
| | (1,2,0) | -2.255290 | -2.225499 | -2.456215 | 0.524581 | 0 | |

**Table 8. Residual Correlogram**

| Y | | X1 | | X2 | |
|---|---|---|---|---|---|
| Auto Corr. | Partial Corr. | Auto Corr. | Partial Corr. | Auto Corr. | Partial Corr. |
|  | |  | |  | |

Source: Output Eviews

The goal is to identify the values of $p$ and $q$ in an ARIMA model by generating ACF and PACF diagrams using a correlogram. The autocorrelation function (ACF) involves calculating autocorrelation coefficients, whereas the partial autocorrelation function (PACF) involves calculating partial autocorrelation coefficients. The ACF indicates the value of $q$, which relates to MA, while the PACF indicates the value of $p$, which relates to AR. The initial models for coal energy consumption (X1) in EViews are either 0 or 1: (1, 1, 0) or (1, 1, 1). Similarly, the ARIMA models considered are 0, 1, or 2: (0, 2, 1), (1, 2, 1), or (1, 2, 0) for climate change (Y) and renewable energy consumption (X2). To select the best ARIMA model, the AIC, Schwarz criterion (SC), and Hannan-Quinn criterion (HC) will be compared, along with the adjusted R-squared values. The results in Table 7, generated using EViews, suggest that an AR(1) model is preferable for all variables in this study over an MA(0) model.

Based on these recommendations, it is essential to move to the next diagnostic checking phase to verify the adequacy of the model specifications. This will be done through residual correlogram analysis, using the results from the recommended automatic ARIMA model. As shown in Table 8, the residual correlogram for all variables appears random, supported by the ACF and PACF values crossing the designated limit line. This indicates that the recommended model specifications are appropriate.

**Table 9. Forecasting Result**

| Period | Y | | X1 | | X2 | |
|---|---|---|---|---|---|---|
| | Million Tons | % | Million Tons | % | Million Tons | % |
| **2025** | 686.4750 | - | 810.9500 | - | 1.520000 | - |
| **2026** | 745.3250 | 8.57 | 883.3500 | 8.93 | 1.623333 | 6.80 |
| **2027** | 810.9500 | 8.80 | 962.5250 | 8.96 | 1.726000 | 6.32 |
| **2028** | 883.3500 | 8.93 | 1048.475 | 8.93 | 1.828000 | 5.91 |
| **2029** | 962.5250 | 8.96 | 1141.200 | 8.84 | 1.929333 | 5.54 |
| **2030** | 1048.475 | 8.93 | 1240.700 | 8.72 | 2.030000 | 5.22 |

Source: Output Eviews 13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Having obtained a satisfactory result from the diagnostic test, the next step is to forecast future trends through 2030, as outlined in Table 9. As illustrated in Table 9, the forecast results, based on an analysis of the current situation, indicate a worsening of climate change conditions for each projection period. The highest level of climate change is expected in 2030 at 1,048,475 million tons, showing an increase of 8.93%. Coal energy consumption rose to 1,240.7 million tons, up 8.72%. The most significant outcome of the forecast is that increasing the use of renewable energy helps prevent climate change. The study demonstrates that renewable energy use in Indonesia, China, and India is projected to rise by 2.03 million tonnes by 2030, a 5.22% increase.

These results support previous research indicating that using low-carbon fossil energy technologies is a crucial way to address climate change today, especially for reducing carbon emissions from coal combustion. Using renewable energy sources to reduce carbon emissions can help lower atmospheric $CO_2$ levels, benefiting the climate. This approach has been shown to reduce both global warming and extreme weather events (Yang et al., 2025; Yusuf & Ibrahim, 2023). Another study also concluded that transitioning to a 100% clean, renewable energy system is essential to tackling climate change (Fthenakis et al., 2025). The exploration of renewable energy sources, including wind, solar, and hydropower, continues, along with emerging technologies such as hydrogen energy systems and long-duration energy storage, all aimed at decreasing emissions that contribute to climate change (Fthenakis et al., 2025).

This study also supports the findings of a previous study on India's transition from coal to renewable energy. Most experts interviewed in India believe that coal use will continue for the next two decades to ensure energy security and affordability for consumers. At the same time, the analysis considered the lower costs of solar power, which it identified as a major factor in the study. There has also been a rise in the perception of carbon management technologies (Singh et al., 2025; Tiwari et al., 2023). The findings also align with previous research in China, which states that the transition must be guided by a thorough evaluation of technical, economic, and environmental factors.

Additionally, it is essential to develop a metric to prioritize early plant retirement. This study found that 18% of plants consistently perform poorly across all three evaluation criteria. These plants can be considered 'low-hanging fruit', making them suitable for quick retirement. Regarding rapid retirement, existing plants can continue to operate for at least 20 or 30 years. This can be achieved by gradually reducing their use, helping meet the 1.5°C or well below 2°C climate targets. The complete phase-out of these plants is expected to be achieved by 2045 and 2055, respectively (Lv et al., 2025).

In Indonesia, this study supports government policy. In accordance with the Paris Agreement, the Republic of Indonesia has pledged to reach net-zero emissions (NZE) by 2060, and to do so, comprehensive legal policies must be enacted (Massagony et al., 2025). Government policy can promote the transition to renewable energy. This research supports a previous study in Indonesia, which found that the least-cost transition is strongly supported by a carbon tax policy. This intervention also generates revenue for the government, which can be reinvested sustainably in society or used to boost the competitiveness of renewable energy. Carbon taxes and other policies help define the costs,

capacity additions, and $CO_2$ emission reduction spectrum for decarbonizing Indonesia's electricity sector (Ali & Kim, 2024; Halimatussadiah et al., 2024; Shah et al., 2024).

Another study in Germany found that the successful implementation of climate policies depends on public support. Previous research has shown that support for general climate policies is relatively high. However, support for specific measures, such as emission trading systems and carbon taxes, is lower, despite their effectiveness in reducing greenhouse gas emissions and providing incentives to do so (Moon et al., 2025). Finally, in Indonesia, reaching more ambitious climate goals requires a strategic shift from coal to natural gas, combined with the adoption of renewable energy sources. Additional research shows that the country's climate targets could be met through a mix of transitioning from coal to natural gas and increasing the use of renewable energy. Potential synergies between the national electricity company, PLN, and the palm oil industry were also identified, and collaboration between these sectors could greatly enhance the sustainability of both.

## CONCLUSION

This study examines the impact of coal consumption in Indonesia, the world's largest coal exporter, and in China and India, two of the world's largest coal importers, which are considering phasing out or reducing their use. The study emphasizes the importance of increasing the use of renewable energy sources, such as solar, wind, and hydropower, to reduce reliance on coal and mitigate the effects of climate change.

These findings have clear policy implications for achieving the Sustainable Development Goals: The governments of Indonesia, India, and China are advised to revise their strategies and adopt renewable energy sources such as solar, wind, and hydropower. These sources are clean and environmentally friendly, helping reduce climate change through their low emissions. However, the transition to renewable energy requires more than just shutting down coal-fired power stations. It also involves strategies to address economic and social issues, such as emission trading systems and carbon taxes, while ensuring local communities can participate in decision-making. The government must also provide support to accelerate the development process through environmental policies.

## REFERENCES

Adebayo, T. S. (2023). Trade-off between Environmental Sustainability and Economic Growth through Coal Consumption and Natural Resources Exploitation in China: New Policy Insights from Wavelet Local Multiple Correlation. *Geological Journal*, *58*(4), 1384–1400. https://doi.org/10.1002/gj.4664.

Agrawal, K., Pathak, M., Jana, K., Unni, J., & Shukla, P. (2024). Just Transition Away from Coal: Vulnerability Analysis of Coal Districts in India. *Energy Research and Social Science*, *108,* 103355. https://doi.org/10.1016/j.erss.2023.103355.

Alhassan, A., Ozturk, I., Al-Zyoud, M. F., & Bekun, F. V. (2024). Coal Consumption-Environmental Sustainability Nexus in Developed and Developing Major Coal-Consuming Economies. *Heliyon*, *10*(4), e25619. https://doi.org/10.1016/j.heliyon.2024.e25619.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.49676

Ali, P. O., & Kim, K. N. (2024). Analysis of Indonesia's Priority Selection: Energy Transition, Energy-Related Measures, Mining Governance, and Resource Transition Using The Analytic Hierarchy Process (AHP). *Energy for Sustainable Development*, *83,* 101559. https://doi.org/10.1016/j.esd.2024.101559.

Ansell, C., Sørensen, E., & Torfing, J. (2022). Co-Creation for Sustainability: The UN SDGs and the Power of Local Partnership. *Co-Creation for Sustainability: The UN SDGs and the Power of Local Partnership*, 1–241. https://doi.org/10.1108/9781800437982.

Babaremu, K., Olumba, N., Chris-Okoro, I., Chuckwuma, K., Jen, T. C., Oladijo, O., & Akinlabi, E. (2025). Integrating Solar and Wind Energy into the Electricity Grid for Improved Power Accessibility. *Unconventional Resources*, *5*(16), 100129. https://doi.org/10.3390/en15166014.

Chen, H., Liu, K., Shi, T., & Wang, L. (2022). Coal Consumption and Economic Growth: A Chinese City-Level Study. *Energy Economics*, *109,* 105940. https://doi.org/10.1016/j.eneco.2022.105940.

Do, T. N., & Burke, P. J. (2023). Phasing Out Coal Power in a Developing Country Context: Insights from Vietnam. *Energy Policy*, *176,* 113512. https://doi.org/10.1016/j.enpol.2023.113512.

Fthenakis, V. M., Montague, C., Abraham, A., Liu, K., & Jacobson, M. Z. (2025). The Transition to 100% Clean, Renewable Energy. In. Letcher, M., & Fthenakis, V. M (Eds). *Energy and Climate Change: Our New Future*, 575–604. London: Academic Press. https://doi.org/10.1016/B978-0-443-21927-6.00012-X.

Gosens, J., Turnbull, A. B. H., & Jotzo, F. (2022). China's Decarbonization and Energy Security Plans will Reduce Seaborne Coal Imports: Results From an Installation-Level Model. *Joule*, *6*(4), 782–815. https://doi.org/10.1016/j.joule.2022.03.008.

Gulagi, A., Oyewo, A. S., Bogdanov, D., Simamora, P., Tampubolon, A., Pujantoro, M., Gordon, P., Tumiwa, F., & Breyer, C. (2025). Accelerating the Transition from Coal to Renewables in Indonesia to Achieve a Net-Zero Energy System. *IET Renewable Power Generation*, *19*(1), e13188. https://doi.org/10.1049/RPG2.13188.

Halimatussadiah, A., Kruger, W., Wagner, F., Afifi, F. A. R., Lufti, R. E. G., & Kitzing, L. (2024). The Country of Perpetual Potential: Why Is It so Difficult to Procure Renewable Energy in Indonesia? *Renewable and Sustainable Energy Reviews*, *201,* 114627. https://doi.org/10.1016/j.rser.2024.114627.

Handayani, I. G. A. K. R., Yosiana, C., & Kongrawd, S. (2025). Reform of Environmental Approval Policy for Renewable Energy in Indonesia. *Journal of Sustainable Development and Regulatory Issues*, *3*(2), 286–323. https://doi.org/10.53955/jsderi.v3i2.101.

Hyun, M., Cherp, A., Jewell, J., Kim, Y. J., & Eom, J. (2023). Feasibility Trade-Offs in Decarbonising the Power Sector with High Coal Dependence: The Case of Korea. *Renewable and Sustainable Energy Transition*, *3,* 100050. https://doi.org/10.1016/j.rset.2023.100050.

Jermain, D. O., & Pilcher, R. C. (2023). Trusting Clean Energy: Novel Perspectives on Transition Pathways for Coal Phaseouts and Clean Electrification Phase-Ins. *Electricity Journal*, *36*(7), 107318. https://doi.org/10.1016/j.tej.2023.107318.

Kocak, E., & Alnour, M. (2025). The Path to China's Zero-Carbon Target: Implications for the Relationship Between De-Coal, Economic Output, and Carbon Dioxide Emissions. *Sustainable Development*, *33*(1), 100–112. https://doi.org/10.1002/sd.3111.

Küfeoğlu, S. (2022). Emerging Technologies: Value Creation for Sustainable Development. *Sustainable Development Goals Series*, *Part F2738*, 1–510. https://doi.org/10.1007/978-3-031-07127-0.

Li, B., & Haneklaus, N. (2022). The Potential of India's Net-Zero Carbon Emissions: Analyzing the Effect of Clean Energy, Coal, Urbanization, and Trade Openness. *Energy Reports*, *8*, 724–733. https://doi.org/10.1016/j.egyr.2022.01.241.

Li, J., Peng, L., Zhang, J., Wang, Y., Li, Z., Yan, Y., Zhang, S., Li, M., & Xie, K. (2025). Synergetic Mitigation of Air Pollution and Carbon Emissions of Coal-Based Energy: A Review and Recommendations for Technology Assessment, Scenario Analysis, and Pathway Planning. *Energy Strategy Reviews*, *59,* 101698. https://doi.org/10.1016/j.esr.2025.101698.

Li, M., Jin, X., & Tang, Q. (2012). Policies, Regulations, and Eco-Ethical Wisdom Relating to Ancient Chinese Fisheries. *Journal of Agricultural and Environmental Ethics*, *25*(1), 33–54. https://doi.org/10.1007/S10806-010-9288-9.

Liu, K., Chen, Y., & Zheng, W. (2022). Impact of COVID-19 on China's Coal Imports: Effects and Solutions. *Transnational Corporations Review*, *14*(1), 31–45. https://doi.org/10.1080/19186444.2022.2025728.

Mangalagiu, D., Lieu, J., Biddau, F., Martinez Reyes, A., & Witajewska-Baltvilka, B. (2025). Enabling Sustainable Transitions in Coal and Carbon-Intensive Regions: Interdisciplinary Social Science Perspectives. *Global Environmental Change*, *93*, 103022. https://doi.org/10.1016/j.gloenvcha.2025.103022.

Massagony, A., Pandit, R., & White, B. (2025). Political Economy of Energy Policy in Indonesia towards Net Zero Emissions by 2060. *Energy for Sustainable Development*, *88*, 101757. https://doi.org/10.1016/j.esd.2025.101757.

Moallemi, E. A., Malekpour, S., Hadjikakou, M., Raven, R., Szetey, K., Ningrum, D., Dhiaulhaq, A., Bryan, B. A. (2020). Achieving the Sustainable Development Goals Requires Transdisciplinary Innovation at the Local Scale. *One Earth*, *3*(3), 300–313. https://doi.org/10.1016/j.oneear.2020.08.006.

Montrone, L., Ohlendorf, N., & Chandra, R. (2021). The Political Economy of Coal in India – Evidence from Expert Interviews. *Energy for Sustainable Development*, *61*, 230–240. https://doi.org/10.1016/j.esd.2021.02.003.

Moon, S., Lee, J., Kim, J., & Choi, H. (2025). Analysis on the Acceptance of Coal Phase-Out Policy Considering Public Preferences: Policy Implications and Future Direction Based on Empirical Evidence from South Korea. *Energy Economics*, *145*, 108453. https://doi.org/10.1016/j.eneco.2025.108453.

Munawir, Mahidin, Away, Y., Azwar, & Ismail, W. I. N. W. (2025). Mapping and Analysis of Local Potential for New and Renewable Energy and Its Conversion Technology in Aceh-Indonesia. *Renewable and Sustainable Energy Transition*, *8,* 100126. https://doi.org/10.1016/j.rset.2025.100126.

Nwagu, C. N., Ujah, C. O., Kallon, D. V. V., & Aigbodion, V. S. (2025). Integrating Solar and Wind Energy into the Electricity Grid for Improved Power Accessibility. *Unconventional Resources*, *5*, 100129. https://doi.org/10.1016/j.uncres.2024.100129.

Okolie, C. C., Danso-Abbeam, G., Ogundeji, A. A., Owolabi, S. T., & Kunguma, O. (2025). Achieving the Sustainable Development Goals through Nature-based Solutions amidst Climate Change. Evidence from Scopus and Web of Science (WoS) Databases. *Sustainable Futures*, *10*, 100855. https://doi.org/10.1016/j.sftr.2025.100855.

Orhan, A., Adebayo, T. S., Genç, S. Y., & Kirikkaleli, D. (2021). Investigating the Linkage Between Economic Growth and Environmental Sustainability in India: Do Agriculture and Trade Openness Matter? *Sustainability*, *13*(9), 4753. https://doi.org/10.3390/su13094753

Ospina, R., Gondim, J. A. M., Leiva, V., & Castro, C. (2023). An Overview of Forecast Analysis with ARIMA Models during the COVID-19 Pandemic: Methodology and Case Study in Brazil. *Mathematics, 11*(4), 3069. https://doi.org/10.3390/math11143069.

Pan, Y., Jiang, L., & Wang, H. (2024). Cost–Benefit Analysis of the China's Household Coal-to-Electricity Transition: A Case Study on the Beijing Mentougou Area. *Energies*, *17*(23), 5933. https://doi.org/10.3390/en17235933.

Pandey, J. G., & Kumar, A. (2025). Navigating India's Energy Transition: A Systematic Literature Review of Risks in the Coal Phase-Down Process. *Renewable and Sustainable Energy Reviews*, *210*, 115260. https://doi.org/10.1016/j.rser.2024.115260.

Pereira da Veiga, C., Pereira da Veiga, C. R., Girotto, F. M., Marconatto, D. A. B., & Su, Z. (2024). Implementation of the ARIMA Model for Prediction of Economic Variables: Evidence from the Health Sector in Brazil. *Humanities and Social Sciences Communications*, *11*(1), 1068. https://doi.org/10.1057/s41599-024-03023-3.

Reyseliani, N., Pratama, Y. W., Hidayatno, A., Mac Dowell, N., & Purwanto, W. W. (2024a). Power Sector Decarbonisation in Developing and Coal-Producing Countries: A Case Study of Indonesia. *Journal of Cleaner Production*, *454*, 142202. https://doi.org/10.1016/j.jclepro.2024.142202.

Reyseliani, N., Pratama, Y. W., Hidayatno, A., Mac Dowell, N., & Purwanto, W. W. (2024b). Power Sector Decarbonisation in Developing and Coal-Producing Countries: A Case Study of Indonesia. *Journal of Cleaner Production*, *454*, 142202. https://doi.org/10.1016/j.jclepro.2024.142202.

Shah, K. U., Raghoo, P., & Blechinger, P. (2024). Is There A Case for a Coal Moratorium in Indonesia? Power Sector Optimization Modeling of Low-Carbon Strategies. *Renewable and Sustainable Energy Transition*, *5*, 100074. https://doi.org/10.1016/j.rset.2023.100074.

Shrimali, G. (2020). Making India's Power System Clean: Retirement of Expensive Coal Plants. *Energy Policy*, *139*, 111305. https://doi.org/10.1016/j.enpol.2020.111305.

Shrivastava, P., Stafford Smith, M., O'Brien, K., & Zsolnai, L. (2020). Transforming Sustainability Science to Generate Positive Social and Environmental Change Globally. *One Earth*, *2*(4), 329–340. https://doi.org/10.1016/j.oneear.2020.04.010.

Singh, U., Vishwanathan, S. S., Garg, A., Singh, A. K., & Iyer, S. H. (2025). Socio-Technical Feasibility of Coal Transitions in India: Results from Stakeholder Interviews. *Energy and Climate Change*, *6*, 100188. https://doi.org/10.1016/j.egycc.2025.100188.

Sun, C., & Zuo, X. (2025). Sustainable growth like China: The Economic Effects of Clean Coal Power Generation. *Energy Economics*, *151*, 108939. https://doi.org/10.1016/j.eneco.2025.108939.

Tiwari, V., Garg, A., Kapshe, M., Deshpande, A., & Vishwanathan, S. (2023). Assessing Possibilities for Coal Continuance in India Under Climate Constraints. *International Journal of Greenhouse Gas Control*, *122,* 103811. https://doi.org/10.1016/j.ijggc.2022.103811.

Wollff, I. (2023). Coal Resources, Production, and Use in Indonesia. In. Osborne, D (Ed). *The Coal Handbook: Volume 2: Towards Cleaner Coal Utilization, 2nd Edition*, *2*, 361–430. Cambridge: Woodhead Publishing. https://doi.org/10.1016/B978-0-12-824327-5.00008-9.

Wu, H., Liu, J., Hu, X., He, G., Zhou, Y., Wang, X., Liu, Y., Ma, J., & Tao, S. (2024). Fewer than 15% of Coal Power Plant Workers in China Can Easily Shift to Green Jobs by 2060. *One Earth*, *7*(11), 1994–2007. https://doi.org/10.1016/j.oneear.2024.10.006.

Xu, X., Dong, J., Zhong, X., & Xie, D. (2024). Climate Impact of Coal-to-Clean-Energy Shift Policies in Rural Northern China. *Journal of Cleaner Production*, *434*, 139870. https://doi.org/10.1016/j.jclepro.2023.139870.

Yang, W., Wang, B., & Gupta, R. (2025). Coal and Climate Change. In. Letcher, T. M., & Fthenakis, V. M (Eds). *Energy and Climate Change: Our New Future*, 153–194. London: Academic Press. https://doi.org/10.1016/B978-0-443-21927-6.00001-5.

Yusuf, M., & Ibrahim, H. (2023). A Comprehensive Review on Recent Trends in Carbon Capture, Utilization, and Storage Techniques. *Journal of Environmental Chemical Engineering*, *11*(6), 111393. https://doi.org/10.1016/j.jece.2023.111393

Zhang, R., Li, W., Li, Y., & Li, H. (2024). Job Losses or Gains? The Impact of Supply-Side Energy Transition on Employment in China. *Energy*, *308*. https://doi.org/10.1016/j.energy.2024.132804.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Carbon Accountability in Indonesia's State-Owned Assets Management

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## ABSTRACT

**Research Originality**: This study is among the first to introduce an Environmentally Extended Input-Output (EE-IO) framework to quantify the carbon externalities of state-owned assets (BMN) management in Indonesia. This area has received limited empirical attention.

**Research Objectives**: The study aims to systematically measure direct and indirect carbon emissions associated with BMN utilization and assess their implications for public asset governance.

**Research Methods**: An EE-IO model is constructed using Indonesia's 2016 input-output table, sectoral emission intensities, and audited government electricity expenditure data to estimate emission multipliers and carbon impacts.

**Empirical Results**: The Electricity and Gas Supply sector exhibits the highest emission multiplier (4,919.05 tons $CO_2$ per billion Rupiah). Electricity-related BMN expenditure is estimated to generate 28.4 million tons of $CO_2$, revealing a substantial but previously under-recognized source of environmental burden.

**Implications**: The findings support emission-informed budgeting, emission-based performance indicators, and the integration of carbon accountability into public asset management.

**Keywords:**
environmentally extended input-output analysis; carbon emission multiplier; Indonesia's climate policy; emission-based budgeting; public asset governance

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## INTRODUCTION

As climate change intensifies, public institutions face mounting challenges in managing the environmental risks embedded within national infrastructure and development systems (Markolf et al., 2018). The climate crisis increasingly manifests as systemic stress on state-controlled assets—transport corridors, public facilities, energy grids—that were often designed without accounting for environmental volatility (Jentsch & Beierkuhnlein, 2008; Weiskopf et al., 2020). Rising temperatures, extreme weather events, and ecological degradation threaten service delivery and impose long-term fiscal burdens. Carbon dioxide ($CO_2$), the principal driver of global warming, persists in the atmosphere for centuries, amplifying the urgency of mitigation efforts (Davis & Caldeira, 2010; Eby et al., 2009; Solomon et al., 2009). Climate risk must therefore be understood not only as an ecological crisis but also as a governance challenge affecting pubic asset management.

Indonesia plays a pivotal role in the global climate landscape. It is the largest carbon emitter in Southeast Asia and consistently ranks among the top global $CO_2$ emitters, with national greenhouse gas emissions reaching approximately 1.2 Gt $CO_2$-equivalent in 2021 (Wiloso et al., 2024; Zhong et al., 2025). With a 13.14% year-on-year increase in emissions, it ranks fourth in terms of emission growth rate. It is the largest contributor in Southeast Asia (Amheka et al., 2022), reinforcing Indonesia's strategic importance in global mitigation efforts. Indonesia's updated Nationally Determined Contribution (NDC) in 2022 raises its mitigation targets to 31.89% unconditionally and 43.20% conditionally. However, nearly 97% of the projected reductions are concentrated in two sectors—forestry and land use and energy —leaving limited attention to other high-impact sectors, including infrastructure governance and public asset management.

Despite its central role in Indonesia's development agenda, the infrastructure sector receives comparatively limited attention in the country's climate strategy (Hsiao & Kuipers, 2025; Republic of Indonesia, 2022). This is a critical oversight. Sustainable infrastructure both contributes to emissions and offers transformative mitigation potential (Gómez-Villarino et al., 2021; Kadić et al., 2025; Sang & Pan, 2024). Evidence from Thacker et al. (2019) underscores this point: infrastructure systems are linked—either directly or indirectly—to 121 out of 169 Sustainable Development Goal (SDG) targets, including SDG 3 (Health), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 11 (Sustainable Cities and Communities). The absence of an integrated, climate-conscious approach to state asset governance therefore represents a critical blind spot in Indonesia's climate strategy.

The urgency highlighted by Thacker et al. (2019) is reinforced by the property and construction sector's status as one of the most carbon-intensive domains, accounting for more than one-third of global emissions (Chen et al., 2022). In this context, Indonesia's state-owned assets (Barang Milik Negara, or BMN)—which are fully under government control—represent a strategically important yet underutilized level for sustainable


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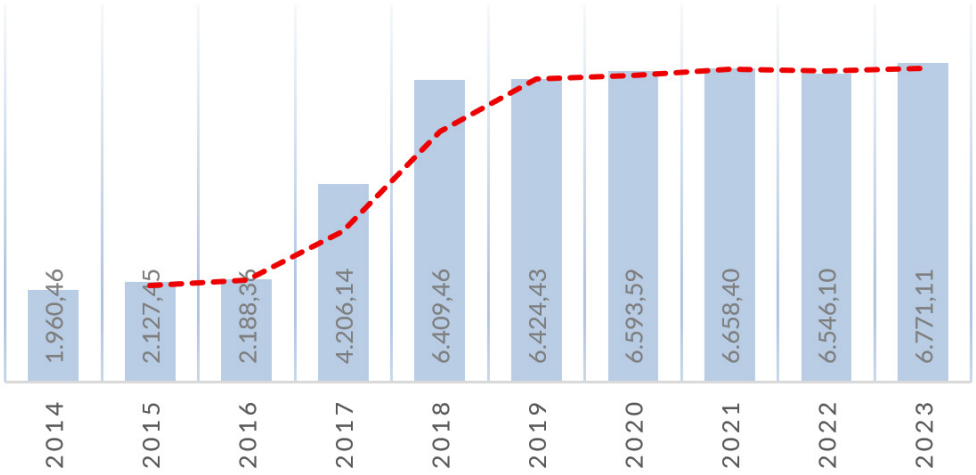
development. The total value of state-owned assets (BMN) has grown nearly 2.5 times over the past decade—from IDR 1,960.46 trillion in 2014 to IDR 6,771.11 trillion in 2023 (Figure 1)— reflecting the expanding scale of publicly managed infrastructure. As this value grows, so too does its contribution to carbon emissions, arising from the construction, operation, and maintenance of these assets (Kwok et al., 2016).

**Figure 1. State-Owned Assets (BMN) Value (2014–2023 in Trillion Rupiah)**




Historical growth in the total value of Indonesia's state-owned assets (BMN) over a 10-year period.
Source: Author's work based on State-Owned Assets Report 2023 Audited.

Given their scale and administrative reach, state-owned assets (BMN) can serve as a platform for embedding climate accountability within public infrastructure governance by evolving from a purely administrative and economic orientation toward a more holistic framework (Surachman, 2024). Integrating principles of resource efficiency, carbon reduction, and climate resilience into national asset management practices would strengthen Indonesia's sustainable development trajectory (Focardi & Fabozzi, 2020). However, such transformation requires a robust carbon accounting framework capable of systematically quantifying emissions, both direct and indirect, associated with asset-related activities (Hong et al., 2016; Kaur et al., 2023).

Existing infrastructure-related carbon studies predominantly employ Life Cycle Assessment (LCA), focusing on individual buildings or specific lifecycle stages (Bakindi et al., 2025; Li et al., 2025). Li et al. (2025) used LCA to identify emission hotspots primarily in the production and operation phases of an individual high-rise residential building in Beijing. Similarly, Dsilva et al. (2023) apply LCA to an individual multi-use building in Dubai to evaluate how proactive material selection during early construction phases can mitigate embodied carbon. Kumar et al. (2025) further note that LCA integration remains limited in early design, with many assessments restricted to cradle-to-gate or cradle-to-site boundaries because detailed data for later lifecycle stages is often unavailable during conceptual design. While valuable, these studies do not capture wider supply-chain effects or inter-sectoral dependencies.

In parallel, Environmentally Extended Input-Output (EE-IO) analysis has been widely applied to assess the carbon footprint of broad economic systems and sectors. This approach builds on traditional Input-Output models by integrating environmental dimensions, including carbon emissions, resource use, and energy consumption. EE-IO enables a comprehensive, economy-wide analysis of environmental impacts and their relationships with sectoral economic activities (Demeter et al., 2021). Amheka et al. (2022) used an environmentally extended Multi-Region Input-Output model in the ASEAN region to demonstrate that significant carbon reductions can be achieved while maintaining GDP growth, particularly through decarbonizing the electricity sector. He and Hertwich (2019), using the EXIOBASE database, traced global embodied carbon flows across 49 regions and showed that manufacturing remains the largest source of indirect emissions in developing economies. In the Indonesian context, Irfany and Klasen (2017) found that household expenditure—especially on fuel and transportation—drives carbon footprints. At the infrastructure scale, Martinez et al. (2022) employed EE-IO to quantify embodied environmental impacts in a diversion dam project, revealing that steel and cement alone account for nearly three-quarters of total impacts. Collectively, these studies demonstrate the strength of EE-IO in revealing indirect and upstream emissions embedded within economic activities.

Despite growing attention to carbon emissions from infrastructure and the built environment, existing empirical studies remain limited in their analytical scope. Project-level assessments predominantly rely on LCA, focusing on individual buildings, construction materials, or specific lifecycle stages, thereby overlooking wider inter-sectoral and supply-chain effects. In parallel, EE-IO models have been extensively applied to estimate economy-wide, sectoral, and consumption-based carbon footprints, offering a broader perspective, capturing indirect or upstream emissions that are often overlooked (Demeter et al., 2021). However, although EE-IO models have been widely applied in environmental–economic analysis, there remains a notable absence of empirical frameworks that operationalize EE-IO to measure the carbon footprint of state-owned asset (BMN) governance. Existing applications of EE-IO largely focus on sectoral emissions, consumption-based accounting, or specific projects, and do not explicitly link public asset management activities and government fiscal operations to economy-wide carbon emission multipliers. As a result, the environmental consequences of managing state-owned assets (BMN) remain largely invisible within prevailing policy, fiscal, and analytical frameworks.

This gap is particularly consequential in Indonesia, where state-owned assets (BMN) represent a substantial component of public capital formation and infrastructure delivery. Without an analytical framework capable of tracing both direct and indirect emissions, policymakers lack systematic tools to reposition public asset governance as an instrument of climate mitigation rather than a passive contributor to emissions.

This study explicitly addresses this research gap by developing an analytical framework grounded in Environmentally Extended Input-Output analysis to systematically quantify both direct and indirect carbon emissions associated with the operational management of state-owned assets (BMN) in Indonesia. Accordingly, this study is guided by the following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research question: How can an Environmentally Extended Input-Output framework be operationalized to measure the direct and indirect carbon emissions embedded in the management of Indonesia's state-owned assets? The novelty of this research lies in integrating EE-IO methodology into the domain of public asset governance, an area that has received limited empirical attention in existing literature. Unlike prior studies that focus on individual construction projects, private-sector assets, or isolated economic sectors, this study conceptualizes state-owned assets (BMN) as an economy-wide emission driver and a strategic public-sector policy instrument. By doing so, the study provides a data-driven foundation for emission-informed budgeting, climate-conscious asset governance, and sustainable infrastructure planning, while strengthening Indonesia's alignment with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities), as well as its commitments under the Paris Agreement.

## METHODS

This study employs three datasets to construct an analytical framework for measuring the environmental impact—particularly carbon emissions—associated with the management of state-owned assets (BMN) using the Environmentally Extended Input-Output approach. The first dataset is the Input-Output (IO) Table of Domestic Transactions at Producer Prices, published by Statistics Indonesia (BPS) (BPS, 2021). This IO table provides detailed information on inter-industry linkages across the Indonesian economy, covering 52 industrial sectors. At the time this study was conducted, the most recent available IO table was from 2016. Despite its time lag, the 2016 IO table remains the authoritative representation of Indonesia's inter-sectoral economic structure and is widely used in applied input-output and environmental-economic studies.

The second dataset is sector-specific greenhouse gas (GHG) emission intensity data published by BPS in 2022 (BPS, 2024), which reports carbon dioxide ($CO_2$) emission intensities for seven aggregated industrial sectors. Emission intensity is defined as the ratio of total sectoral $CO_2$ emissions to total sectoral output and serves as the environmental extension of the IO framework. The third dataset is government electricity expenditure related to state-owned asset (BMN) operations, obtained from audited State Budget (APBN) records published by the Ministry of Finance. Electricity expenditure is treated as final demand directed to the electricity sector within the input-output table. This expenditure represents operational spending on energy consumption for state-owned assets (BMN) and serves as the entry point for linking state-owned assets (BMN) management activities to the input-output framework.

To ensure compatibility between the 52-sector IO table and the seven-sector emission intensity dataset, the IO sectors are aggregated into seven composite sectors following the International Standard Industrial Classification (ISIC) Revision 4. This harmonization step, while reducing sectoral granularity, is commonly applied in EE-IO studies. It enables consistent integration of economic and environmental data while preserving inter-sectoral linkages. The detailed sectoral mapping is provided in the Appendix.

Carbon emissions associated with state-owned assets (BMN) operations are estimated using an EE-IO framework adapted from Miller and Blair (2009) to estimate both direct and indirect emissions. The calculation steps are explained as follows.

The technical coefficient $t_{ij}$ is calculated for each sector in the 2016 IO table. It represents the amount of input from sector $i$ required to produce one unit in sector $j$.

$$t_{ij} = \frac{v_{ij}}{y_j} \quad (1)$$

where $v_{ij}$ denotes the amount of input from sector $i$ used by sector $j$, and $y_j$ represents the total output of sector $j$. All technical coefficients $t_{ij}$ are then organized into a technical coefficient matrix $T$ as shown in Equation 2:

$$T = \begin{bmatrix} t_{11} & \cdots & t_{1n} \\ \vdots & \ddots & \vdots \\ t_{n1} & \ldots & t_{nn} \end{bmatrix} \quad (2)$$

The total output $y$ is then calculated by incorporating the final demand $d$ using the following expression derived from the Leontief Input-Output model:

$$y = (I - T)^{-1}.d \quad (3)$$

where $I$ denotes the identity matrix and $(I - T)^{-1}$ is the Leontief Inverse, which captures the total requirements needed to satisfy final demand.

Next, the greenhouse gas emission intensity data by sector are obtained from BPS (2022). These data are then integrated into the model in the form of a matrix $E$, where each element $e_n$ represents the amount of carbon emissions generated per unit of output in sector $n$.

$$E = \begin{bmatrix} e_1 \\ \cdots \\ e_n \end{bmatrix} \quad (4)$$

Finally, the carbon emission multiplier is calculated to identify the total impact of an increase in final demand on carbon emissions—capturing both direct and indirect effects across all sectors in the economy. This multiplier is derived by multiplying the emission intensity matrix $E$ by the Leontief Inverse matrix $(I - T)^{-1}$, as expressed in Equation 5.

$$M = E.(I - T)^{-1} \quad (5)$$

Each element in matrix $M$ reflects the total amount of carbon emissions, both direct and indirect, generated per unit increase in output in the respective sector.

In this study, state-owned assets (BMN) related activities are operationalized through government expenditure on electricity consumption associated with the operation of state-owned assets. By mapping electricity spending to final demand in the EE-IO model, the framework captures both direct emissions from electricity generation and indirect emissions embodied in upstream supply chains, providing an empirical basis for assessing the carbon externalities from the operational phase of state-owned assets (BMN) management.

The focus on electricity expenditure reflects current data availability and serves as an initial operational entry point for integrating state-owned assets (BMN) management into


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an EE-IO framework. Comprehensive and standardized data covering the full lifecycle of state-owned assets (BMN)—including construction, maintenance, procurement, and asset disposal—remain limited; therefore, electricity consumption is used as a demonstrative case to develop and test the analytical framework. The resulting model functions as a proof of concept and is designed to be scalable, allowing future research to incorporate more detailed and disaggregated state-owned assets (BMN) expenditure components as data availability and classification systems improve.

## RESULTS AND DISCUSSION

Using the Environmentally Extended Input-Output (EE-IO) model, this analysis estimates carbon emission multipliers for Indonesia's major economic sectors (Table 1 and Figure 2). The Electricity and Gas Supply sector (Sector D) records the highest multiplier at 4,919.05 tons $CO_2$ per billion Rupiah, implying that each additional billion Rupiah of output generates nearly 5,000 tons of economy-wide emissions. This reflects both its high direct emission intensity—driven largely by fossil-fuel-based power generation—and its strong inter-sectoral linkages, as electricity functions as a universal intermediate input for manufacturing, transport, construction, and other activities.

**Table 1. Carbon Emission Multiplier and Direct Intensity by Sector**

| No. | Sector | *(ton CO2 per billion rupiah)* | |
|---|---|---|---|
| | | Multiplier Effect | Carbon Intensity |
| 1 | A: Agriculture, Forestry, and Fishing | **260.79** | 60.20 |
| 2 | B: Mining and Quarrying | **1,400.23** | 34.10 |
| 3 | C: Manufacturing | **1,322.28** | 142.20 |
| 4 | D: Electricity and Gas Supply | **4,919.05** | 2,426.30 |
| 5 | E: Water Supply, Sewerage, Waste Management, Wastewater, and Remediation Activities | **3,110.01** | 3,023.50 |
| 6 | H: Transportation | **494.02** | 166.50 |
| 7 | OTHER: Other Industries | **1,401.55** | 3.70 |

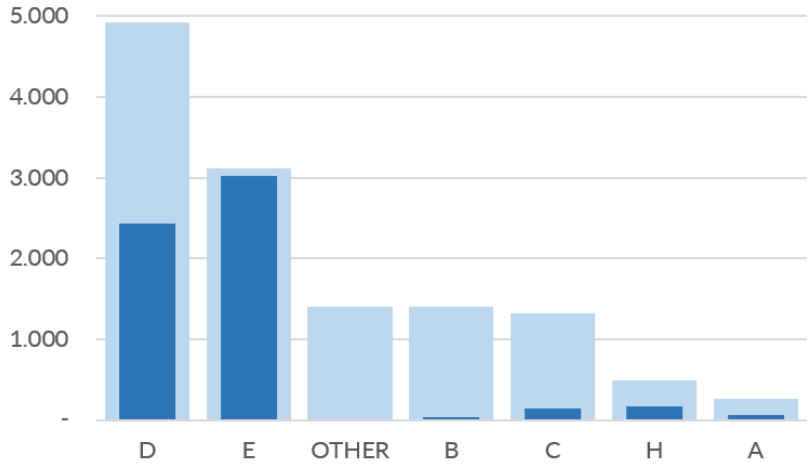
Carbon emission multiplier effect and direct carbon intensity across seven aggregated economic sectors in Indonesia. Source: Author's calculation based on EE-IO.

The Water Supply, Sewerage, Waste Management, and Remediation sector (Sector E) follows with a multiplier of 3,110.01 tons $CO_2$ per billion Rupiah, with a substantial share arising from direct emissions, consistent with the energy-intensive nature of treatment and processing activities. The remaining sectors exhibit considerably lower multipliers, indicating that carbon externalities are concentrated in a limited number of structurally critical sectors. This concentration suggests that decarbonization efforts—particularly within state-managed infrastructure and service provision—would yield greater marginal impact if focused on these high-multiplier sectors.

Table 1 further reveals notable discrepancies between direct emission intensity and total multipliers. The Mining and Quarrying sector (Sector B), for example, shows

relatively low direct intensity (34.10 tons $CO_2$ per billion Rupiah) but a high total multiplier (1,400.23 tons $CO_2$), reflecting its upstream role in supplying carbon-intensive downstream industries. A similar pattern appears in Other Industries, where low direct intensity (3.70 tons $CO_2$) corresponds to a multiplier of 1,401.55 tons $CO_2$. These results indicate that Indonesia's carbon structure is shaped not only by emission-intensive sectors but also by upstream enablers embedded within supply chains. The Electricity and Gas Supply sector is distinctive in combining both high direct intensity and strong inter-sectoral transmission effects. Overall, the multiplier framework demonstrates that reliance on direct emission metrics alone would underestimate the true carbon footprint of economic activities.

**Figure 2. Comparison of Direct and Total Carbon Emission Effects by Sector (ton CO2 per billion Rupiah)**




This figure compares the direct carbon emission intensity with the total carbon emission multiplier across major economic sectors, illustrating the role of indirect emissions transmitted through inter-sectoral linkages. **Source:** Author's calculation based on EE-IO

To operationalize the EE-IO framework within public asset governance, this study examines electricity consumption in the operations of state-owned assets (BMN). Given its highest emission multiplier, the Electricity and Gas Supply sector serves as the empirical entry point. According to the 2024 Audited Central Government Financial Statement (LKPP), the central government allocated IDR 5,776.78 billion to electricity expenditure. Applying the sectoral multiplier of 4,919.05 tons $CO_2$ per billion Rupiah yields an estimated 28.42 million tons of $CO_2$ emissions.

This estimate reveals a substantial environmental burden embedded in the routine operations of state-owned assets (BMN). Electricity spending—typically treated as an administrative cost—constitutes a significant channel of economy-wide emissions, capturing indirect and upstream effects that remain absent from conventional fiscal reporting. Electricity consumption, therefore, emerges as both an emissions hotspot and a strategic leverage point for mitigation. Improvements in energy efficiency, cleaner energy sourcing, and optimized asset utilization could yield meaningful reductions in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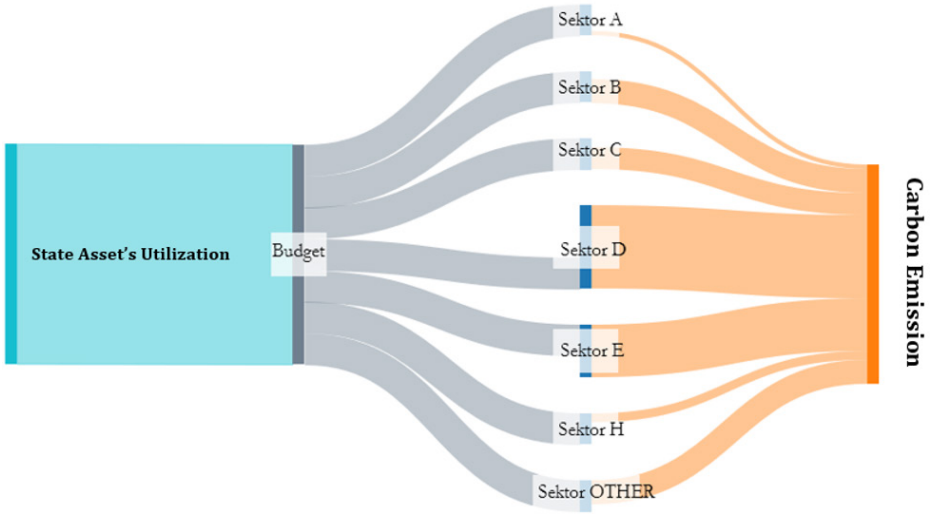
emissions across public infrastructure systems. While the estimate does not represent the full lifecycle carbon footprint of state-owned assets (BMN), its magnitude demonstrates that operational expenditures alone can carry significant environmental externalities when assessed through an economy-wide perspective.

The empirical findings are consistent with—and extend—recent EE-IO applications emphasizing indirect and supply-chain-induced emissions in national carbon accounting (Demeter et al., 2021). While prior studies focus on consumption-based emissions, embodied trade flows, or sectoral decarbonization (Amheka et al., 2022; He & Hertwich, 2019; Irfany & Klasen, 2017; Martinez et al., 2022), this study situates EE-IO analysis within public asset governance. It demonstrates that state-owned assets (BMN) function not merely as administrative entities but as structural contributors to economy-wide carbon emissions.

The carbon emission multipliers derived from the EE-IO model provide a practical basis for quantifying environmental externalities associated with the management of state-owned assets (BMN). By linking BMN-related government expenditure to aggregated economic sectors, both direct and indirect emissions can be systematically traced (Figure 3), illustrating how routine fiscal decisions translate into broader economy-wide impacts. Unlike project-level LCA studies that assess emissions at the level of individual buildings or infrastructure assets (Bakindi et al., 2025; Kumar et al., 2025), the EE-IO-based framework developed in this study captures emissions propagated through complex inter-sectoral supply chains. This distinction is particularly relevant for public asset management, where operational decisions—such as electricity consumption—have system-wide emission implications that extend beyond the physical boundaries of individual assets.

**Figure 3. Carbon Emission Mapping Framework from State-Owned Assets (BMN) Utilization**




This figure illustrates the analytical framework used to trace carbon emissions arising from state-owned assets (BMN) utilization through government budget expenditures. BMN-related operational spending is mapped to seven aggregated economic sectors (A–H and OTHER) within the EE-IO structure, enabling the estimation of both direct and indirect carbon emissions transmitted through inter-sectoral linkages. The framework demonstrates how public asset utilization translates into economy-wide environmental externalities and provides a methodological pathway for integrating carbon accountability into public asset governance.

**Source:** Author's visualization based on EE-IO model integration.

The dominance of the Electricity and Gas Supply sector aligns with regional EE-IO findings identifying power generation as a primary driver of economy-wide emissions (Amheka et al., 2022; Irfany & Klasen, 2017). This study extends that insight by showing that electricity demand from state-owned assets (BMN) operations constitutes a significant transmission channel of carbon emissions. Similarly, the high multiplier observed in water and waste-related services corresponds with infrastructure-focused EE-IO evidence highlighting substantial indirect emissions in operational services (Martinez et al., 2022).

This framework represents an initial operationalization rather than a full lifecycle assessment of state-owned assets (BMN). Comprehensive tracing across construction, procurement, maintenance, and disposal would require more detailed disaggregation of the State Budget (APBN) and sectoral mapping. Electricity expenditure is therefore used as a strategic entry point due to data availability and its central operational role. Nevertheless, the framework is scalable. With more granular budget data and refined sectoral classification, it can be extended to estimate the full lifecycle carbon footprint of state-owned assets (BMN) management. Beyond empirical estimation, the study establishes a methodological pathway that renders visible the carbon implications of public asset utilization—an area traditionally treated as environmentally neutral within fiscal and administrative systems.

The scale of operational emissions associated with electricity consumption reveals a largely invisible carbon footprint embedded in state governance. Although categorized as routine administrative expenditures, these emissions are substantial when evaluated through an EE-IO lens. This "hidden" carbon burden reflects a critical institutional blind spot that is increasingly incompatible with global climate commitments (Bocken & Short, 2021).

This finding resonates with recent studies on public sector sustainability, which argue that government operations themselves constitute a significant and under-recognized source of emissions (Kaur et al., 2023). While the existing literature emphasizes industrial decarbonization and household consumption (He & Hertwich, 2019; Irfany & Klasen, 2017), this study highlights the environmental significance of the routine operations of state-owned assets (BMN). Addressing this gap requires integrating mitigation considerations into the budget cycle, beginning at the planning stage (Focardi & Fabozzi, 2020). By mapping BMN-related expenditures to aggregated EE-IO sectors, potential carbon impacts can be estimated before allocations are finalized (Demeter et al., 2021). Such emission-linked budgeting introduces a new layer of transparency into public finance. Beyond tracking financial allocations, it enables policymakers to assess the environmental implications of program design and implementation (Kaur et al., 2023). This is particularly relevant in the context of state-owned assets (BMN) governance, where decisions on asset utilization, renovation, and operational intensity directly shape long-term emission trajectories.

More importantly, this framework creates the conditions for strategic intervention. Ministries associated with high projected emissions can be required to adopt mitigation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measures—such as energy efficiency upgrades or renewable energy integration—while low-carbon operational practices can be incentivized. In this way, climate objectives become embedded within fiscal decision-making rather than treated as external compliance requirements (Bocken & Short, 2021). This integration represents a structural shift in public sector governance, aligning public expenditure with national climate targets and supporting the management of low-carbon infrastructure (Bocken & Short, 2021; Kaur et al., 2023).

Emission-Based Performance Indicators (EPIs) provide a complementary mechanism for operationalizing carbon accountability in the governance of state-owned assets (BMN). Unlike conventional metrics focused solely on budget absorption or output delivery, EPIs assess the environmental efficiency of public operations (Bocken & Short, 2021). Using EE-IO–derived emission multipliers, ministries can establish baseline carbon performance and monitor changes over time (Demeter et al., 2021). Performance can then be evaluated in terms of emissions per unit of output or budget, reorienting bureaucratic incentives toward lower-carbon service delivery—"doing better with less carbon" (Kaur et al., 2023). EPIs also strengthen cross-ministerial coherence. Ministries achieving sustained emission reductions can be recognized through evaluation mechanisms or sustainability-linked incentives. Over time, these indicators can be embedded into routine monitoring frameworks, reshaping how performance is defined and assessed in the public sector (Bocken & Short, 2021).

Integrating EPIs into state-owned assets (BMN) governance, therefore, constitutes an institutional innovation: it aligns administrative accountability with long-term sustainability objectives and embeds carbon considerations within governance structures (Bocken & Short, 2021; Kaur et al., 2023).

The application of the Environmentally Extended Input-Output (EE-IO) model demonstrates its potential as a decision-support tool for environmentally accountable public asset governance (Demeter et al., 2021). By linking state-owned assets (BMN) expenditures to sectoral carbon emission multipliers, the framework quantifies both direct and indirect environmental impacts arising from asset operations, consistent with broader EE-IO applications in infrastructure and public systems (Amheka et al., 2022; Martinez et al., 2022).

To ensure upstream integration, carbon accounting should be embedded within the budget planning cycle. Because government expenditures can be mapped to the aggregated EE-IO sectors, ministries can estimate projected carbon impacts at the program design stage. This enables emission-informed budgeting, where allocation decisions consider environmental performance alongside financial efficiency (Kaur et al., 2023). In parallel, Emission-Based Performance Indicators (EPIs) can complement conventional fiscal and output metrics. By monitoring carbon intensity per unit of service or expenditure, EPIs embed environmental efficiency into routine performance management and strengthen sustainability-oriented accountability (Bocken & Short, 2021). Furthermore, when state-owned assets (BMN) are utilized to generate non-tax state revenue (PNBP), a portion

of this income may be earmarked for mitigation measures, such as renewable energy deployment or energy-efficiency retrofits. This helps internalize environmental externalities and align revenue generation with climate objectives.

It is important to acknowledge the limitations of this study's scope. The present analysis operationalizes state-owned assets (BMN) related emissions through electricity expenditure as a demonstrative case and relies on a seven-sector aggregation of the Indonesian input-output table due to data compatibility constraints. While consistent with EE-IO practice, this masks intra-sectoral variation. Future research should therefore (i) disaggregate State Budget (APBN) data to enable full lifecycle mapping of BMN-related activities, and (ii) utilize higher-resolution input-output and emission datasets as they become available. Collectively, these steps would strengthen Indonesia's transition toward carbon-conscious public asset governance and reinforce alignment with national climate commitments, advancing the achievement of SDG 9 and SDG 11, as well as Indonesia's commitments under the Paris Agreement (Bocken & Short, 2021).

## CONCLUSION

This study answers the research objective by demonstrating that the environmental externalities of state-owned assets (BMN) management can be systematically measured using an Environmentally Extended Input-Output (EE-IO) framework. By integrating sectoral emission intensities, inter-industry linkages, and government expenditure data, the analysis captures both direct and indirect carbon emissions associated with public asset operations. The results show that electricity-related activities represent a major carbon hotspot, and that several sectors with low direct emission intensity generate substantial indirect emissions through supply chains. This result confirms that multiplier-based approaches are essential for accurately assessing the carbon responsibility embedded in the utilization of state-owned assets (BMN).

Based on these findings, this study proposes three policy-relevant implications. First, carbon accounting should be integrated into the budget planning process through emission-informed budgeting, enabling ministries to anticipate the carbon consequences of state-owned assets (BMN) related expenditures at the planning stage. Second, emission-based performance indicators can complement existing fiscal and output metrics, strengthening accountability for emission-intensive public asset operations. Third, in cases where state-owned assets (BMN) utilization generates non-tax state revenue, a portion of this revenue should be earmarked for carbon mitigation measures, such as energy efficiency improvements, renewable energy adoption, or offset mechanisms linked to public asset operations. These measures provide a practical pathway for embedding carbon accountability into public asset governance, repositioning state-owned assets (BMN) management as a strategic instrument for climate mitigation, and aligning fiscal operations with Indonesia's commitments under the Paris Agreement and the achievement of SDG 9 and SDG 11.


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https://doi.org/10.15408/sjie.v15i1.46638

## REFERENCES

Amheka, A., Nguyen, H. T., Yu, K. D., Noach, R. M., Andiappan, V., Dacanay, V. J., & Aviso, K. (2022). Towards a Low-Carbon ASEAN: An Environmentally Extended MRIO Optimization Model. *Carbon Balance and Management*, *17*, 13. https://doi.org/10.1186/s13021-022-00213-x.

Bakindi, A., Wiberg, A. H., Norman, J., Marsh, E., & Allen, S. (2025). Hybrid Life Cycle Assessment (H-LCA) for Buildings and Construction Materials: A Systematic Review and Meta-Analysis. *Building and Environment, 272*, 112630. https://doi.org/10.1016/j.buildenv.2025.112630.

Bocken, N. M. P., & Short, S. W. (2021). Unsustainable Business Models – Recognising and Resolving Institutionalised Social and Environmental Harm. *Journal of Cleaner Production, 312*, 127828. https://doi.org/10.1016/j.jclepro.2021.127828.

BPS. (2021). *Indonesian Input–Output Table of Domestic Transactions At Producer Prices (52 Industries), 2016 (Million Rupiah)*. Jakarta: BPS

BPS. (2024). *Indonesia Energy Flow Accounts and Greenhouse Gas Emissions Accounts 2018–2022*. Jakarta: BPS.

Chen, L., Msigwa, G., Yang, M., Osman, A. I., Fawzy, S., Rooney, D. W., & Yap, P.-S. (2022). Strategies to Achieve a Carbon Neutral Society: A Review. *Environmental Chemistry Letters, 20*(4), 2277–2310. https://doi.org/10.1007/s10311-022-01435-8.

Davis, S. J., & Caldeira, K. (2010). Consumption-based Accounting of CO2 Emissions. *Proceedings of the National Academy of Sciences, 107*(12), 5687–5692. https://doi.org/10.1073/pnas.0906974107.

Demeter, C., Lin, P.-C., Sun, Y.-Y., & Dolnicar, S. (2021). Assessing the Carbon Footprint of Tourism Businesses Using Environmentally Extended Input-Output Analysis. *Journal of Sustainable Tourism, 30*(1), 128–144. https://doi.org/10.1080/09669582.2021.1924181.

Dsilva, J., Zarmukhambetova, S., & Locke, J. (2023). Assessment of Building Materials in the Construction Sector: A Case Study Using Life Cycle Assessment Approach To Achieve The Circular Economy. *Heliyon, 9*(10), e20404. https://doi.org/10.1016/j.heliyon.2023.e20404.

Eby, M., Zickfeld, K., Montenegro, A., Archer, D., Meissner, K. J., & Weaver, A. J. (2009). Lifetime of Anthropogenic Climate Change: Millennial Time Scales of Potential CO2 and Surface Temperature Perturbations. *Journal of Climate, 22*(10), 2501–2511. https://doi.org/10.1175/2008JCLI2554.1.

Focardi, S. M., & Fabozzi, F. J. (2020). Climate Change and Asset Management. *The Journal of Portfolio Management, 46*(3), 95–107. https://doi.org/10.3905/jpm.2020.46.3.095.

Gómez-Villarino, M. T., Gómez Villarino, M., & Ruiz-García, L. (2021). Implementation of Urban Green Infrastructures in Peri-Urban Areas: A Case Study of Climate Change Mitigation in Madrid. *Agronomy, 11*(1), 31. https://doi.org/10.3390/agronomy11010031.

He, K., & Hertwich, G. G. (2019). The Flow of Embodied Carbon through the Economies of China, the European Union, and the United States. *Resources, Conservation & Recycling, 145*, 190–198. https://doi.org/10.1016/j.resconrec.2019.02.016.

Hong, J., Shen, G. Q., Peng, Y., Feng, Y., & Mao, C. (2016). Uncertainty Analysis for Measuring Greenhouse Gas Emissions in the Building Construction Phase: A Case Study in China. *Journal of Cleaner Production, 129*, 183–195. https://doi.org/10.1016/j.jclepro.2016.04.085.

Hsiao, A., & Kuipers, N. (2025). Climate Crisis and Policy Inaction in Indonesia. *American Journal of Political Science, 1*–17. https://doi.org/10.1111/ajps.70002.

Irfany, M. I., & Klasen, S. (2017). Affluence and Emission Tradeoffs: Evidence from Indonesian Households' Carbon Footprint. *Environment and Development Economics, 22*(5), 546–570. https://doi.org/10.1017/S1355770X17000262.

Jentsch, A., & Beierkuhnlein, C. (2008). Research Frontiers in Climate Change: Effects of Extreme Meteorological Events on Ecosystems. Comptes Rendus. *Géoscience, 340*(9–10), 621–628. https://doi.org/10.1016/j.crte.2008.07.002.

Kadić, A., Maljković, B., Rogulj, K., & Pamuković, J. K. (2025). Green Infrastructure's Role in Climate Change Adaptation: Summarizing the Existing Research in the Most Benefited Policy Sectors. *Sustainability, 17*(9), 4178. https://doi.org/10.3390/su17094178.

Kaur, R., Patsavellas, J., Haddad, Y., & Salonitis, K. (2023). The Concept of Carbon Accounting in Manufacturing Systems and Supply Chains. *Energies, 17*(1), 10. https://doi.org/10.3390/en17010010.

Kumar, D., Maurya, K. K., Mandal, S. K., Mir, B. A., Nurdiawati, A., & Al-Ghamdi, S. G. (2025). Life Cycle Assessment in the Early Design Phase of Buildings: Strategies, Tools, and Future Directions. *Buildings, 15*(10), 1612. https://doi.org/10.3390/buildings15101612.

Kwok, K. Y. G., Kim, J., Chong, W. K. O., & Ariaratnam, S. T. (2016). Structuring a Comprehensive Carbon-Emission Framework for the Whole Lifecycle of Building, Operation, and Construction. *Journal of Architectural Engineering, 22*(3), 04016006. https://doi.org/10.1061/(ASCE)AE.1943-5568.0000215.

Li, L., Gao, L., Zhang, X., Xu, H., & Jiang, L. (2025). Research on Building's Carbon Emission Calculation and Reduction Strategy Based on Life Cycle Assessment (LCA) and Building Information Modeling (BIM): A Case Study in Beijing, China. *Buildings, 15*(9), 1403. https://doi.org/10.3390/buildings15091403.

Markolf, S. A., Chester, M. V., Eisenberg, D. A., Iwaniec, D. M., Davidson, C. I., Zimmerman, R., Miller, T. R., Ruddell, B. L., & Chang, H. (2018). Interdependent Infrastructure as Linked Social, Ecological, and Technological Systems (Setss) to Address Lock-In and Enhance Resilience. *Earth's Future, 6*(12), 1638–1659. https://doi.org/10.1029/2018EF000926.

Martinez, S., Delgado, M. d. M., Marin, R. M., Marchamalo, M., & Alvarez, S. (2022). Pre-Construction Quantification of Embodied Environmental Impacts to

Promote Sustainable Construction Projects: The Case Study of A Diversion Dam. *Journal of Environmental Management, 314*, 115061. https://doi.org/10.1016/j.jenvman.2022.115061.

Miller, R. E., & Blair, P. D. (2009). *Input-Output Analysis: Foundations and Extensions.* Cambridge: Cambridge University Press.

Sang, J., & Pan, L. (2024). Impact of Green Infrastructure Investment on Urban Carbon Emissions in China. *Sustainability, 16*(7), 2668. https://doi.org/10.3390/su16072668.

Solomon, S., Plattner, G.-K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences, 106*(6), 1704–1709. https://doi.org/10.1073/pnas.0812721106.

Surachman, E. N. (2024). State Asset Utilization to Support Public-Private Partnership Project in Indonesia: A State Asset Management Review. *Ilomata International Journal of Management, 5*(1), 79–96. https://doi.org/10.52728/ijjm.v5i1.1007.

Thacker, S., Adshead, D., Fay, M., Hallegatte, S., Harvey, M., Meller, H., O'Regan, N., Rozenberg, J., Watkins, G., & Hall, J. W. (2019). Infrastructure for sustainable development. *Nature Sustainability, 2*(4), 324–331. https://doi.org/10.1038/s41893-019-0256-8.

Weiskopf, S. R., Rubenstein, M. A., Crozier, L. G., Gaichas, S., Griffis, R., Halofsky, J. E., Hyde, K. J. W., Morelli, T. L., Morisette, J. T., Muñoz, R. C., Pershing, A. J., Peterson, D. L., Poudel, R., Staudinger, M. D., Sutton-Grier, A. E., Thompson, L., Vose, J., Weltzin, J. F., & Whyte, K. P. (2020). Climate Change Effects on Biodiversity, Ecosystems, Ecosystem Services, and Natural Resource Management in the United States. *Science of The Total Environment, 733*, 137782. https://doi.org/10.1016/j.scitotenv.2020.137782.

Wiloso, E. I., Wiloso, A. R., Setiawan, A. A. R., Jupesta, J., Fang, K., Heijungs, R., & Faturay, F. (2024). Indonesia's Contribution to Global Carbon Flows: Which Sectors are Most Responsible for the Emissions Embodied in Trade? *Sustainable Production and Consumption, 48*, 157–168. https://doi.org/10.1016/j.spc.2024.05.005.

Zhong, S., Su, B., He, J., & Ng, T. S. (2025). Moving towards a Net-Zero Emissions Economy in Indonesia. *Science of the Total Environment, 1001*, 180542. https://doi.org/10.1016/j.scitotenv.2025.180542.

## APPENDIX

**Aggregated Input-Output Sectors**

| Aggregated EE-IO Code | EE-IO Sector | IO Code* |
|---|---|---|
| A | Agriculture, Forestry, and Fishing | I-01 - I-07 |
| B | Mining and Quarrying | I-08 - I-11 |
| C | Manufacturing | I-12 - I-27 |
| D | Electricity and Gas Supply | I-28 - I-29 |
| E | Water Supply, Sewerage, Waste Management, Wastewater, and Remediation Activities | I-30 |
| H | Transportation | I-34 - I-39 |
| OTHER | Other Industries | I-31 - I-33 and I-40 - I-52 |

*Sector descriptions follow the 52-sector BPS (2021) Input–Output classification. Aggregation is conducted to ensure compatibility with sectoral emission data.


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# ASEAN Single Window and ASEAN Trade in Goods Agreement Utilization in Indonesia

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## ABSTRACT

**Research Originality**: This study provides novel empirical evidence by introducing the Cross-Border Paperless Trade Index as a proxy for ASEAN Single Window implementation to examine how the depth of digital trade facilitation influences Indonesia's utilization of the ASEAN Trade in Goods Agreement.

**Research Objectives:** This research aims to analyze the impact of ASEAN Single Window implementation on Indonesia's utilization of the ASEAN Trade in Goods Agreement, both at the aggregate level and across sectors.

**Research Methods:** This study uses unpublished Indonesian import panel data from eight ASEAN member countries for the period 2018–2023, and analyzes them using two-way fixed-effects panel data to control for unobserved heterogeneity across product-trading partners and over time.

**Empirical Results:** Higher levels of ASEAN Single Window implementation in partner countries have a positive and statistically significant effect on Indonesia's ATIGA utilization, indicating that digital trade facilitation reduces transaction costs and administrative barriers.

**Implications:** These findings suggest that strengthening the effectiveness of digital trade facilitation, particularly through the ASEAN Single Window, is crucial for increasing the practical use of preferential trade agreements and supporting deeper economic integration within ASEAN.

**Keywords:**
digital trade facilitation; free trade agreement utilization; international trade policy; preferential tariff scheme; regional economic integration

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## INTRODUCTION

International trade plays a pivotal role in driving global economic growth, with Free Trade Agreements (FTAs) serving as key instruments for promoting economic integration. According to the World Trade Organization (2024), as of July 2024, 374 Regional Trade Agreements (RTAs) have been implemented globally. The Association of Southeast Asian Nations (ASEAN) began its participation in regional trade cooperation through the ASEAN Free Trade Area (AFTA) in 1993. This initiative was later reinforced and institutionalized through the ASEAN Trade in Goods Agreement (ATIGA) in 2010. ATIGA aims to eliminate both tariff and non-tariff barriers and to promote the growth of intra-ASEAN trade, offering significant opportunities for regional economic development.

As a central pillar of ASEAN's economic integration agenda, ATIGA is expected to strengthen regional value chains, enhance the region's resilience to external shocks, and contribute to the realization of the ASEAN Economic Community (AEC) as a single market and production base. Despite offering preferential incentives, the use of ATIGA remains relatively low among businesses (Hayakawa et al., 2009; Sitepu & Nurhidayat, 2015). Data from the ASEAN Secretariat show that although the value of intra-ASEAN trade increased from 2010 to 2023, its share of ASEAN's total global trade has remained stagnant at around 20 percent. This data indicates that intra-ASEAN trade has not grown in proportion to the region's total trade, which is primarily driven by trade with external partners.

**Figure 1. Intra-ASEAN and Extra-ASEAN Trade, 2010–2022**


Source: aseanstats (2023)

This pattern is also evident in Indonesia's trade relations with other ASEAN member states. ASEAN remains one of Indonesia's most important trading partners,


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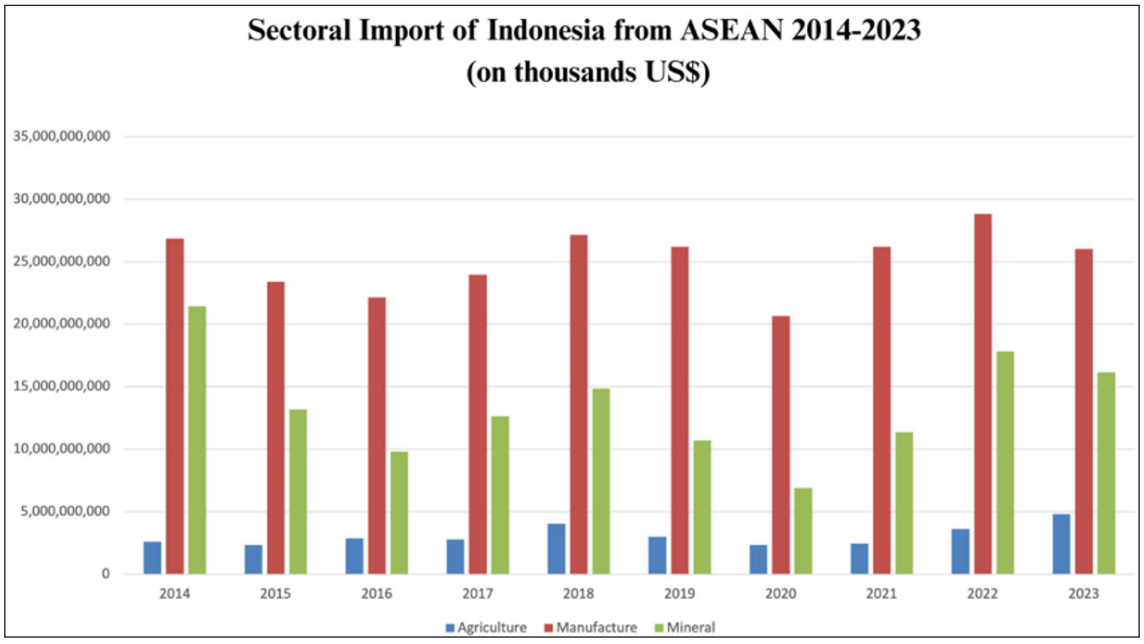
particularly as a source of imports. According to Statistics Indonesia (2025), ASEAN is the second-largest regional source of Indonesian imports after other APEC economies. Indonesia's imports from ASEAN countries reached USD 50 billion in 2014, declined to approximately USD 37 billion in 2017, and rebounded to USD 46.8 billion by 2023. At the sectoral level, manufacturing dominates Indonesia's imports—particularly machinery, intermediate inputs, and raw materials—while mineral imports exhibit greater volatility and agricultural imports remain relatively stable. These trends highlight the strategic importance of intra-ASEAN trade for Indonesia's production structure. Nevertheless, Indonesia's trade patterns indicate that the utilization of ATIGA's preferential tariff scheme remains suboptimal.

**Figure 2. Sectoral Import of Indonesia from ASEAN, 2014–2023**




Source: aseanstats (2023)

Several factors contribute to low ATIGA utilization, including the complexity of rules of origin (RoO), limited access to relevant information among businesses, and administrative burdens in the certificate of origin (COO) process (Wignaraja, 2014). A study by ERIA (2021) found that ATIGA utilization remains constrained by complex regulations and high administrative costs. Hayakawa et al. (2016) estimate that fixed documentation costs for FTA usage range from 3% to 5% of product value. Jinji et al. (2020) further estimate that total administrative costs related to FTA scheme compliance can reach 27 percent, significantly exceeding the cost of RoO compliance, which is only around 4 percent per unit of production.

From a theoretical perspective, FTAs promote market integration by allowing firms to exploit economies of scale and improve productive efficiency (Krugman et al., 2012). However, due to firm heterogeneity, the benefits of trade liberalization are unevenly distributed. More productive firms are better positioned to absorb fixed compliance

costs, while less productive firms face higher barriers to participation. Within this framework, firms' decisions to utilize FTAs are shaped by cost–benefit considerations, including margins of preference and compliance costs (Estevadeordal & Suominen, 2003; Hayakawa et al., 2014; Jinji et al., 2020; ERIA, 2021; Arini, 2022; Qu & Zhang, 2023; Legge & Lukaszuk, 2024; Qu et al., 2024). As a result, many firms may find the cost of FTA compliance outweighs its benefits, especially if margins of preference are low.

In response to these challenges, ASEAN introduced the ASEAN Single Window (ASW) as a regional digital trade facilitation platform. The World Customs Organization (WCO) defines SW as a platform that allows traders to submit all required data and documents through a single access point using standardized formats (APEC, 2018). ASW integrates the National Single Windows (NSWs) of ASEAN member states and enables real-time electronic exchange of trade documents and data. According to UN/CEFACT, a Single Window enables traders to submit standardized information through a single entry point to meet all trade-related regulatory requirements. A key feature of ASW is the electronic exchange of Certificates of Origin via e-Form D, which directly supports the application of ATIGA preferences. By digitalizing and harmonizing trade procedures, ASW is expected to reduce administrative delays, enhance transparency, and lower fixed trade costs associated with FTA utilization (ASEAN Secretariat, 2023b; ASEAN Secretariat, 2024; Meng et al., 2024). Thus, ASW plays a crucial role in enhancing the implementation of ATIGA by creating a more efficient, transparent, and integrated trade system across ASEAN. While ATIGA focuses on reducing tariffs and non-tariff barriers to boost intra-regional trade, ASW complements this by accelerating customs procedures and cross-border document exchange. By linking each member state's National Single Window, ASW functions as an integrated digital platform that enables businesses to access tariff information, trade regulations, and customs procedures in real time, while streamlining communication between traders and regulatory agencies. Beyond serving as a centralized information system, it operates as a hub for inter-agency coordination, real-time validation, and secure data exchange, thereby enhancing transparency, improving administrative efficiency, and reducing uncertainty, compliance burdens, and transaction costs (Intal et al., 2014; Martinez-Zarzoso & Chelala, 2020).

Several empirical studies suggested that simplified trade procedures and improved access to information positively influence firms' participation in FTA schemes (Wignaraja, 2014; Legge & Lukaszuk, 2024). However, the evidence on digital trade facilitation remains mixed. Martinez-Zarzoso (2023) found that aggregate measures of digital trade facilitation do not always yield statistically significant effects, while OECD (2018) and Song (2022) cautioned that poorly designed digital systems may introduce new technical and procedural complexities. Moreover, sectoral studies indicate that the benefits of digital trade facilitation tend to be concentrated in sectors that are highly integrated into global value chains (Carballo et al., 2016; Martinez-Zarzoso, 2023). Other previous studies on digital trade facilitation have examined its impact on trade or on GVCs (Roy & Huang, 2020).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Despite extensive research on FTA utilization, the literature largely explains low utilization rates through trade cost barriers such as tariff complexity, rules of origin compliance, and administrative documentation costs (Estevadeordal & Suominen, 2003; Hayakawa et al., 2014; Jinji et al., 2020; ERIA, 2021; Arini, 2022; Qu & Zhang, 2023; Qu et al., 2024). While these studies highlight important constraints faced by firms, they provide limited empirical evidence on whether digital trade facilitation mechanisms function as enabling policies that actively increase FTA utilization. In particular, empirical studies directly linking the implementation of regional Single Window systems to actual FTA usage remain scarce, especially within ASEAN and at the sectoral level. Moreover, existing studies on digital trade facilitation primarily examine its impact on aggregate trade flows, customs efficiency, or participation in global value chains, rather than on firms' utilization of preferential tariff schemes (Martinez-Zarosozo, 2023; Legge & Lukaszuk, 2024). These studies often rely on binary adoption indicators or broad facilitation indices, which do not capture cross-country and intertemporal variation in the depth and effectiveness of digital system implementation. As a result, it remains unclear whether deeper and more effective digital trade facilitation translates into higher FTA utilization.

This study addresses these gaps by examining digital trade facilitation as an enabling mechanism for FTA utilization, using the ASEAN Single Window as a case study. The key contribution of this research is the use of the Cross-Border Paperless Trade Index as a proxy for the depth of Single Window implementation, allowing for a more granular assessment of digital facilitation intensity beyond formal adoption. To the best of our knowledge, this approach has not been applied in the FTA utilization literature.

Accordingly, this study aims to estimate the impact of implementing the ASEAN Single Window on Indonesia's utilization of the ASEAN Trade in Goods Agreement at both the aggregate and sectoral levels. Using product-level import panel data and a two-way fixed-effects framework, the analysis explicitly links variation in the intensity of digital trade facilitation to observed FTA utilization outcomes, ensuring consistency among the research question, empirical strategy, and policy implications.

## METHODS

This study employed unpublished panel data from the Ministry of Finance, covering the period from 2018 to 2023. The selection of the study period was constrained by data availability and institutional validation requirements. Disaggregated import transaction data identifying ATIGA utilization at the product and partner-country level were only reliably available for this period at the time the study was conducted. In particular, utilization data for 2024 had not yet been finalized, validated, or formally authorized for research use by the Ministry of Finance. Given that the empirical analysis relied exclusively on officially verified utilization records to ensure data consistency and measurement accuracy, extending the sample to include unvalidated observations would have risked

introducing measurement error and biasing the estimation results. Earlier years were also excluded because the Ministry of Finance did not release comparable, consistently recorded utilization data for research purposes.

Accordingly, the chosen period represented the longest feasible and methodologically sound time span for rigorous empirical analysis. Future research may revisit this limitation as more recent, fully validated data become available. The starting year, 2018, was particularly relevant for analytical purposes as it coincided with the initial operational implementation of the ASEAN Single Window, including the electronic exchange of Certificates of Origin (e-Form D) among ASEAN member states. Focusing on the post-implementation period allowed the analysis to capture meaningful variation in the depth of ASEAN Single Window implementation and to assess its role as a digital trade facilitation mechanism influencing ATIGA utilization. Consequently, the selected time frame ensured both data consistency and conceptual alignment between the policy intervention and the empirical analysis.

The dataset covered Indonesia's imports from eight ASEAN member countries—Brunei Darussalam, Cambodia, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam—at the 6-digit level of the Harmonized System (HS) Code 2017. Lao PDR was excluded from the analysis due to the unavailability of data on ATIGA utilization. These data were obtained from Indonesian Customs and Excise and were sourced from Indonesia's import declaration system. This level of product classification enabled detailed analysis of trade flows and utilization patterns across different product categories, ensuring consistency in international trade reporting standards and comparability across countries. The dataset served as the basis for calculating the ATIGA utilization rate, which reflects the extent to which importers actually obtained and applied the tariff preferences under the agreement. By adopting a granular, product-level approach, the analysis captured sector-specific dynamics in FTA usage. It provided more precise insights into which industries or product categories benefited from preferential access. Such granularity was essential for evaluating the effectiveness of trade agreements and identifying sectors with underutilized potential.

A two-way fixed-effects panel data model was used to assess the impact of ASEAN Single Window implementation on the utilization of the ASEAN Trade in Goods Agreement. This approach was chosen to control for potential bias arising from unobserved but time-invariant factors at the product-country and year levels. The model incorporated product-country fixed effects to account for heterogeneity in the complexity of rules of origin across products and countries of origin, as well as year fixed effects to capture common external influences such as global economic fluctuations and the COVID-19 pandemic. This empirical specification was consistent with previous studies by Legge and Lukaszuk (2024) and Hayakawa et al. (2023), which examined the effects of free trade agreements.

The dependent variable is the utilization rate of ATIGA (*Uijt*), measured as the proportion of Indonesia's imports conducted under ATIGA preferential tariffs relative to total imports for each product and partner country. The implementation of the ASEAN


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Single Window (ASW) was measured using two components. First, the year of initial live operation of ASW implementation in each ASEAN member state (*dummyaswjt*) was used to assess the impact of ASW on the utilization of the ASEAN Trade in Goods Agreement (ATIGA). Second, the Cross-Border Paperless Trade Index will serve as a proxy to measure the level of ASW implementation in each ASEAN member state (*indexpaperlessjt*). To date, no study has examined the impact of single-window implementation, as measured by the Cross-Border Paperless Trade Index (CBPTI), on the utilization of Free Trade Agreements (FTAs). The approach using the CBPTI has been employed by the United Nations (2024) and Martinez-Zarzoso (2023) in studies analysing the impact of digital trade facilitation on trade costs and firm productivity. Both studies concluded that digital trade facilitation reduced trade costs and improved firm productivity. The Cross-Border Paperless Trade Index was considered an appropriate component because the survey elements closely aligned with the facilities intended under the ASW—namely, the exchange of electronic customs declarations, electronic certificates of origin, and electronic sanitary and phytosanitary data. The United Nations (2023) report on trade facilitation also stated that survey results on cross-border paperless trade in ASEAN countries reflected the level of implementation of the ASEAN Single Window. This variable of interest was derived from the UN Global Survey on Digital and Sustainable Trade Facilitation.

To ensure robust results, the model controlled for several additional variables. Margin of Preference (*MOPijt*), defined as the tariff margin between the Most-Favoured Nation (MFN) rate and the preferential tariff under ATIGA at the product level (6-digit HS 2017 level) of an ASEAN member country, captures the benefit firms gain from trade under an FTA. Based on Hayakawa et al. (2014), a higher tariff margin increased the attractiveness of utilizing FTAs for traders. GDP per capita of the exporting country (*GDPPjt*) served as an indicator of economic development and export capacity (Hayakawa et al., 2017). A higher GDP per capita suggested better infrastructure and compliance capability with FTA rules, increasing the likelihood of FTA utilization. It also proxied the level of ICT infrastructure development, which influenced the implementation of trade facilitation tools such as Single Window (SW) systems (Kok Yaw, 2016; OECD, 2018). The exchange rate of the exporting country's currency against the USD (*ERjt*) was included as a control variable in this model. As suggested by Hayakawa et al. (2017), a depreciation in the exporter's currency could enhance FTA utilization by making it easier to meet rules of origin (ROO) requirements. The final control variable, Indonesia's import value at the product level from ASEAN countries (*Importijt*), was included to control for the size of export transactions. Higher import volumes may reflect greater demand and scale economies, increasing the incentive for exporters to utilize FTAs (Hayakawa et al., 2014; 2023).

Based on the description above, the following regression model was specified to measure the impact of the implementation of ASW on the utilization of ATIGA:

$$Ui_{jt} = \beta 0 + \beta 1 dummyasw_{jt} + \beta 2 indexpaperles_{jt} + \beta 3 MOPi_{jt} + \beta 4 lnImportijt + \beta 5 lnGDPP_{jt} + \beta 6 lnER_{jt} + \rho_{ij} + \delta_{t} + \varepsilon_{ijt}$$

## RESULTS AND DISCUSSION

The main finding of this study shows that the **depth of ASEAN Single Window (ASW) implementation**, rather than its initial launch, significantly increases the utilization of the ASEAN Trade in Goods Agreement (ATIGA), especially in the manufacturing sector. The official launch of ASW did not immediately affect ATIGA utilization. However, deeper and more mature digital trade facilitation reduces administrative barriers and encourages firms to use preferential tariffs. This highlights the importance of operational quality and institutional readiness in ensuring that digital trade reforms produce real trade benefits.

Table 1 presents the aggregate estimation results. The ASW implementation dummy variable (dummyasw), which represents the year a country officially started ASW operations, shows an insignificant effect on ATIGA utilization. This indicates that formal participation in ASW alone is not enough to change firms' trade behavior. This finding is consistent with Martinez-Zarzoso (2023), who argues that digital trade facilitation is a gradual process moving from "not implemented" to "fully implemented," with stronger trade effects over time.

**Table 1. Estimation Results of the Impact of the Implementation of ASW on the Utilization of ATIGA**

| Variables | Utilization |
|---|---|
| dummyasw | 0.0117 |
| | (0.0121) |
| indexpaperless | 0.131* |
| | (0.0726) |
| mop | 0.0144** |
| | (0.00643) |
| lnimport | 0.0288*** |
| | (0.00155) |
| lngdpp | 0.254*** |
| | (0.0344) |
| lner | 0.481*** |
| | (0.0706) |
| Constant | -4.147*** |
| | (0.523) |
| Observations | 21,774 |
| R-squared | 0.842 |

Robust standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1
Source: Author's estimation

In contrast, the Cross-Border Paperless Trade Index (indexpaperless), which measures the quality and level of digital trade facilitation, shows a positive effect at the 10 percent


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level. The estimated coefficient suggests that a one-unit increase in the index increases ATIGA utilization by 0.131, ceteris paribus. Since the index ranges from 0 to 1, this effect is economically meaningful and shows that improvements in digital trade systems can increase the use of free trade agreements. This finding supports trade facilitation theory, which states that reducing administrative and information barriers encourages firms to participate in trade agreements.

One key mechanism is the real-time electronic exchange of e-Form D among ASEAN member states. By replacing manual, paper-based verification with automated electronic systems, ASW shortens document processing time and speeds up customs clearance, thereby reducing logistics costs (APEC, 2018; Legge & Lukaszuk, 2024; Noor, 2023). These efficiency gains lower the fixed costs of claiming preferential tariffs and encourage firms to use ATIGA preferences (Wignaraja, 2014).

The positive impact of the ASEAN Single Window (ASW) on ATIGA utilization is also explained by improved access to information and a single-entry system for regulatory compliance. Single Window systems simplify information exchange between firms and government authorities, especially in meeting trade regulations (Weber, 2011). Firms can submit all required trade data and documents through a single integrated portal in a standardized format. This reduces duplication, fragmented information, and coordination problems among border agencies.

In the ASEAN context, ASW applies this principle by allowing firms to comply with rules of origin and customs procedures through a unified electronic platform. This reduces informational and procedural complexity. As noted by APEC (2018), the Single Window system allows traders to submit required information to border authorities only once. This improves transparency, reduces uncertainty in document processing, and helps firms better understand trade rules and procedures. The results show that digital trade facilitation increases FTA utilization by lowering costs and improving information access, but only when the system reaches sufficient operational maturity, meaning that formal adoption alone is not enough to change firms' behavior (Martinez-Zarzoso, 2023).

In contrast, this study does not support the argument that technology-based trade facilitation may reduce FTA utilization due to higher compliance costs, as suggested by the OECD (2018). OECD (2018) noted that building Single Window systems from scratch can be costly. However, in ASEAN, ASW builds on existing national systems and operates through cross-country interoperability. Most implementation costs are borne by governments rather than firms. As a result, firms benefit from simpler procedures and better information exchange without facing additional costs. This explains why ASW implementation in this study is associated with lower trade costs and higher FTA utilization, highlighting the importance of implementation design and cost-sharing arrangements in digital trade facilitation.

The control variables behave as expected, supporting the validity of the model. The margin of preference (MOP) shows a positive effect, meaning that larger tariff

differences encourage firms to use FTAs. This is because a wider preferential margin yields greater savings on import duties than the Most Favored Nation (MFN) tariff rate. As margins increase, firms gain greater cost advantages from using FTA schemes (Arini, 2022; Hayakawa et al., 2014; Qu & Zhang, 2023; Qu et al., 2024). Therefore, higher MOP values improve the cost–benefit calculation of compliance and increase firms' willingness to use preferential trade agreements. From a policy perspective, this suggests that procedural improvements alone cannot maximize FTA utilization if tariff margins decline due to MFN tariff reductions.

**Table 2. Estimation Results of the Impact of Implementation of ASW on Utilization of ATIGA Sectoral**

| | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | **Agriculture** | **Manufacture** | **Mineral** |
| dummyasw | -0.0161 | 0.0131 | 0.0522 |
| | (0.0445) | (0.0127) | (0.0629) |
| indexpaperless | 0.0824 | 0.142* | -1.094 |
| | (0.326) | (0.0746) | (0.855) |
| mop | -0.0404 | 0.0177*** | -0.0847 |
| | (0.0285) | (0.00662) | (0.0729) |
| lnimport | 0.0262*** | 0.0290*** | 0.0161 |
| | (0.00757) | (0.00159) | (0.0158) |
| lngdpp | -0.116 | 0.271*** | 0.580*** |
| | (0.151) | (0.0355) | (0.214) |
| lner | -0.354 | 0.524*** | 0.839 |
| | (0.300) | (0.0729) | (0.599) |
| Constant | 2.557 | -4.502*** | -6.954** |
| | (2.200) | (0.541) | (3.303) |
| Observations | 1,424 | 20,076 | 274 |
| R-squared | 0.829 | 0.837 | 0.907 |

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1
Source: Author's estimation

Import value also has a positive, highly significant effect, indicating that firms with higher trade volumes are more likely to use ATIGA preferences. This result reflects the fixed costs associated with FTA utilization, such as administrative costs for obtaining certificates of origin and adjustments to meet rules-of-origin requirements. Firms with larger import volumes can spread these costs across bigger transactions, making FTA utilization more economically feasible (Hayakawa et al., 2009; Hayakawa et al., 2023). Higher transaction values also mean greater tariff savings when preferential rates are applied (Hayakawa et al., 2014; Legge & Lukaszuk, 2024). As a result, firms with higher trade


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volumes face a more favorable cost–benefit balance and are more likely to claim FTA preferences (Hayakawa et al., 2009).

GDP per capita of exporting countries (GDPP) is also positively related to ATIGA utilization. This indicates that exporters from more developed economies are more likely to use FTA preferences. Firms in higher-income countries generally have better knowledge, experience, and internal systems to handle the complex documentation and procedures required for FTA utilization. Stronger institutions and more advanced digital systems also help them comply with rules of origin and other regulatory requirements (Hayakawa et al., 2017). This finding suggests that policymakers should reduce gaps in digital capacity and institutional readiness across ASEAN countries. Efforts such as harmonizing customs procedures, improving national single-window systems, and providing technical support to less developed members can help ensure more inclusive use of ATIGA.

Finally, the exchange rate (ER) variable shows a positive effect, indicating that currency depreciation increases ATIGA utilization. A depreciation of the exporter's currency raises export prices in local-currency terms, which can increase the value-added share of exported products and help firms meet the Regional Value Content (RVC) requirements under FTA rules (Hayakawa et al., 2017). This makes it easier for exporters to qualify for preferential tariffs and strengthens their incentive to use FTA schemes. The result also shows that FTA utilization is influenced by broader macroeconomic conditions, highlighting the importance of coordinating trade policy with macroeconomic stability. Previous research, including Martinez-Zarzoso (2023), suggests that the effects of cross-border paperless trade facilitation may differ across product sectors. Based on this idea, this study analyzes the impact of ASEAN Single Window (ASW) implementation on ATIGA utilization across three sectors: agriculture, manufacturing, and minerals. The results in Table 3 show clear differences across sectors, indicating that the benefits of digital trade facilitation depend on sector characteristics and the institutional readiness of exporting countries.

The sectoral estimates show that ASW implementation has a positive effect only in the manufacturing sector, while the coefficients for agriculture and minerals, although positive, are not statistically significant. One possible explanation is the difference in sample size. The number of observations in agriculture (1,424) and minerals (274) is much smaller than in manufacturing (20,076), which may reduce the statistical strength of the estimates. Beyond this statistical issue, the results are also consistent with trade facilitation theory. Digital trade facilitation tends to be more effective for products deeply integrated into global value chains (GVCs), where rapid information exchange and efficient procedures are essential. Manufacturing goods—especially intermediate inputs and capital goods—are usually more involved in GVCs than primary products such as agriculture and minerals, making them more responsive to improvements in digital trade systems (Li & Wang, 2025; Martinez-Zarzoso, 2023). Similar findings are reported by Carballo et al. (2016), who show that trade facilitation measures,

including simplified document processing, have stronger effects on industrial inputs and manufactured goods.

Similarly, the OECD (2018) notes that trade facilitation reforms are especially important for high-technology manufactured components, which are highly sensitive to procedural delays and administrative uncertainty. Overall, these findings suggest that the benefits of ASW implementation are sector-specific and strongest in sectors with fragmented production and high time sensitivity. In the agriculture sector, the ASW implementation index also shows a positive sign, but the effect is not statistically significant. This may reflect the continued importance of non-tariff measures (NTMs), especially sanitary and phytosanitary (SPS) regulations, which limit the use of ATIGA in agricultural trade. Although ASEAN began exchanging electronic SPS (e-SPS) data in 2022, its implementation was limited to only two countries—Indonesia and Thailand—and covered only one year of the sample period, which likely reduced its measurable impact. The results also suggest that FTA utilization in agriculture is driven more by transaction value than by digital procedures. As shown in Table 2, import value has a positive and significant effect, meaning that larger transactions create greater tariff savings and stronger incentives to use FTA preferences. This finding is consistent with previous studies showing that firms are more likely to claim FTA benefits when tariff savings are large enough to offset compliance costs (Arini, 2022; Hayakawa et al., 2009; Hayakawa et al., 2014). These results indicate that, in agriculture, economic scale currently plays a greater role than digital trade facilitation, especially because electronic SPS systems remain limited.

Across all sectors, the ASW dummy variable—which marks the year of official ASW activation—shows no statistically significant effect. The coefficients are negative for agriculture and small but positive for manufacturing and minerals. This supports the earlier conclusion that the timing of ASW launch does not necessarily reflect its effectiveness. The ASEAN Secretariat (2021) also noted that although all ASEAN countries formally joined the ASW framework, the level of system integration and use varies widely across ASEAN countries, depending on digital infrastructure and institutional capacity.

Regarding the control variables, import value consistently shows a positive, significant effect in agriculture and manufacturing, indicating that higher trade volumes increase ATIGA utilization. This reflects the economic logic that firms are more likely to claim tariff preferences when transaction values are larger. The margin of preference (MOP) also has a significant positive effect in manufacturing, showing that larger tariff differences create stronger incentives to use FTAs. In contrast, GDP per capita and exchange rates show mixed but statistically insignificant effects across sectors. This suggests that while these macroeconomic factors may influence ATIGA utilization at the aggregate level, their role becomes less clear when analyzed by specific product sectors.


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## CONCLUSION

This study analyzes whether the implementation of the ASEAN Single Window (ASW) affects Indonesia's utilization of the ASEAN Trade in Goods Agreement (ATIGA) at both aggregate and sectoral levels. The results show that the initial implementation of ASW—represented by the introduction of the electronic Certificate of Origin—does not significantly increase ATIGA utilization. This indicates that simply introducing a digital policy is not enough to change firms' behavior. However, deeper ASW implementation—reflected in stronger digital infrastructure, better system integration, and improved functionality—has a positive and significant impact on ATIGA utilization at the aggregate level. This effect is mainly observed in the manufacturing sector, where firms are more integrated into regional production networks and benefit more from efficient trade procedures. In contrast, the effects are not significant in the agriculture and mineral sectors, likely due to persistent non-tariff barriers and limited digital coverage.

The findings also show that macroeconomic factors such as tariff margins, transaction values, exporters' income levels, and exchange rate movements remain important drivers of ATIGA utilization. Overall, the study suggests that increasing the use of free trade agreements requires deeper and more effective digitalization, stronger regional coordination among ASEAN members, and better domestic coordination among government agencies to support efficient and integrated trade systems.

## REFERENCES

Akbar, S., Mendoza, M. W., & Febriansyah. (2025). ASEAN Single Window Implementation: Exploring Benefits, Challenges, Solutions, and Future Roadmap. *Journal of Principles Management and Business, 4*(1), 186–209. https://doi.org/10.55657/jpmb.v4i01.229.

Arini, T. (2022). Determinants of ASEAN–China Free Trade Agreement (ACFTA) Utilization for Indonesia's Imports. (*Unpublished Thesis*). International Institute of Social Studies, Erasmus University.

ASEAN Secretariat. (2021). *ASEAN Digital Integration Index (ADII) Report 2021*. Jakarta: ASEAN Secretariat.

ASEAN Secretariat. (2023a). *ASEAN Statistical Highlights 2022*. Jakarta: ASEAN Secretariat.

ASEAN Secretariat. (2023b). *ASEAN Annual Report 2022–2023*. Jakarta: ASEAN Secretariat.

ASEAN Secretariat. (2024). *ASEAN Annual Report 2023 (June–December)*. Jakarta: ASEAN Secretariat.

Asia-Pacific Economic Cooperation. (2018). *Study on Single Window Systems' International Interoperability: Key Issues For Its Implementation*. Singapore: APEC Policy Support Unit.

Basu Das, S. (2017). *ASEAN Single Window: Advancing Trade Facilitation for Regional Integration* (ISEAS Perspective No. 72). Singapore: ISEAS–Yusof Ishak Institute.

Carballo, J., Schaur, G., & Volpe Martincus, C. (2016). Trust No One? Security and International Trade. *IDB Working Paper No. 7684*, *Inter-American Development Bank*.

Chow, N. (2018). The Single Window and the TFA: ASEAN's Best Chance at a Common Rule of Law. *Asian Journal of Law and Economics, 9*(2), 1-12. https://doi.org/10.1515/ajle-2017-0022.

Czapnik, B., & Saeed, M. (2025). Trade Facilitation: Making Trade More Efficient. In. Prakash, A (Ed). *Asia–Europe connectivity vision 2025: Challenges and opportunities,* 96–107. Economic Research Institute for ASEAN and East Asia.

Economic Research Institute for ASEAN and East Asia. (2021). *Impact of the ATIGA on Intra-ASEAN Trade*. Jakarta: ERIA.

Estevadeordal, A., & Suominen, K. (2003). Rules of Origin: A World Map and Trade Effects. *Conference Papers*, *Purdue University, Global Trade Analysis Project*.

Ferracane, M. F., González Ugarte, S., & Rogaler, T. (2025). Global trends in digital trade policies and practices: Evidence from the Digital Trade Integration Database. *World Trade Review, 25*(1), 127–151. https://doi.org/10.1017/S1474745625100955.

Ha, N. N., & Phuong, D. M. (2025). Trade Facilitation in ASEAN through Customs Cooperation: Advancing towards Sustainable Development Goals 8, 9, and 17. *Journal of Lifestyle and SDGs Review, 5*(4), 5642. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n04.pe05642.

Hayakawa, K., Hiratsuka, D., Shiino, K., & Sukegawa, S. (2009). Who Uses Free Trade Agreements? *ERIA Discussion Paper Series, ERIA-DP-2009-2.*

Hayakawa, K., Kim, H., & Lee, H. H. (2014). Determinants of Utilization of the Korea–ASEAN Free Trade Agreement: Margin Effect, Scale Effect, and ROO Effect. *World Trade Review, 13*(3), 499–515. https://doi.org/10.1017/S1474745613000323.

Hayakawa, K., Laksanapanyakul, N., & Urata, S. (2016). Measuring the Costs of FTA Utilization: Evidence from Transaction-Level Import Data of Thailand. *Review of World Economics, 152*, 559–575. https://doi.org/10.1007/s10290-016-0248-y.

Hayakawa, K., Kim, H.-S., & Yoshimi, T. (2017). Exchange Rates and Utilization of Free Trade Agreements: Focus on Rules of Origin. *Journal of International Money and Finance, 75*, 93–108. https://doi.org/10.1016/j.jimonfin.2017.05.002.

Hayakawa, K., Laksanapanyakul, N., & Yoshimi, T. (2023). Firm-Level Utilization Rates of Regional Trade Agreements: Importers' Perspective. *Journal of Asian Economics, 86*, 101610. https://doi.org/10.1016/j.asieco.2023.101610.

Intal, P. S., Jr., Fukunaga, Y., Kimura, F., Han, P., Dee, P., & Narjoko, D. (2014). ASEAN and AEC: Progress and Challenges. In *ASEAN Rising: ASEAN and AEC beyond 2015* (pp. 1–52). ERIA.

Jinji, N., Hayakawa, K., Laksanapanyakul, N., Matsuura, T., & Yoshimi, T. (2020). A New Approach for Quantifying the Costs of Utilizing Regional Trade Agreements. *Discussion Paper No. e-19-010, Kyoto University*.

Junaidi, A. (2019). Estimating the Impact of the ASEAN–China Free Trade Agreement on Indonesia's Trade Balance. (*Unpubslished Thesis*). Depok: Universitas Indonesia.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.46436

Kohpaiboon, A., & Jongwanich, J. (2022). Restrictiveness of RCEP Rules of Origin: Implications for Global Value Chains in East Asia. *ERIA Discussion Paper No. 455*.

Kok Yaw, W. (2016). The Study of ASEAN's Readiness in Implementing a Single Window: Perspective from Malaysia's IT Development. *International Journal of Business & Management Science, 2*(4), 1-9. https://doi.org/10.53555/eijbms.v2i4.17.

Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2012). *International Economics: Theory and Policy* (9th ed.). New Jersey: Pearson Education.

Legge, S., & Lukaszuk, P. (2024). The Firm-Level Costs of Utilizing Free Trade Agreements. *International Economics, 178*, 100484. https://doi.org/10.1016/j.inteco.2024.100484.

Li, Y., & Wang, Z. (2025). Digital Trade Facilitation and GVC Restructuring: Implications For Manufacturing Upgrading in Developing Countries. *Finance Research Letters, 86*(B), 108413. https://doi.org/10.1016/j.frl.2025.108413.

Martínez-Zarzoso, I., & Chelala, S. (2020). The Impact of Single Windows on Trade. *IAI Discussion Paper No. 245*. University of Göttingen.

Martínez-Zarzoso, I. (2023). Trade Facilitation and Global Value Chains in a Post-Pandemic World. *ADBI Working Paper No. 1378*. Asian Development Bank Institute.

Meng, J., Lu, H., & She, S. (2024). An Analysis of How Digital Technology Impacts Trade Costs: Evidence from RCEP Countries. *Financial Economics Letters, 3*(3), 31. https://doi.org/10.58567/fel03030001.

Moïsé, E., & Sorescu, S. (2013). Trade Facilitation Indicators: The Potential Impact on Developing Countries' Trade. *OECD Trade Policy Paper No. 144*. OECD Publishing.

Noor, M. M. (2023). *ASEAN Single Window (ASW) & Indonesia National Single Window (INSW): Best practice of cross-border paperless trade integration*. UNESCAP.

Organisation for Economic Co-operation and Development (OECD). (2018). *Trade Facilitation And The Global Economy*. Paris: OECD.

Qu, Y., & Zhang, R. (2023). Assessing the Effects of Rules of Origin and Tariff Margins on China–ASEAN FTA Utilization. *PLOS ONE, 18*(5), e0286106. https://doi.org/10.1371/journal.pone.0286106.

Qu, Y., Yang, H., Wu, K., & Jiao, Y. (2024). Exploring the Effects of Rules of Origin and Tariff Margins on China's Export Enterprises Under the China–Korea FTA. *Asia-Pacific Economic Literature, 39*(1), 65-85. https://doi.org/10.1111/apel.12426.

Roy, C. K., & Huang, X. (2020). Effects of Paperless Trade Policy and Aid for Trade on Export Performance. *Asian Development Policy Review, 8*(1), 61–74. https://doi.org/10.18488/journal.107.2020.81.61.74.

Sitepu, E. M. P., & Nurhidayat, R. (2015). Measuring Indonesia's FTA utilization: A Case Study. *Kajian Ekonomi dan Keuangan, 19*(3), 1-15.

Song, J.-H. (2022). Empirical Analysis of Factors Affecting FTA Utilization by Exporting SMEs. *East Asian Economic Review, 26*(3), 227–253. https://doi.org/10.11644/KIEP.EAER.2022.26.3.412.

UNESCAP. (2023). *Digital and Sustainable Trade Facilitation: Global Report 2023*. Retrieved from: https://www.untfsurvey.org/report/2023.

Weber, R. H. (2011). Legal Framework for the Single Window Concept in ASEAN. *Asian Journal of Law and Economics, 2*(4), 78–95.

Wignaraja, G. (2014). The Determinants of FTA Use in Southeast Asia: A Firm-Level Analysis. *Journal of Asian Economics, 35*, 32–45. https://doi.org/10.1016/j.asieco.2014.10.002.



http://journal.uinjkt.ac.id/index.php/signifikan
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# Tariff Policy Challenges for Electronic Transmissions in Indonesia

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## ABSTRACT

**Research Originality**: This research introduces a novel empirical estimate of potential customs duty revenue from digitally transmitted imports in Indonesia, addressing a gap in digital trade policy research that has been largely filled by conceptual and legal analyses.

**Research Objectives:** This study aims to operationalize digitally transmitted imports using Harmonized System (HS) codes across five subsectors registered in the Indonesian HS: (1)films/movies, (2)printed matter-books, (3)sound & media, (4)software, and (5)video games.

**Research Methods:** This study constructs a panel dataset covering the period 2018–2023, using data from the Ministry of Finance and Central Bureau of Statistics. The analysis employs a two-way fixed-effects panel econometric regression model to control for unobserved heterogeneity across subsectors and over time.

**Empirical Results:** The results indicate a positive relationship between import volume and state revenue from import duties, suggesting that higher import volumes directly contribute to increased fiscal receipts, strengthening the role of import duties.

**Implications:** These findings highlight the growing fiscal relevance of digitally transmitted trade and suggest that the government should accelerate investment in digital infrastructure and strengthen cyber oversight to support sustainable growth in digital trade.

**Keywords:**
digital trade; international trade policy; customs duty; harmonized system

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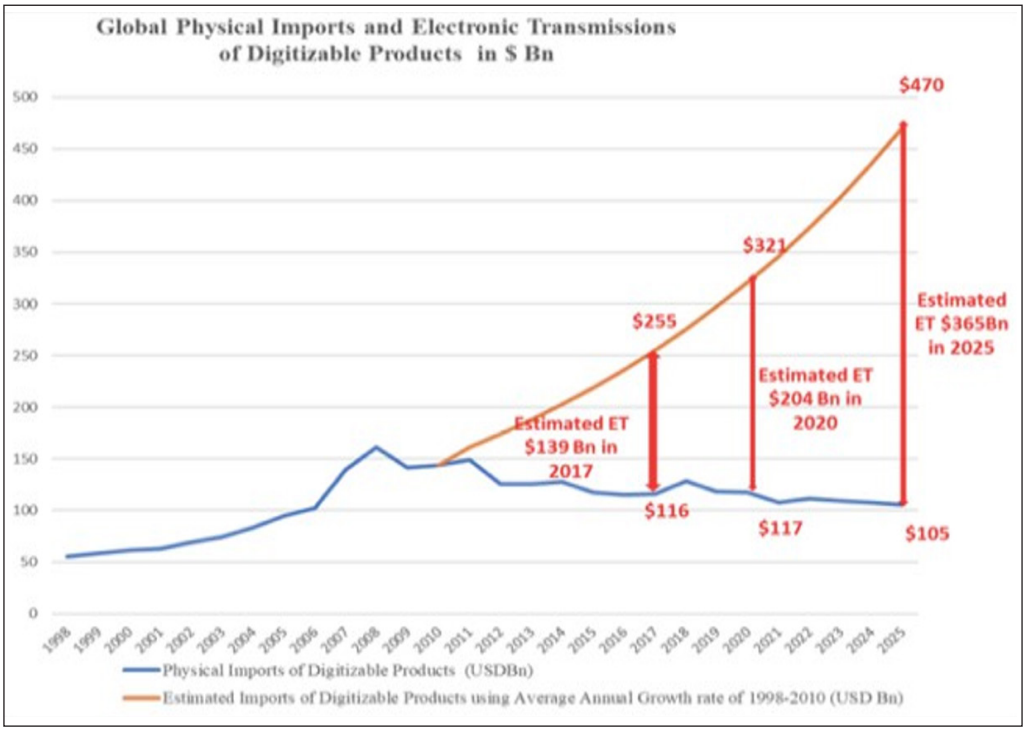
## INTRODUCTION

The shift from physical to digital products has become a defining feature of modern international trade as data flows and digital technologies reshape cross-border transactions. This transformation poses significant challenges for customs administration and tax policy, which were originally designed for tangible goods with observable border crossings (Meltzer, 2019). This paper examines the implications of digitalization for customs and taxation, reviews relevant literature and policy debates, and provides an empirical assessment of Indonesia's experience with digital goods imports.

Digitally delivered cross-border transactions complicate enforcement, classification, and measurement, creating uncertainty over their fiscal and regulatory impacts. As emphasized in the digital trade measurement literature, distinguishing between digitally ordered and delivered transactions is essential, as reliable statistics are crucial for designing effective, evidence-based policy responses.

**Figure 1. The distinction in value between the importation of tangible products and the electronic transmission of digital goods**




Source: International Monetary Fund (2023)

As illustrated in Figure 1, the estimated value of digital goods imports in 2017, calculated using an 8 per cent Average Annual Growth Rate (AAGR), was USD 255 billion. In contrast, the physical imports of these digitizable products totaled USD 116 billion. Consequently, the disparity between the estimated import value and the actual physical import value reached USD 139 billion, which can be interpreted as the value of digital goods imported via electronic transmission, a form of trade that is not systematically captured by conventional customs statistics (WTO, 2023). This gap has important policy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implications, as it suggests that a substantial and growing share of cross-border digital trade is excluded from traditional trade measurement frameworks. This condition creates challenges for policymakers because inaccurate or incomplete import data can undermine effective revenue estimation and impede the enforcement of trade and taxation policies, ultimately affecting the government's ability to design and implement appropriate fiscal measures in response to the digitalization of trade.

From a taxation and customs perspective, import duties and tax revenues, particularly Value Added Tax (VAT), serve as key indicators of the potential of digital products. The House of Representatives observed that transactions involving digital products in the music, games, and video categories in Indonesia alone totaled IDR 37 trillion in 2020, far exceeding the government's estimated figure of IDR 880 billion, implying substantial untapped VAT potential. Furthermore, administrative records show that from 2020 to May 2024, 105 registered importers were involved in digital goods imports via electronic transmission, with 1,815 declared documents and a reported import value of USD 775.95 million (Directorate General Customs and Excise, 2024).

These figures indicate that ET-related imports are not merely theoretical. They already exist in measurable form, reinforcing the practical relevance of evaluating customs duty policy options for digitally transmitted goods. At the global level, the debate is closely linked to the WTO Work Programme on Electronic Commerce and the longstanding practice, first adopted in 1998, of not imposing customs duties on electronic transmissions (the WTO moratorium), which has been regularly extended.

This policy has become increasingly contested because it raises both fiscal and development concerns for countries that remain relatively reliant on trade-related revenues. The WTO's own development-oriented discussions emphasize that digital trade can bring meaningful opportunities for developing economies, but also highlight implementation challenges, including regulatory capacity and digital infrastructure constraints that may shape how benefits are distributed. In WTO discussions, dedicated General Council sessions have addressed electronic commerce issues over time, reflecting ongoing uncertainty about its scope, definition, and implications.

Early work raised concerns that tariff-free electronic transmissions could have uneven fiscal implications, potentially affecting developing countries more because of their greater reliance on trade taxes (Andrenelli, 2023). Longstanding policy research also noted that developing countries often lacked the resources and evidence to quantify revenue implications of electronic commerce rules, which limited their bargaining position in multilateral debates. More recent contributions have attempted to estimate the potential tariff-revenue effects of the moratorium and the scope of digitizable products, including studies that highlight potential future revenue trade-offs for developing countries as digitization expands.

Other analyses argue that the full implications of levying customs duties on electronic transmissions remain uncertain and depend heavily on definitional scope, classification practices, and substitution patterns between physical and digital delivery, leading to different

conclusions across studies. This divergence in the literature reinforces the need for country-specific empirical evidence grounded in administrative realities, rather than relying only on global assumptions.

**Table 1. Product Classification under HS Subheading 99.01**

| HS Code | Description of Good | Import Duty |
|---|---|---|
| 99.01 | Software and other digital product transmitted electronically | |
| 9901.10.00 | Operation system software | 0% |
| 9901.20.00 | Application software | 0% |
| 9901.30.00 | Multimedia (audio, video or audio visual) | 0% |
| 9901.40.00 | Supporting or driver data, including design for machinery system | 0% |
| 9901.90.00 | Other software and digital product | 0% |

Source: Minister of Finance Regulation No.26/2022

Table 1 explains that the basis for determining the five digital goods is the volume of digital goods with the greatest impact on VAT and income tax during a certain period (Directorate General Customs and Excise, 2022). In the classification, it is noted that import duties are imposed on the digital content itself. Software and other digital products transmitted electronically, as mentioned in heading 99.01, are not those that pertain to machines or devices that have been or will be imported. In addition, software and other digital products transmitted electronically that are associated with machines or devices that have been or will be imported are categorized alongside those machines or devices. The subheading 9901.40.00 tariff line covers software that serves as a renewal or update of the aforementioned software for machines or devices that have already been imported (Minister of Finance Regulation No.26, 2022).

According to Hidayat et al. (2023), there are five fundamental reasons for the need to regulate the importation of digital goods transmitted electronically. First, imposing customs duties on electronic transmissions enables customs authorities to monitor cross-border digital flows and generate reliable trade statistics. These data are essential for evidence-based policymaking, particularly in supporting e-commerce infrastructure, retail sector adjustment, and national digital capacity development. Second, the WTO moratorium creates unequal tax treatment between digital and physical goods, as only physical imports are subject to customs duties. The current tax asymmetry, caused by the moratorium on customs duties on electronic transmissions, results in discriminatory impacts on traditional businesses relative to e-commerce, and the imposition of import duties on digital goods could help restore tax neutrality and foster a fairer competitive landscape (Hidayat et al., 2023).

Third, customs duties on digital content can enhance the competitiveness of domestic creative industries and MSMEs, which often compete with large global digital platforms. A well-designed CDET policy can support local value creation and inclusive


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industrial development. Fourth, clear customs regulations for digital goods provide regulatory certainty for governments and businesses. Finally, while strengthening risk assessment related to tax evasion, intellectual property violations, and other non-economic risks associated with digital content. Enhanced customs oversight thus contributes to both fiscal sustainability and broader economic security.

One of the most prominent global policy issues arising from this transformation is the World Trade Organization (WTO) moratorium on customs duties on electronic transmissions. The moratorium restricts member countries from imposing import duties on digitally delivered products, effectively narrowing the traditional tariff base. For developing countries, where customs duties remain a significant source of government revenue, this policy has important implications for fiscal sustainability, domestic resource mobilization, and the state's capacity to support inclusive development. Consequently, the debate surrounding customs duties on electronic transmissions (CDET) is not merely a trade policy issue, but also a development concern linked to long-term fiscal resilience.

Despite growing debate on CDET and the WTO moratorium, country-specific empirical evidence quantifying potential customs duty revenue from electronically transmitted digital goods remains scarce, particularly for large developing economies such as Indonesia. This study addresses this gap by using the Indonesia Non-Tariff Measures dataset to construct a 2018–2023 panel for five HS-registered digital goods subsectors and to estimate the relationship between ET-related import volumes and customs duty revenue using a two-way fixed-effects panel regression that controls for subsectoral and temporal heterogeneity.

The novelty of this research lies in translating digitally transmitted imports into an HS-compatible empirical structure and generating a development-relevant, policy-oriented revenue estimate grounded in Indonesian administrative and statistical data. Accordingly, the purpose of this study is to assess the potential revenue implications and policy feasibility of implementing CDET in Indonesia, and to provide empirical evidence to inform ongoing discussions on digital trade governance, fiscal capacity, and the future of the WTO moratorium for developing countries.

## METHODS

Digitalization enables innovative cross-border collaboration in goods production and introduces new delivery mechanisms via digital platforms and physical devices (López, 2017). Panel data from the Ministry of Finance, the Central Bank of Indonesia, and the Central Statistics Agency (BPS) are utilized, covering current prices across five digital industry subsectors in Indonesia from 2018 to 2023. The analysis applies an econometric model at a 5 per cent significance level. Following data cleansing, 360 observations are retained five years. The dependent variable in the logarithmic equation is categorical, specifically representing the amount of CDET revenue in Indonesia.

As Indonesia has not yet implemented a CDET-type tax, actual numerical revenue from CDET is unavailable. Consequently, the value is estimated using a proxy approach based on demand-side monthly consumption data from 2018 to 2023. This period captures a significant phase of structural transformation in the digital economy, including the acceleration of cross-border digital trade during and after the COVID-19 pandemic. The selected timeframe also coincides with intensified policy debates regarding the WTO moratorium on electronic transmissions, thereby ensuring policy relevance. Restricting the sample to recent years enhances data consistency and mitigates structural bias associated with earlier periods when digital imports were minimal. The primary independent variable is import volume, defined as the volume of digital goods transmitted electronically. Data are sourced from international trade statistics under HS code 99.01, provided by the Directorate General of Customs and Excise, Ministry of Finance.

Several control variables are incorporated to evaluate the effects of economic and demographic factors within each subsector. These control variables include Foreign exchange reserves (foreignexchangereserves_idr), Per capita consumption based on goods and services expenditure (consumptionpercapita), Rupiah to USD exchange rate (exchange rate), Consumer Price Index (CPI) capture nominal valuation and inflationary effects, Population aged 15 and over by primary employment in the information and communication sector (working-age population), also Population aged 15 and over who have completed higher education at public or private universities in Indonesia (tertiary education) are included. Tertiary education serves as a proxy for human capital and digital readiness, highlighting the importance of skilled labor in facilitating digital trade. Potential CDET revenue is estimated by multiplying total household consumption expenditure by an 8 per cent CDET rate, as recommended by the AAGR (UNCTAD, 2019). The estimation formula is as follows:

$lnCDET_{ijt}$ = Σ(importvolume$_{it}$ * workingagepopulation$_{it}$ * consumptionpercapita$_{it}$ * 12 * 8%)

With the following notes,

$lnCDET_{ijt}$ : The value of potential Goods and Services Tax (GST) revenue in region *i* in year *j* and month *t*, expressed in natural logarithmic form.

importvolume$_{it}$ : The import volume of digital goods transmitted electronically is represented in natural logarithmic form.

workingagepopulation$_{it}$ : People aged 15–64 years who are employed in the Information and Communication sector as their main job.

consumptionpercapita$_{it}$ : The percentage of household per capita expenditure on goods and services categories

12 : Number of months in a year

8% : Average Annual Growth Rate


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The regression estimation model used in this study comprises two scenarios, distinguished by the application of lags to the control variables, specifically import volume and foreign exchange reserves. The rationale for Scenario (1) introduces a lag to the import volume variable as a corrective measure against endogeneity, recognizing that the dependent variable already embeds import-related dynamics. By introducing a lag, the model aims to mitigate this issue and ensure that the effects from the previous period are appropriately accounted for. Import volume in one period may influence state revenue in the following period due to administrative procedures, the collection of import duties, and the time required for revenue recording and processing.

In Scenario (2), lags are applied to both the import volume and foreign exchange reserve variables. The use of these lags enables a deeper analysis of how changes in import volumes and foreign exchange reserves affect the dependent variable over time. Foreign exchange reserves available in one period may influence import decisions in the subsequent period, as procurement processes, contracts, and transactions require time to complete (Sukarniati et al., 2023).

Based on the description above, we develop the following regression model to measure the implementation of volume import duties on digital goods through electronic transmission:

$$lnCDET_{ijt} = \beta_0 + \beta_1 \text{l.lnimportvolume}_{it} + \beta_2\, lnforeignexchangereserves\_IDR + \beta_3\, lexchange\_rate_{it} + \beta_4\, \text{lCPI}_{it} + \beta_5 tertiaryeducation_{it} + \lambda_{jt} + \varepsilon_{ijt}$$

$$lnCDET_{ijt} = \beta_0 + \beta_1 \text{l.lnimportvolume}_{it} + \beta_2\, \text{l.}lnforeignexchangereserves\_IDR_{it} + \beta_3\, lexchange\_rate_{it} + \beta_4\, \text{lCPI}_{it} + \beta_5 tertiaryeducation_{it} + \propto_i + \lambda_{jt} + \varepsilon_{ijt}$$

This equation estimates how CDET revenue responds to changes in trade, macroeconomic, and structural variables, while controlling for unobserved differences across entities and over time. Because most variables are in log form, the coefficients can be interpreted as elasticities (percentage changes), which is especially appropriate for macroeconomic modeling and development analysis and aligns well with this research focus.

## RESULTS AND DISCUSSION

The main finding of this study is that digital consumption of imported goods increases state revenue through customs receipts. This result is consistent with the empirical evidence from Bhoosan and Byanjankar (2022), who demonstrate that imposing import tariffs increases tax revenue through customs duties. The prior study highlights the uneven fiscal consequences of tariff-free electronic commerce. Mattoo and Schuknecht (2000) and Susanne (2002) argue that although the overall share of digital trade was initially small in developed economies, developing countries could experience disproportionate revenue losses due to their greater reliance on tariff income. These studies also emphasize that the fiscal impact of the moratorium extends beyond immediate tariff losses, as it interacts with structural shifts from physical to digitally delivered goods. In addition,

Khan (2023) demonstrates that the General Agreement on Trade and Services (GATS) can be implemented and interpreted wisely to comply with principles of security, privacy, and internet openness. However, much of this literature remains conceptual and does not provide country-specific empirical estimates of potential revenue implications in developing economies.

From a broader development finance perspective, empirical studies consistently show that trade taxes play a critical role in supporting government revenue and sustaining imports in developing countries. Basirat et al. (2014) found that rising import volumes contribute positively to government revenue through import-related taxes, while Epaphra (2014) demonstrates that tariff reductions significantly weaken customs revenue performance. In addition, the determinants of import demand and digital trade expansion have been widely examined in the development economics literature. Rising per capita consumption has been shown to stimulate import demand (Jin & Liu, 2000), while foreign exchange reserves and income growth help sustain imports in developing economies (Sultan, 2011; Arize & Osang, 2007).

Exchange rate movements also affect import activities, with currency depreciation often exerting contractionary effects on output and trade in developing and transition economies (Mitchell & Pentecost, 2001; Kandil, 2013). Inflationary pressures, measured by the Consumer Price Index (CPI), further constrain imports by increasing the cost of imported goods (Jamil et al., 2017; Gunawan et al., 2023; Mulyawan & Japlani, 2022). Moreover, improvements in internet penetration and demographic factors such as the working-age population are closely associated with productivity growth and digital adoption, reinforcing technology's role in shaping trade patterns and development outcomes (Koyuncu et al., 2017).

The model identifies import volume as a statistically significant determinant of CDET revenue, supporting the idea that rising digital goods consumption can provide a stable tax base. Including control variables such as foreign exchange reserves, consumer price index, and tertiary education levels shows that macroeconomic and demographic factors influence both the feasibility and scale of potential CDET revenue. Table 2 reports the estimated parameters under two model scenarios. In Scenario (1), import volume is the main determinant of potential CDET revenue, where a one per cent increase in import volume raises CDET revenue by 0.397 per cent and is statistically significant at the one per cent level. This result suggests a structural linkage between digital customs revenue and the scale of cross-border trade.

Foreign exchange reserves are positively and significantly associated with CDET revenue, with a one-unit increase raising revenue by 0.458 per cent, indicating that macroeconomic stability and external liquidity support CDET's digital import capacity and fiscal base. In contrast, the exchange rate shows a negative, though statistically insignificant, effect, suggesting that currency volatility is not a key determinant of digital customs revenue in Indonesia. This result aligns with theoretical and empirical evidence that inflation, proxied by the CPI, dampens import demand


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and consequently reduces customs revenue (Mulyawan & Japlani, 2022). Overall, the model demonstrates strong explanatory power with an adjusted R-squared of 0.657, indicating that approximately 65.7 per cent of the variation in CDET revenue is explained by the included variables. This result supports the robustness of the econometric specification. It provides empirical backing for policy discussions on the fiscal implications of lifting the WTO moratorium on electronic transmissions in a developing country.

**Table 2. Estimation Result of the Implementation of Import Duties on Digital Goods through Electronical Transmission**

| **Variable** | | |
|---|---|---|
| **ln_CDET_8 (dependent variable)** | **(1)** | **(2)** |
| ln_importvolume | | |
| l.ln_importvolume | 0.397*** | 0.661*** |
| ln_foreignexchangereserves_idr | (0.061)<br>0.458*** | (0.073) |
| | (0.060) | |
| l.ln_foreignexchangereserves_idr | | -0.059** |
| | | (0.027) |
| ln_exchange_rate | -5.113 | 0.358 |
| | (10.011) | (11.359) |
| ln_cpi | -4.380 | -1.687 |
| | (3.437) | (3.939) |
| Tertiary education | 0.308 | 1.076** |
| | (0.446) | (0.506) |
| _cons | 12.830 | -0.965 |
| | (25.835) | (29.351) |
| Observations | 360 | 360 |
| Within R-square | 0.6970 | 0.6080 |
| Adjusted R-square | 0.6570 | 0.5560 |

*** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimation

In Scenario (2), the model yields a within R-squared of 0.608, indicating that over sixty percent of the observed variation in CDET revenue. Notably, this specification introduces import volume and foreign exchange reserves with a one-period lag, reflecting the hypothesis that shifts in trade activity and macroeconomic conditions may influence digital customs revenue with a lag rather than an immediate effect. The results show that lagged import volume remains positive, suggesting that increases in import activity persistently affect potential CDET revenue in the subsequent period. This finding

reinforces the robustness of import volume as a key determinant of digital customs revenue. In contrast, lagged foreign exchange reserves display a statistically significant negative association at the 5 percent level. This divergence from standard theory indicates short-term adjustment processes, policy interventions, or latent structural characteristics of digital trade that the current model specification fails to capture. A similar departure is observed in the signs of the exchange rate and CPI coefficients, both of which challenge conventional theoretical priors.

These outcomes indicate that while the lagged specification introduces some intertemporal nuance, the interplay between macroeconomic indicators and CDET revenue is likely better than static theoretical models anticipate. This result underscores the need for further methodological refinement, including the integration of additional structural and digital-economy variables to more adequately elucidate the underlying economic mechanisms.

## CONCLUSIONS

Based on the results, this study concludes that Indonesia has considerable potential to increase state revenue by implementing Customs Duties on Electronic Transmissions (CDET). The analysis indicates that digitally transmitted imports across five subsectors—films/movies, printed matter (books), sound and media, software, and video games—are statistically significant and positively associated with economic outcomes, supporting Indonesia's position on digital trade governance and discussions to lift the WTO moratorium. Overall, CDET implementation appears feasible and potentially revenue-enhancing, with estimated additional annual revenue of approximately IDR 18.58 billion.

Accordingly, the government is advised to review relevant domestic and international frameworks to guide tariff design, clearly define taxable subjects, and introduce targeted incentives for domestic digital industries. In parallel, investments in digital infrastructure and strengthened coordination with stakeholders are necessary to support effective implementation, along with enhanced cyber oversight to address existing monitoring constraints.

## REFERENCES

Andrenelli, A., & Gonzalez, J. (2023). Understanding The Potential Scope, Definition, and Impact of The WTO E-Commerce Moratorium. *OECD Trade Policy Paper*.

Basirat, M., Aboodi, F., & Ahangari, A. (2014). Analyzing the Effect of Economic Variables on Total Tax Revenues in Iran. *Asian Economic and Financial Review, 4*(6), 755–767.

Directorate General of Customs and Excise. (2022). *Provisions of the 2022 Indonesian Customs Tariff Book*. Jakarta: Ministry of Finance, Republic of Indonesia.

Directorate General of Customs and Excise. (2023). *International Standards in E-Commerce*


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.49744

*Trade & The Development of Import Duty Issues on Digital Goods in International Forums*. Jakarta: Ministry of Finance, Republic of Indonesia.

Directorate General of Customs and Excise. (2024). *Statistics of Digital Goods Importation (HS 99.01) After The Implementation Of The Mof Regulation 190/2022*. Jakarta: Ministry of Finance, Republic of Indonesia.

Hidayat, A., Nainggolan, Y. A. S. U., & Pamutra, G. R. (2023). Indonesia's Perspective on World Trade Organization (WTO) Moratorium on Customs Duties on Electronic Transmission: A Brief Review of Literature. *Jurnal Pajak dan Keuangan Negara (PKN), 4*(2), 462–467. https://doi.org/10.31092/jpkn.v4i2.1907.

International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations Conference on Trade and Development, & World Trade Organization. (2023). *Handbook on Measuring Digital Trade* (2nd ed.). Paris: OECD Publishing

Jin, M., & Liu, M. (2020). Structural and Regional Research on Per Capita Consumption Expenditure of Urban Residents in China. *Proceedings of the International Conference on Financial Economics and Investment Management 2020.*

Khan, A. (2023). Rules on Digital Trade in the Light of WTO Agreements. *(Unpublished Dissertation).* School of Law, Zhengzhou University China.

Koyuncu, J. Y., Yılmaz, R., & Yıldırım, S. (2017). Internet Penetration and Productivity: A Panel Study. *Anadolu University Journal of Social Sciences, 17*(1), 59–66.

López González, J., & Jouanjean, M. (2017). Digital Trade: Developing Framework for Analysis. *OECD Trade Policy Papers*. No. 205. OECD Publishing.

Meltzer, J. P. (2019). Governing Digital Trade. *World Trade Review*. *18*(S1), S23-S48. https://doi.org/10.1017/S1474745618000502.

Mitchell, A., & Pentecost, E. J. (2021). The Real Exchange Rate and the Output Response in Four Transition Economies: A Panel Data Study. In: Papazoglou, C., & Pentecost, E. J. (Eds). *Exchange Rate Policies, Prices, and Supply-Side Response.* London: Palgrave Macmillan.

Mulyawan, D., & Japlani, A. (2022). Pengaruh Ekspor, Impor dan Indeks Harga Konsumen (IHK) Terhadap Produk Domestik Regional Bruto (PDRB) Provinsi Lampung. *Jurnal Manajemen Diversifikasi, 2*(1), 48–58.

OECD. (2019). *Going Digital: Shaping Policies, Improving Lives***.** Paris: OECD Publishing.

Sukarniati, L., Widara, W., & Asmara, G. D. (2025). The Influence of Macroeconomic Indicators on Foreign Exchange Reserves in Indonesia. *Journal of Economics Research and Social Sciences*, *9*(2), 165–183. https://doi.org/10.18196/jerss.v9i2.24447.

United Nations Conference on Trade and Development. (2019). Digital Economy Report 2019: Value Creation and Capture—Implications for Developing Countries. Washington, D.C.: United Nations.

Wahyudi, I. T. & Firdiansyah, A. (2019). A Perspective on Imposing Duty on Digital Goods in Indonesia. *Customs Research and Application Journal*, *1*(1), 64-77. https://doi.org/10.31092/craj.v1i1.21.

World Trade Organization. (2023). *Digital Trade for Development*. Geneva: World Trade Organization.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Impact of the Family Hope Program on Cognitive Outcomes in Poor Rural Indonesia

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## ABSTRACT

**Research Originality:** This article assesses the impact of Indonesia's Family Hope Program (PKH) using a composite cognitive score rather than single test scores and jointly analyzing additional outcomes (Body Mass Index and the Early Development Instrument), which previous conditional cash transfer evaluations have not examined together.

**Research Objectives:** The study examines whether PKH improves cognitive outcomes among primary school children aged 6–9 years in poor rural areas of Indonesia.

**Research Method:** The analysis uses 2013 ECED survey data about 11,183 children aged 6–9 years and employs propensity score matching to address selection bias using observational data.

**Empirical Results:** PKH has no statistically significant effect on any cognitive test score or the composite index, and does not improve Body Mass Index. However, it has small positive effects on Early Development Instrument scores for language and cognitive development, especially basic literacy and numeracy.

**Implications:** The findings indicate that investments in school quality, early-childhood education, home learning resources, and nutrition should complement PKH.

**Keywords:**

cognitive outcome; conditional cash transfer; early development instrument; family hope program (PKH); propensity score matching

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## INTRODUCTION

Conditional cash transfer (CCT) programs are social protection policies typically provided to poor households with pregnant mothers, young children, or school-aged children. They are conditioned on beneficiaries fulfilling requirements such as regular health check-ups and school attendance (Evans et al., 2019; Marx, 2023; Sanchez et al., 2016). These conditions are designed to encourage early investment in children's health, nutrition, and education, which accumulates over the life cycle and is expected to break the intergenerational transmission of poverty (Cahyadi et al., 2020). Examining whether CCTs actually improve children's cognitive outcomes is crucial because cognitive outcomes are strong predictors of both educational success and economic well-being in adulthood (Heckman et al., 2006).

Indonesia has implemented CCTs through the Family Hope Program (PKH) since 2007. PKH targets poor households and links cash benefits to the utilization of health and education services. Previous research on PKH has focused on its impact on consumption, vaccination coverage, children's physical growth, and school attendance rates (Cahyadi et al., 2020; Kusuma, McConnell, et al., 2017; Kusuma, Thabrany, et al., 2017). However, evidence regarding whether PKH improves children's cognitive achievement remains scarce, particularly for children enrolled in primary school. This question is especially relevant for Indonesia, where low foundational skills among early-grade students remain a major policy concern. At the same time, PKH continues to absorb a substantial share of the social protection budget and is often justified as an investment in human capital.

Previous research on the impact of CCTs on children's cognitive outcomes generally relies on single test scores as outcomes, including math and language scores (Marx, 2023; Ponce & Bedi, 2010; Zhou et al., 2020). Some of these studies report positive but modest gains in test scores among beneficiary children (Garcia & Hill, 2010; Marx, 2023), while others find no clear improvement in general cognitive ability despite better nutrition or health (Sanchez et al., 2016). In addition, very few evaluations jointly consider cognitive achievement and other dimensions of child development, such as nutritional status or school readiness, even though CCTs are expected to influence multiple aspects of child well-being. This study addresses these limitations by using a more integrative measure of cognitive outcomes and complementing it with additional indicators of child development. First, instead of focusing solely on single test scores, we construct a composite cognitive score as the average of test scores in Bahasa Indonesia, mathematics, and abstract reasoning. Each domain is scaled from 0 to 100, standardized to z-scores, and the composite score summarizes overall cognitive performance across subjects. The use of a composite cognitive measure is motivated by evidence that average scores across domains can predict adult outcomes more strongly than any single test score alone (Watts, 2020). It also reflects educational practices in Indonesia in 2013, when graduation and selection into higher levels of schooling relied on average scores across several subjects. Thus, an integrative indicator is arguably more relevant for capturing children's human capital.


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Second, in addition to cognitive test scores, we analyze the impact of PKH on Body Mass Index (BMI) and Early Development Instrument (EDI) scores, specifically the language and cognitive development domain and its subdomains. BMI captures children's nutritional status, which is a key intermediate channel through which CCTs may affect cognitive development. EDI indicators reported by caregivers provide information on children's readiness to learn, including basic literacy, interest in books and numbers, memory, advanced literacy, and basic numeracy skills. They are thus closely related to later cognitive achievement in school. Combining these outcomes paints a broader picture of how PKH may shape multiple, interconnected aspects of child development than cognitive test scores alone.

Third, the analysis focuses on poor rural districts in Indonesia, using data from the 2013 Early Childhood Education and Development (ECED) survey, which covers 310 villages across nine districts in nine provinces. All sampled villages were rural areas classified as underdeveloped and with high poverty rates. Studying PKH in these disadvantaged rural contexts is important to understand whether CCTs can effectively support children's learning in areas where households face multiple deprivations and local education systems may be constrained by limited infrastructure and teacher supply.

This study addresses three related gaps in the literature. First, existing PKH evaluations in Indonesia focus on consumption, health, and schooling indicators and do not examine children's cognitive test scores, particularly for primary-school children in poor rural areas. Second, CCT studies of cognitive outcomes rely primarily on single test scores. In contrast, we employ a composite cognitive score that captures multiple domains and better aligns with how educational success is defined in practice. Third, the literature rarely examines cognitive achievement alongside BMI and EDI measures of school readiness, limiting our understanding of the broader developmental pathways through which CCTs may operate. To fill these gaps, this study examines the impact of PKH on (i) Bahasa Indonesia, mathematics, abstract reasoning, and composite cognitive scores, (ii) children's BMI, and (iii) EDI language and cognitive development outcomes for elementary school children aged 6–9 years and living in poor rural Indonesia, using propensity score matching to address selection bias.

## METHODS

This study uses cross-sectional data from the 2013 ECED survey, administered in 310 poor rural villages across 9 districts in 9 provinces. The ECED survey collected detailed information on children's schooling, cognitive achievement, anthropometric measures, early development, and household socioeconomic characteristics in low-income rural communities. We restricted the sample to children aged 6–9 years who were enrolled in primary school at the time of the survey. PKH participation is not randomly assigned in the ECED sample. The program targets poor and vulnerable households using a combination of proxy means testing and eligibility criteria related to the presence of pregnant women, young children, and school-aged children. As a result, children in

PKH-recipient households differ systematically from children in non-recipient households, and simple comparisons of mean outcomes, even with regression adjustments, are likely to be biased. To address this selection problem, we employed propensity score matching (PSM) to estimate the average treatment effect on the treated (ATT) (Rosenbaum & Rubin, 1983). PSM summarizes a household's characteristics into a single propensity score, which indicates the predicted probability that a child's household receives PKH. This measurement allows matching treated children with observationally similar untreated children based on comparable propensity scores. Under the assumptions of conditional independence and common support, PSM can reduce selection bias and approximate the counterfactual outcomes that treated children would have experienced in the absence of the program.

First, we estimated each child's propensity score using a logistic regression of the treatment variable (PKH participation) on a set of covariates that plausibly affect both program eligibility and child outcomes. The treatment variable is a binary indicator at the child level, equal to 1 if the household reported ever receiving PKH benefits and 0 otherwise. The covariates affecting both program eligibility and child outcomes include the child's age (Baker, 2016; Gemellia & Wongkaren, 2021) and gender (Baker, 2016), the head of household's level of education (Choi & Min, 2024; Garcia & Hill, 2010), age (Garcia & Hill, 2010), and gender (Ponce & Bedi, 2010), whether the mother was working (Gemellia & Wongkaren, 2021), the number of children in the household (Becker, 1962), a wealth index constructed using principal component analysis of asset ownership and housing characteristics (Jeffery et al., 2020; Sanchez et al., 2016), and regional characteristics, namely, a dummy variable distinguishing Western from Eastern Indonesia (Garcia & Hill, 2010).

Second, we used the estimated propensity scores to match treated and untreated children. Several matching algorithms were applied, including nearest-neighbor matching, kernel matching, and radius matching with different calipers. We assessed the quality of matching by examining the reduction in standardized bias and the balance of each covariate after matching. The final specification relies on radius matching with a narrow caliper, which provided the best overall balance across covariates.

After constructing the matched sample, we estimated the impact of PKH on children's outcomes. The first group of outcomes captures children's cognitive achievement. In the ECED survey, children completed standardized tests in Bahasa Indonesia, mathematics, and abstract reasoning. The Bahasa Indonesia and mathematics tests were developed based on the national early primary school curriculum, while abstract reasoning was assessed using Raven's Colored Progressive Matrices. Two versions of the test were administered: a short version for children aged 6–7 years and a longer version for those aged 8–9 years. For analysis, only the 38 items present in both versions were used. Raw scores on each test were rescaled to a 0–100 range and then standardized into z-scores using the mean and standard deviation of scores for 6-year-old children in the sample. The composite cognitive score is the average of the three domain scores and ranges from 0 to 100. All cognitive outcomes were then standardized into


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z-scores using the mean and standard deviation of cognitive scores among 6-year-old children.

The second outcome is children's nutritional status, represented by BMI, calculated as body weight (in kilograms) divided by the square of height (in meters). The third group of outcomes is based on the Early Development Instrument (EDI) language and cognitive development domain, as reported by caregivers. This domain aggregates items from four subdomains: basic literacy, interest in books and numbers, having a good memory, and advanced literacy and basic numeracy skills. We used the overall domain score and four subdomain scores, each ranging from 0 to 10, with higher values indicating better school readiness. Analyzing cognitive test scores, BMI, and EDI indicators together enabled us to assess not only narrow test-based skills but also the broader developmental environment in which those skills are formed.

## RESULTS AND DISCUSSION

The sample derived from the 2013 ECED survey comprised 11,183 children aged 6–9 years. Among them, only 603 children (5.4%) lived in households that had received PKH. Table 1 presents summary statistics for all the variables used in the analysis. All cognitive outcomes were presented in z-scores, calculated using the mean and standard deviation of the test scores of 6-year-old children. The mean values of all cognitive outcomes were positive, indicating that, on average, the children aged 6–9 years in the sample performed better than 6-year-olds. The sample children had an average BMI of 14.275, which corresponds to the underweight category according to World Health Organization standards, reflecting generally poor nutritional status in these high-poverty rural areas. In contrast, average EDI scores were relatively high, ranging from 8.390 to 9.451 on a 0–10 scale, suggesting that many children displayed relatively strong language and cognitive development according to caregiver reports.

The average age of children in the sample was 7.63 years, with a gender distribution of 50.9% male and 49.1% female. Heads of household were on average 40.88 years old and had completed 7.55 years of schooling, with the majority being male (91.8%). The average number of children per household was 2.23. The wealth index was presented as a z-score with a mean of 0 and a standard deviation of 1. Approximately 51.3% of the children resided in the Western Region of Indonesia and 48.7% in the Eastern Region.

The first step of the PSM method is to estimate the propensity score, defined as the probability that the household where the child lives is a PKH recipient. A logit model was estimated with PKH participation as the dependent variable and a set of observable covariates reflecting child, household, socioeconomic, and regional characteristics as regressors.

**Table 1. Summary of Descriptive Statistics**

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Dependent variables** | | | | | |
| Bahasa Indonesia skills | 11,183 | 0.787 | 1.069 | -1.399 | 1.987 |
| Mathematics skills | 11,183 | 0.480 | 0.982 | -1.610 | 1.672 |
| Abstract reasoning skills | 11,183 | 0.712 | 1.132 | -1.615 | 2.870 |
| Composite cognitive skills | 11,183 | 0.796 | 1.117 | -1.871 | 2.571 |
| Body Mass Index | 11,004 | 14.275 | 1.755 | 4.401 | 30.755 |
| EDI/Language and cognitive development | 8,758 | 9.150 | 1.574 | 0 | 10 |
| EDI/Basic literacy skills | 8,994 | 9.451 | 1.424 | 0 | 10 |
| EDI/Interest in books, numbers, and good memory | 8,915 | 9.373 | 1.570 | 0 | 10 |
| EDI/Advanced literacy skills | 8,986 | 8.390 | 2.866 | 0 | 10 |
| EDI/Basic numeracy skills | 8,933 | 9.236 | 1.669 | 0 | 10 |
| **Independent variable** | | | | | |
| PKH | 11,183 | 0.054 | 0.226 | 0 | 1 |
| **Control variables** | | | | | |
| Child's age | 11,183 | 7.633 | 0.921 | 6 | 9 |
| Child's gender | 11,183 | 0.509 | 0.499 | 0 | 1 |
| Head of household's years of schooling | 11,183 | 7.549 | 4.181 | 0 | 20 |
| Head of household's age | 11,183 | 40.875 | 9.219 | 16 | 64 |
| Head of household's gender | 11,179 | 0.918 | 0.273 | 0 | 1 |
| Total number of children in the household | 11,183 | 2.229 | 1.193 | 0 | 10 |
| Working mother | 10,734 | 0.406 | 0.491 | 0 | 1 |
| Wealth index | 11,183 | 0 | 1 | -2.835 | 2.599 |
| Regional classification | 11,183 | 0.513 | 0.499 | 0 | 1 |

Source: ECED Survey 2013, processed by the author.

The results presented in Table 2 indicate that most covariates significantly influenced the likelihood of being a PKH recipient. The estimation results suggest that increases in the child's age and the number of children in the household, as well as having a working mother and residing in the Western region of Indonesia, raised the likelihood of households being PKH recipients by 12%, 51.7%, 22.5%, and 57.8%, respectively. Meanwhile, higher levels of schooling among the household head and a higher wealth index reduced the probability of receiving PKH by 5.1% and 43.9%, respectively.

For the PSM estimates to be credible, each treated observation must have comparable control observations within the region of common support. Table 3 summarizes the common support evaluation for several matching algorithms: nearest neighbor matching with one, five, and ten neighbors [NN(1), NN(5), NN(10)], kernel matching with bandwidth 0.06 and 0.03 [Kernel (0.06), Kernel (0.03)], and radius matching with calipers 0.10, 0.05, and 0.01 [Radius (0.1), Radius (0.05), Radius (0.01)].


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**Table 2. Logit Estimation of the Probability of a Child's Household Being a PKH Recipient**

| Variable | Coef. | S.E. | Odds Ratio | p>\|z\| |
|---|---|---|---|---|
| Child's age | 0.114 | 0.048 | 1.12 | 0.018** |
| Child's gender | -0.052 | 0.087 | 0.949 | 0.551 |
| Head of household's years of schooling | -0.053 | 0.013 | 0.949 | 0.000*** |
| Head of household's age | -0.001 | 0.005 | 0.999 | 0.872 |
| Head of household's gender | -0.143 | 0.141 | 0.866 | 0.311 |
| Total number of children in household | 0.417 | 0.089 | 1.517 | 0.000*** |
| Working mother | 0.203 | 0.031 | 1.225 | 0.000*** |
| Wealth index | -0.561 | 0.053 | 0.571 | 0.000*** |
| Regional classification | 0.456 | 0.094 | 1.578 | 0.000*** |
| Constant | -4.255 | 0.448 | 0.014 | 0.000*** |
| **Observations:** 10,730 | | | | |
| **Pseudo $R^2$:** 0.0703 | | | | |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

The results show that, in general, common support was adequate across all algorithms. Using the nearest-neighbor matching algorithm, all observations fell within the common support. For kernel and radius matching, some observations were off support, but their number was very small; therefore, the condition of sufficient common support was met.

**Table 3. Common Support Evaluation Results**

| Algorithm | On support | | Off support | | Matched | |
|---|---|---|---|---|---|---|
| | Treatment | Control | Treatment | Control | Treatment | Control |
| NN(1) | 581 | 10,149 | 0 | 0 | 0 | 530 |
| NN(5) | 581 | 10,149 | 0 | 0 | 0 | 2,264 |
| NN(10) | 581 | 10,149 | 0 | 0 | 0 | 3,792 |
| Kernel (0.06) | 581 | 10,143 | 0 | 6 | 0 | 10,143 |
| Kernel (0.03) | 581 | 10,133 | 0 | 16 | 0 | 10,133 |
| Radius (0.1) | 581 | 10,147 | 0 | 2 | 0 | 10,147 |
| Radius (0.05) | 581 | 10,140 | 0 | 9 | 0 | 10,140 |
| Radius (0.01) | 581 | 10,128 | 0 | 21 | 0 | 10,128 |

Source: ECED Survey 2013, processed by the author.

The next step was to assess the quality of matching. To this end, we examined the reduction in overall standardized bias and the balance of each covariate before and after matching. A covariate is considered balanced if the difference in means between the treatment and control groups is not statistically significant based on the t-test.

As shown in Table 4, the matching process successfully reduced bias between groups. The mean standardized bias across covariates before matching (23.7%) was substantially

reduced after matching, ranging from 1.2% to 18.0% across algorithms. However, several algorithms (kernel matching with a bandwidth of 0.06 and radius matching with calipers of 0.1 and 0.05) still showed significant differences between some covariates after matching, indicating incomplete balance. Therefore, the estimated ATT is not reported. Radius matching with calipers of 0.01 provided the best performance, reducing the mean and median biases to 1.2% and 0.7%, respectively, and balancing all covariates between the treated and control groups. Consequently, ATT estimates based on a Radius (0.01) specification were used as the preferred specification, while results from nearest-neighbor matching and a Kernel (0.03) specification served as robustness checks.

**Table 4. Matching Quality Test Results**

| Algorithm | Before matching (%) | | After matching (%) | | Bias reduction (%) | | Description |
|---|---|---|---|---|---|---|---|
| | Mean bias | Med bias | Mean bias | Med bias | Mean bias | Med bias | |
| NN(1) | 23.7 | 14 | 3.8 | 3.5 | 83.97 | 75.00 | All covariates are balanced. |
| NN(5) | 23.7 | 14 | 2.2 | 1.7 | 90.72 | 87.86 | All covariates are balanced. |
| NN(10) | 23.7 | 14 | 1.9 | 1.3 | 91.98 | 90.71 | All covariates are balanced. |
| Kernel (0.06) | 23.7 | 14 | 8.7 | 5.1 | 63.29 | 63.57 | The covariates of the head of household's years of schooling, working mother, number of children in the household, and wealth index still show significant differences. |
| Kernel (0.03) | 23.7 | 14 | 3.3 | 2.5 | 86.08 | 82.14 | All covariates are balanced. |
| Radius (0.1) | 23.7 | 14 | 18 | 10.3 | 24.05 | 26.43 | The covariates of the child's age, head of household's years of schooling, head of household's gender, working mother, number of children, and wealth index still show significant differences. |
| Radius (0.05) | 23.7 | 14 | 9.6 | 5.6 | 59.49 | 60.00 | The covariates of the head of household's years of schooling, working mother, number of children in the household, and wealth index still show significant differences. |
| Radius (0.01) | 23.7 | 14 | 1.2 | 0.7 | 94.94 | 95.00 | All covariates are balanced. |

Source: ECED Survey 2013, processed by the author.

Table 5 presents ATT estimates of PKH using various matching algorithms for the four cognitive outcomes: composite cognitive score, Bahasa Indonesia skills, mathematics skills, and abstract reasoning. Across all algorithms, the estimated ATT values were small, negative, and statistically insignificant, with t-statistics below 1.645 (i.e., the significance threshold at a 90% confidence level). According to these findings, there was no statistically significant difference in cognitive test scores between children from PKH-recipient and non-recipient households, even after balancing observable characteristics using PSM.


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**Table 5. Estimated ATT of PKH on Cognitive Outcomes Using PSM**

| Algorithm | Obs. | Composite cognitive | | Bahasa Indonesia | | Mathematics | | Abstract reasoning | |
|---|---|---|---|---|---|---|---|---|---|
| | | ATT (S.E) | t-stat | ATT (S.E) | t-stat | ATT (S.E) | t-stat | ATT (S.E) | t-stat |
| NN(1) | 1,085 | -0.061 (0.070) | -1.3 | -0.036 (0.068) | -0.54 | -0.027 (0.062) | -0.45 | -0.100 (0.069) | -1.45 |
| NN(5) | 2,845 | -0.050 (0.055) | -0.96 | -0.020 (0.052) | -0.39 | -0.038 (0.049) | -0.78 | -0.073 (0.055) | -1.31 |
| NN(10) | 4,373 | -0.049 (0.053) | -1.07 | -0.028 (0.050) | -0.56 | -0.040 (0.047) | -0.86 | -0.055 (0.053) | -1.03 |
| Kernel (0.03) | 10,714 | -0.066 (0.050) | -1.44 | -0.046 (0.047) | -0.97 | -0.059 (0.044) | -1.34 | -0.059 (0.051) | -1.16 |
| Radius (0.01) | 10,709 | -0.050 (0.050) | -1.11 | -0.032 (0.048) | -0.67 | -0.046 (0.045) | -1.03 | -0.048 (0.051) | -0.94 |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

The absence of significant effects on cognitive outcomes is broadly in line with the mixed evidence on the educational impacts of CCTs documented in recent literature. Meta-analyses and reviews indicate that although CCTs often improve school enrolment and attendance, their effects on learning outcomes are generally smaller and more heterogeneous, especially in disadvantaged settings (Evans et al., 2023; García & Saavedra, 2017; Millán et al., 2019). Some recent studies document modest gains in specific test scores, but many find no clear impact on cognitive performance, especially when school quality is low and baseline learning levels are weak. In Indonesia, previous evaluations of PKH have shown positive effects on school participation and reductions in child labor (Cahyadi et al., 2020), but standardized cognitive test scores have not been specifically examined. The present study adds to this literature by showing that in poor rural districts, PKH does not lead to measurable improvements in cognitive achievement at ages 6–9, even though it effectively targets disadvantaged households.

To understand why PKH does not translate into better cognitive test scores, it is crucial to consider differences in household conditions between PKH-recipient and non-recipient children, the school environment, and the impact of PKH on nutritional status (BMI) and EDI outcomes. Table 6 compares household socioeconomic characteristics by PKH status. Children from PKH lived in systematically more disadvantaged environments. The heads of household in PKH families had, on average, 1.85 fewer years of schooling than those in non-PKH households and were less likely to have completed basic education. PKH households were also more likely to be headed by women and to have working mothers, while their wealth index was significantly lower. These factors imply that the PKH children grew up in households with tighter financial and time constraints and a more limited capacity to provide cognitively stimulating inputs and educational support. This is consistent with findings in low- and middle-income countries indicating that differences in parental education, household wealth, and early nutritional risks are associated with sizeable disparities in children's cognitive development (Sania et al., 2019).

**Table 6. Household and Socioeconomic Characteristics by PKH Participation Status**

| Variable | Non-PKH | | | PKH | | | t-stat/ chi-square |
|---|---|---|---|---|---|---|---|
| | Obs. | Mean | Std. Dev. | Obs. | Mean | Std Dev. | |
| Head of household's years of schooling | 10,580 | 7.650 | 4.183 | 603 | 5.799 | 3.741 | 0.000*** |
| Head of household's gender | 10,576 | 0.921 | 0.270 | 603 | 0.881 | 0.325 | 0.000*** |
| Working mother | 10,153 | 0.399 | 0.490 | 581 | 0.528 | 0.500 | 0.001*** |
| Wealth index | 10,580 | 0.033 | 1.000 | 603 | -0.578 | 0.796 | 0.000*** |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

**Table 7. Household Book Ownership by PKH Participation Status**

| Variable | Non-PKH | | PKH | | Diff. | t-stat/ chi-square |
|---|---|---|---|---|---|---|
| | Obs. | Mean | Obs. | Mean | | |
| Owns at least one book | 10,566 | 74.03% | 603 | 61.36% | 12.67% | 0.000*** |
| Owns more than 10 books | 10,566 | 8.47% | 603 | 3.48% | 4.99% | 0.000*** |
| Owns more than 15 books | 10,566 | 5.17% | 603 | 1.49% | 3.67% | 0.000*** |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author

The pattern of household investment in learning materials further reinforced this conclusion. Table 7 shows that PKH households were less likely than non-PKH households to own books. Only about 61% of PKH households owned at least one book, compared with 74% of non-PKH households. The gap was only wider for larger numbers of books. These differences were statistically significant at the 1% level. In this context, even with the additional income from PKH, many beneficiary households may still prioritize basic consumption needs and school-related expenses (such as uniforms and transportation) over investments in books and other educational materials, limiting the potential of the transfer to improve cognitive outcomes.

**Table 8. Educational Facilities and Infrastructure per School at the District and Provincial Levels (Academic Year 2024/2025)**

| District | Classrooms/School | | Libraries/School | | Laboratories/School | |
|---|---|---|---|---|---|---|
| | District | Province | District | Province | District | Province |
| East Lampung | 5.480 | 5.962 | 0.411 | 0.472 | 0.349 | 0.413 |
| North Bengkulu | 5.573 | 5.617 | 0.485 | 0.526 | 0.379 | 0.411 |
| Sarolangun | 3.943 | 5.154 | 0.358 | 0.449 | 0.208 | 0.317 |
| Majalengka | 5.723 | 5.862 | 0.344 | 0.405 | 0.248 | 0.381 |
| Rembang | 4.694 | 5.495 | 0.377 | 0.462 | 0.295 | 0.409 |
| Kulon Progo | 3.795 | 4.941 | 0.472 | 0.521 | 0.376 | 0.545 |
| Sidenreng Rappang | 5.884 | 5.772 | 0.574 | 0.550 | 0.363 | 0.384 |
| Ketapang | 5.252 | 5.487 | 0.494 | 0.557 | 0.314 | 0.359 |
| Middle Lombok | 4.415 | 4.761 | 0.385 | 0.395 | 0.194 | 0.260 |

Source: Basic Education Data, Ministry of Education and Culture, processed by the author.


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School takes on an increasingly important role in shaping children's cognitive skills relative to parental investment at home between ages 6 and 9 (Wang et al., 2023). PKH requires school-age children to attend a minimum of 85% of effective learning days, thereby increasing enrolment and attendance. However, being physically present at school does not necessarily imply exposure to effective learning. The quality of school infrastructure and teachers is crucial in determining whether increased attendance leads to better learning outcomes.

Table 8 compares the average number of classrooms, libraries, and laboratories per primary school in the sample districts with provincial averages for the 2024/2025 academic year. The nine sample districts were classified as underdeveloped areas by the Ministry of Development of Underdeveloped Regions, and this was reflected in their educational infrastructure. In most districts, the average number of classrooms, libraries, and laboratories per school was lower than the corresponding provincial averages, with only a few exceptions. Given that these figures are based on recent data, it is likely that the infrastructure gaps were even larger in 2013, when the ECED survey was conducted, before efforts to reduce regional disparities in basic education began.

Teacher availability was similarly constrained. Table 9 shows that most sample districts had fewer teachers per school than provincial and national averages, leading to larger classes and heavier workloads, especially when PKH encourages additional enrolment. In such conditions, teachers may struggle to provide sufficient attention and support to all students, and opportunities for active learning and practice may be limited. The role of teachers is particularly critical in low- and middle-income countries, where many students have few alternative learning opportunities outside school due to low household income (Sanfo, 2024). Yet, recent evidence indicates that higher teaching quality alone is insufficient to close learning gaps, as students from higher socioeconomic backgrounds tend to benefit more in the absence of comparable instructional support for disadvantaged peers (Atlay et al., 2019). In some settings, large declines in dropout have led to larger, more heterogeneous classes, with adverse effects on test scores (Gazeaud & Ricard, 2024). In low-resource settings, enrolling more children in school without simultaneously improving school quality often fails to produce meaningful gains in learning (García & Saavedra, 2017; Millán et al., 2019). These findings show that, in the absence of parallel supply-side improvements, CCTs risk straining limited school resources and having only a modest impact on learning.

Overall, the limited school infrastructure and the shortage of teachers in the sample districts mean that higher attendance induced by PKH did not automatically translate into higher-quality learning. Without adequate classrooms, libraries, laboratories, and teaching staff, students' exposure to effective instruction and learning resources remained constrained. This likely contributed to the absence of significant impacts of PKH on cognitive test scores in this study, despite its success in encouraging school participation.

The age range of 6–9 years covered by the study corresponds to early primary school, when children build on skills acquired earlier in life. A growing body of evidence indicates that early-childhood education has high returns and complements later educational investments (Cunha & Heckman, 2007). In Indonesia, early-childhood education, such as attending kindergartens (TK and RA), can lay important foundations for later learning,

particularly for children from poor households. To explore the role of early-childhood education within the PKH context, this study compared the cognitive outcomes of PKH and non-PKH children based on their participation in TK/RA (Table 10).

**Table 9. Number of Teachers per Primary School in Sample Districts, Provincial, and National Levels (Academic Year 2024/2025)**

| District | Teachers/School | | |
|---|---|---|---|
| | District | Province | National |
| East Lampung | 9.97 | 11.36 | 10.11 |
| North Bengkulu | 10.67 | 11.61 | 10.11 |
| Sarolangun | 10.27 | 11.08 | 10.11 |
| Majalengka | 9.40 | 10.15 | 10.11 |
| Rembang | 8.12 | 8.15 | 10.11 |
| Kulon Progo | 8.10 | 10.03 | 10.11 |
| Sidenreng Rappang | 9.10 | 10.12 | 10.11 |
| Ketapang | 8.67 | 8.41 | 10.11 |
| Middle Lombok | 10.00 | 13.06 | 10.11 |

Source: Basic Education Data, Ministry of Education and Culture, processed by the author.

**Table 10. Cognitive Outcomes of PKH Beneficiary Children by Participation in Kindergarten or Raudatul Athfal**

| Variable | Non-TK/RA | | | | TK/RA | | | |
|---|---|---|---|---|---|---|---|---|
| | PKH | Non-PKH | Diff. | t-stat | PKH | Non-PKH | Diff. | t-stat |
| Bahasa Indonesia | 0.431 | 0.571 | -0.140 | 2.2** | 0.868 | 0.967 | -0.099 | 1.6 |
| Mathematics | 0.053 | 0.249 | -0.196 | 3.4*** | 0.557 | 0.679 | -0.122 | 2.2** |
| Abstract reasoning | 0.354 | 0.510 | -0.156 | 2.4** | 0.742 | 0.890 | -0.148 | 2.2** |
| Composite cognitive | 0.329 | 0.531 | -0.201 | 3.1*** | 0.876 | 1.023 | -0.147 | 2.3** |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

The results indicate that children who attended TK/RA had higher cognitive scores than those who did not, regardless of PKH status. Among children who did not attend TK/RA, PKH beneficiaries performed significantly worse than non-PKH children, with cognitive gaps of around 0.20 standard deviations in composite scores and similar magnitudes in subject-specific tests, as shown in Table 10. Among children who attended TK/RA, PKH beneficiaries still had lower cognitive scores than their non-PKH peers, but the gaps were narrower. This pattern suggests that TK/RA enrolment not only raised average cognitive achievement but also helped to narrow performance gaps between children from PKH and non-PKH households.

Our findings imply that participation in early-childhood education can mitigate some of the disadvantages associated with growing up in a poor PKH-recipient household. In other words, TK/RA has the potential to act as an equalizing force, reducing cognitive disparities between beneficiary and non-beneficiary children. From a policy perspective, this supports the idea of systematically linking PKH to early childhood education services.


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**Table 11. Estimated ATT of the PKH Program on Body Mass Index**

| Variable | Obs. | ATT | S.E | t-stat |
|---|---|---|---|---|
| Body Mass Index | 10,689 | 0.021 | 0.068 | -0.31 |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

Analysis of other child outcomes further illuminates the mechanisms underlying the main results. Table 11 reports the ATT estimates of PKH on children's BMI. The estimated effect was close to 0 (0.021) and statistically insignificant, indicating that PKH did not improve nutritional status among beneficiary children. In high-poverty areas where nutritious food is relatively expensive, the amount of cash transferred by PKH may be insufficient to improve diet quality substantially. Moreover, households may allocate transfers to multiple competing needs, such as staple foods, school-related expenditures, and other basic consumption, leaving little room for upgrading children's nutrition. Evidence indicates that childhood stunting is associated with weaker cognitive and intellectual functioning, highlighting the importance of good nutrition as a foundation for learning (Sideropoulos et al., 2025). A persistently low BMI and poor nutritional status may reduce children's concentration, energy, and memory, thereby constraining their learning capacity and limiting the potential impact of PKH on their cognitive test scores. By contrast, the ATT estimates for EDI outcomes in Table 12 are more encouraging. PKH had a positive, statistically significant effect on the EDI language and cognitive development domain (ATT ≈ 0.14, significant at the 10% level) and on the subdomains of basic literacy and basic numeracy (significant at the 5–10% level). The effects on the subdomains of interest in books, numbers, and good memory and advanced literacy skills were also positive but not statistically significant.

**Table 12. Estimated ATT of the PKH Program on EDI/Language and Cognitive Development**

| Variable | Obs. | ATT | S.E | t-stat |
|---|---|---|---|---|
| Domain | | | | |
| Language and cognitive development | 8,509 | 0.14 | 0.08 | 1.74* |
| **Subdomains** | | | | |
| Basic literacy skills | 8,754 | 0.142 | 0.071 | 2.01** |
| Interest in books, numbers, and having a good memory | 8,678 | 0.101 | 0.079 | 1.28 |
| Advanced literacy skills | 8,744 | 0.159 | 0.148 | 1.08 |
| Basic numeracy skills | 8,693 | 0.143 | 0.082 | 1.76* |

*** significant at 1%; ** significant at 5%; * significant at 10%
Source: ECED Survey 2013, processed by the author.

These findings indicate that PKH was associated with higher school readiness among beneficiary children, particularly in foundational literacy and numeracy. One plausible interpretation is that PKH reduces financial barriers to school entry and continuity, enabling poor households to keep their children in school and meet basic schooling requirements. This may translate into improvements in behaviors and skills captured by the EDI, such as being interested in books, recognizing letters and numbers, and performing simple numerical

operations, even if these changes are not yet reflected in higher scores on more demanding standardized cognitive tests. These modest gains have longer-term implications, provided that they are sustained and supported by improvements in school quality.

These findings imply that cash transfers alone are unlikely to yield substantial improvements in learning outcomes in high-poverty rural settings without complementary investments in early childhood services, school quality, and child nutrition. To ensure that PKH can fully play its role as a human capital investment, policymakers should therefore consider the following strategies.

First, the government should prioritize strengthening school infrastructure, particularly in underdeveloped rural areas where PKH beneficiaries are concentrated. The results show that many schools in the study districts have fewer classrooms, libraries, and laboratories than provincial and national averages, even in recent years. The gap was likely even wider at the time of the ECED survey. In such contexts, additional attendance driven by PKH is unlikely to yield meaningful learning gains if children spend their time in overcrowded classrooms without access to basic learning facilities. Ensuring that primary schools have adequate classrooms, functioning libraries, simple laboratories, and sufficient learning materials is therefore essential. Moreover, these facilities must not only be provided but also effectively used as part of the teaching and learning process so that they genuinely enrich children's learning experiences.

Second, improving both the quantity and the quality of teachers is crucial to convert higher enrolment and attendance into better learning outcomes. The analysis of teacher–school ratios indicates that schools in the sample districts were often understaffed compared with provincial and national benchmarks. When teachers face large classes and additional students due to PKH, they may struggle to provide individual attention and manage classrooms effectively. Policy efforts should therefore focus on recruiting more teachers in underserved rural areas and on enhancing their professional competencies through targeted training programs. Priority areas include subject-matter mastery, classroom management, the use of effective and child-centered teaching strategies, and the reinforcement of teacher discipline and motivation. With more competent and adequately supported teachers, the additional time PKH children spend in school is more likely to lead to real improvements in cognitive skills.

Third, the results highlight the important role of early-childhood education in mitigating the initial disadvantages of PKH children. Children who attended TK/RA had higher cognitive scores than those who did not, and participation in TK/RA appeared to reduce the cognitive achievement gap between PKH and non-PKH children. Early-childhood education can act as an equalizing force. In the medium to long run, it is desirable to more closely integrate PKH with early-childhood education services, for example, by gradually introducing attendance at TK/RA as a program conditionality. A similar approach has been adopted in El Salvador, where CCT conditionalities include minimum school attendance requirements for children aged 5–15 years (Sanchez Chico et al., 2020). Evidence from other CCTs also indicates that cash alone may not be effective for the development of young children; thus, conditionalities should be designed to reflect early childhood needs


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(Lopez Boo & Creamer, 2019). However, this must be done carefully and in stages because access to TK/RA remains limited and uneven, especially in rural and underdeveloped regions (Brinkman et al., 2017; Nakajima et al., 2016). In the initial phase, TK/RA attendance requirements should be applied flexibly, taking into account local service availability: where TK/RA services exist, PKH households should be encouraged or required to enroll their children; where services are absent, such requirements should not be imposed. During this phase, the government's main responsibility is to expand TK/RA infrastructure and services, particularly in poor and remote areas, so that all young children can access inclusive and affordable early-learning opportunities. Only once TK/RA coverage is broadly adequate can the policy move to a second phase, in which TK/RA attendance becomes a standard conditionality for PKH beneficiaries, implemented uniformly across regions.

Finally, given that PKH does not significantly improve children's BMI and that many beneficiary children remain underweight, complementary nutrition interventions are needed to support the development of their cognitive skills. The insignificant ATT on BMI suggests that the current transfer level may not be sufficient to substantially upgrade diet quality, especially when households face multiple competing needs. In high-poverty and underdeveloped areas, PKH could therefore be complemented by the targeted provision of nutritious food for beneficiary children, for example, through school feeding schemes, fortified snacks, or vouchers for nutritious products. To maintain fiscal efficiency, these interventions should carefully target PKH households in the poorest and most disadvantaged regions, where the risk of undernutrition is highest, and the potential returns in terms of improved learning are likely to be greatest. By simultaneously addressing constraints in school infrastructure, teacher capacity, early childhood education, and child nutrition, PKH would have a much greater chance of fulfilling its objective of breaking the intergenerational transmission of poverty through investments in children's human capital.

## CONCLUSION

This study examined whether PKH improves the cognitive outcomes of primary-school children aged 6–9 years in poor rural districts. Using 2013 ECED survey data and PSM to address selection into PKH, we assessed the program's impact on Bahasa Indonesia proficiency, mathematics skills, abstract reasoning, a composite cognitive score, BMI, and EDI language and cognitive development outcomes. The estimates show that PKH does not have a statistically significant effect on any of the cognitive test scores, with small, insignificant ATT values across the matching algorithms. By contrast, PKH is associated with modest but positive effects on EDI outcomes in the language and cognitive development domain, particularly in basic literacy and basic numeracy, suggesting that the program enhances school readiness, even though these gains have not yet translated into higher cognitive test scores. Descriptive evidence points to several constraints that likely attenuate PKH's impact on learning: PKH children grow up in households with lower parental education, lower wealth, and fewer books; they attend schools with below-average infrastructure and teacher availability; they also often remain underweight, with no detectable effect of PKH on BMI.

These findings imply that cash transfers alone are unlikely to yield substantial improvements in learning outcomes in high-poverty rural settings without complementary investments in early childhood services, school quality, and child nutrition. Therefore, to strengthen PKH's role as a human capital investment, policymakers should consider the following strategies. First, school infrastructure should be improved in underdeveloped rural districts by ensuring access to adequate classrooms, libraries, laboratories, and learning materials. Second, both the quantity and the quality of teachers in disadvantaged areas must be increased. Third, PKH should be more closely linked to early childhood education by gradually introducing TK/RA attendance as a condition while simultaneously expanding TK/RA service availability and applying requirements flexibly where access remains limited. Finally, transfers should be complemented with selective nutrition interventions, such as school feeding schemes or vouchers for nutritious foods, focusing on PKH children in the poorest and most underdeveloped regions. By addressing these constraints, PKH will be better positioned to improve children's cognitive achievement and contribute to the long-term goal of breaking the intergenerational transmission of poverty.

## REFERENCES

Atlay, C., Tieben, N., Hillmert, S., & Fauth, B. (2019). Instructional Quality and Achievement Inequality: How Effective is Teaching in Closing the Social Achievement Gap? *Learning and Instruction*, *63*, Article 101211. https://doi.org/10.1016/j.learninstruc.2019.05.008.

Baker, C. E. (2016). African American and Hispanic Fathers' Work Characteristics and Preschool Children's Cognitive Development. *Journal of Family Issues*, *37*(11), 1514–1534. https://doi.org/10.1177/0192513X15576198.

Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy*, *70*(5), 9–49.

Brinkman, S. A., Hasan, A., Jung, H., Kinnell, A., Nakajima, N., & Pradhan, M. (2017). The Role of Preschool Quality in Promoting Child Development: Evidence from Rural Indonesia. *European Early Childhood Education Research Journal*, *25*(4), 483–505. https://doi.org/10.1080/1350293X.2017.1331062.

Cahyadi, N., Hanna, R., Olken, B. A., Prima, R. A., Satriawan, E., & Syamsulhakim, E. (2020). Cumulative Impacts of Conditional Cash Transfer Programs: Experimental Evidence from Indonesia. *American Economic Journal: Economic Policy*, *12*(4), 88–110. https://doi.org/10.1257/pol.20190245.

Choi, S., & Min, I. (2024). Parental Socioeconomic Status and Adolescent Development in Indonesia. *International Journal of Adolescence and Youth*, *29*(1), 2387086. https://doi.org/10.1080/02673843.2024.2387086.

Evans, D. K., Gale, C., & Kosec, K. (2023). The Educational Impacts of Cash Transfers in Tanzania. *Economics of Education Review*, *92*, Article 102332. https://doi.org/10.1016/j.econedurev.2022.102332

Evans, D. K., Holtemeyer, B., & Kosec, K. (2019). Cash Transfers and Health: Evidence from Tanzania. *World Bank Economic Review*, *33*(2), 394–412. https://doi.org/10.1093/wber/lhx001.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50184

Garcia, S., & Hill, J. (2010). Impact of Conditional Cash Transfers on Children's School Achievement: Evidence from Colombia. *Journal of Development Effectiveness*, *2*(1), 117–137. https://doi.org/10.1080/19439341003628681.

García, S., & Saavedra, J. E. (2017). Educational Impacts and Cost-Effectiveness of Conditional Cash Transfer Programs in Developing Countries: A Meta-Analysis. *Review of Educational Research*, *87*(5), 921–965. https://doi.org/10.3102/0034654317723008.

Gazeaud, J., & Ricard, C. (2024). Learning Effects of Conditional Cash Transfers: The Role of Class Size and Composition. *Journal of Development Economics*, *166*, Article 103194. https://doi.org/10.1016/j.jdeveco.2023.103194.

Gemellia, P. A., & Wongkaren, T. S. (2021). Pengaruh Jam Kerja Orang Tua terhadap Kognitif Anak di Indonesia. *Jurnal Ekonomi Dan Pembangunan Indonesia*, *21*(1), 14–30. https://doi.org/10.21002/jepi.2021.02.

Heckman, J. J., Stixrud, J., Urzua, S., Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics*, *24*(3), 411–482.

Jeffery, K., Chatterjee, I., Lavin, T., & Li, I. W. (2020). Young Lives and Wealthy Minds: The Nexus Between Household Consumption Capacity and Childhood Cognitive Ability. *Economic Analysis and Policy*, *65*, 89–104. https://doi.org/10.1016/j.eap.2019.11.002.

Kusuma, D., McConnell, M., Berman, P., & Cohen, J. (2017). The Impact of Household and Community Cash Transfers on Children's Food Consumption in Indonesia. *Preventive Medicine*, *100*, 152–158. https://doi.org/10.1016/j.ypmed.2017.04.020.

Kusuma, D., Thabrany, H., Hidayat, B., McConnell, M., Berman, P., & Cohen, J. (2017). New Evidence on the Impact of Large-Scale Conditional Cash Transfers on Child Vaccination Rates: The Case of a Clustered-Randomized Trial in Indonesia. *World Development*, *98*, 497–505. https://doi.org/10.1016/j.worlddev.2017.05.007.

Lopez Boo, F., & Creamer, J. (2019). Cash, Conditions, and Child Development: Experimental Evidence from a Cash Transfer Program in Honduras. *Economia*, *19*(2), 169–196.

Marx, L. (2023). How is the Bolsa Família Program Associated with the Test Scores Performance of Economically Disadvantaged Pupils in Brazil? *International Journal of Educational Development*, *102*, Article 102878. https://doi.org/10.1016/j.ijedudev.2023.102878.

Millán, T. M., Barham, T., Macours, K., Maluccio, J. A., & Stampini, M. (2019). Long-term Impacts of Conditional Cash Transfers: Review of the Evidence. *World Bank Research Observer*, *34*(1), 119–159. https://doi.org/10.1093/wbro/lky005.

Nakajima, N., Hasan, A., Jung, H., Brinkman, S., Pradhan, M., & Kinnell, A. (2016). Investing in School Readiness: an Analysis of the Cost-Effectiveness of Early Childhood Education Pathways in Rural Indonesia. *Policy Research Working Paper No. 7832.* World Bank Group. https://doi.org/10.1596/1813-9450-7832.

Ponce, J., & Bedi, A. S. (2010). The Impact of a Cash Transfer Program on Cognitive Achievement: The Bono de Desarrollo Humano of Ecuador. *Economics of Education Review*, *29*(1), 116–125. https://doi.org/10.1016/j.econedurev.2009.07.005.

Rosenbaum, P. R., & Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, *70*(1), 41–55. https://doi.org/10.1017/CBO9780511810725.016.

Sanchez, A., Melendez, G., & Behrman, J. R. (2016). The Impact of the Juntos Conditional Cash Transfer Programme in Peru on Nutritional and Cognitive Outcomes: Does the Age of Exposure Matter? *Working Paper No. 153*. Young Lives.

Sanchez Chico, A., Macours, K., Maluccio, J. A., & Stampini, M. (2020). Impacts on School Entry of Exposure Since Birth to a Conditional Cash Transfer Programme in El Salvador. *Journal of Development Effectiveness*, *12*(3), 187–218. https://doi.org/10.1080/19439342.2020.1773900.

Sanfo, J. M. B. (2024). Studies in Educational Evaluation Teaching Quality and Student Achievement Inequalities in Low- and Middle-Income Countries: A Hierarchical Linear Model Analysis. *Studies in Educational Evaluation*, *83*, Article 101419. https://doi.org/10.1016/j.stueduc.2024.101419.

Sania, A., Sudfeld, C. R., Danaei, G., Fink, G., Mccoy, D. C., Zhu, Z., Fawzi, M. C. S., Akman, M., Arifeen, S. E., Barros, A. J. D., Bellinger, D., Black, M. M., Bogale, A., Braun, J. M., Broek, N. Van Den, Carrara, V., Duazo, P., Duggan, C., Fernald, L. C. H., Gladstone, M., Hamadani, J., Handal, A. J., Harlow, S., Hidrobo, M., Kuzawa, C., Kvestad, I., Locks, L., Manji, K., Masanja, H., Matijasevich, A., McDonald, C., McGready, R., Rizvi, A., Santos, D., Santos, L., Save, D., Shapiro, R., Stoecker, B., Strand, T. A., Taneja, S., Tellez-Rojo, M-M., Tofail, F., Yousafzai, A. K., Ezzati, M., & Fawzi, W. (2019). Early Life Risk Factors of Motor, Cognitive, and Language Development: A Pooled Analysis of Studies from Low/Middle- Income Countries. *BMJ Open*, *9*, Article e026449. https://doi.org/10.1136/bmjopen-2018-026449

Sideropoulos, V., Munoz-, B., Ang, L., & Dockrell, E. (2025). Childhood Stunting and Cognitive Development: A Meta-Analysis. *Journal of Global Health*, *15*, Article 04257. https://doi.org/10.7189/jogh.15.04257.

Wang, L., Qian, Y., Warrinnier, N., Attanasio, O., Rozelle, S., & Sylvia, S. (2023). Parental Investment, School Choice, and the Persistent Benefits of An Early Childhood Intervention. *Journal of Development Economics*, *165*, Article 103166. https://doi.org/10.1016/j.jdeveco.2023.103166.

Watts, T. W. (2020). Academic Achievement and Economic Attainment: Reexamining Associations Between Test Scores and Long-Run Earnings. *AERA Open*, *6*(2), 1–16. https://doi.org/10.1177/2332858420928985.

Zhou, L., Jiang, B., & Wang, J. (2020). Do Cash Transfers Have Impacts on Student Academic, Cognitive, and Enrollment Outcomes? Evidence From Rural China. *Children and Youth Services Review*, *116*(19), Article 105158. https://doi.org/10.1016/j.childyouth.2020.105158.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50184

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# The Strategic Role of Stakeholders in Stunting Alleviation through the MACTOR Method

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## ABSTRACT

**Research Originality:** This research is original because it uses a MACTOR analysis to examine the roles and interactions of stakeholders in stunting alleviation and their impact on improving the quality of human resources in Jember Regency.

**Research Objectives:** This study aims to analyze the roles, interests, and influence of key stakeholders involved in stunting alleviation and to assess how their coordination contributes to improving human resource quality in Jember Regency.

**Research Methods:** This research employs a mixed-methods approach, using the MACTOR method, to examine stakeholder relationships. Data were collected through interviews, document analysis, and secondary data related to stunting and human development indicators.

**Empirical Results:** The findings indicate that stakeholder roles in stunting alleviation are uneven, with limited coordination and varying levels of influence. Weak synergy among actors reduces the effectiveness of stunting reduction programs and their impact on human resource quality.

**Implications:** These results suggest the need for stronger stakeholder coordination, clearer role distribution, and integrated policies to enhance stunting alleviation and support sustainable human resource development in Jember Regency.

**Keywords:**
stunting; sustainable development; actor; coordination.

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## INTRODUCTION

Development is a continuous process with the primary objective of improving the standard of living and community welfare. Efforts to enhance human resource quality need to be initiated early in society. Human resources are a crucial factor in driving regional economic growth (Saleh et al., 2020). Quality development requires long-term investment in humans as the primary agents of development. Countries or regions that succeed in fostering healthy, intelligent, and productive generations will achieve higher economic competitiveness. Conversely, if human capital quality is low due to limited access to basic needs such as nutrition, education, and health, the development process will proceed slowly or may even stagnate (Wayes, 2024). One of the main obstacles to creating high-quality human resources is stunting. According to the World Health Organization (2015), stunting is a growth and developmental disorder in children characterized by a height-for-age below the standard due to chronic malnutrition and recurrent infections, which adversely affect physical, cognitive, and future productivity (Arqam et al., 2026; Oyenubi & Rossouw, 2024).

The accelerated stunting reduction program constitutes one of Indonesia's national priority initiatives. East Java Province is among the twelve provinces designated as priority regions for the implementation of this program. Given its large population and extensive territory, East Java has considerable potential to contribute to the overall success of national stunting reduction efforts (Hariani et al., 2023). According to data compiled by the East Java Provincial Government, ten cities and regencies have been identified as primary priority areas for accelerating stunting reduction. These regions are prioritized because stunting prevalence rates exceed 20 percent, including Jember Regency (Muflihah et al., 2024).

**Table 1. Comparison of Stunting Prevalence in East Java and Jember Regency**

| Year | East Java (%) | Jember Regency (%) |
|---|---|---|
| 2019 | 26,86 | 37,94 |
| 2020 | - | - |
| 2021 | 23,5 | 23,9 |
| 2022 | 19,2 | 34,9 |
| 2023 | 17,7 | 29,7 |

Sources: Susenas & SSGBI (2019); SSGI (2021); SSGI (2022); SKI (2023).

Table 1 shows data from 2019 to 2023, indicating that Jember Regency consistently recorded higher prevalence rates compared to the East Java provincial average. In 2019, the prevalence in Jember reached 37.94%, significantly above East Java's 26.86%. Data for 2020 were unavailable; however, in 2021 Jember experienced a notable decline to 23.9%, nearly equal to the provincial average of 23.5%. Nevertheless, in 2022, the situation in Jember worsened sharply, increasing to 34.9%, in contrast to East Java, which continued to decline to 19.2%. In 2023, Jember showed improvement with a decrease to 29.7%, yet the figure remained considerably higher than the provincial average, which further declined to 17.7%.


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International evidence indicates that stunting can hinder economic growth and reduce labor productivity, potentially resulting in a 11% loss of Gross Domestic Product (GDP) and a 20% decline in adult worker earnings. Moreover, stunting contributes to widening inequality, reducing approximately 10% of lifetime earnings, and can trigger intergenerational poverty (poverty traps) (TNP2K, 2017). High socioeconomic disparities across regions in Indonesia are among the factors contributing to elevated stunting rates.

The issue of stunting in a region cannot be separated from its socioeconomic conditions. Social factors, including parental education level, occupation type, and income, play a significant role in determining children's access to adequate nutrition and health services (Prayitno et al., 2025). Various studies show that the roles of government, health services, and the community are important in reducing stunting. Research by Astuti et al. (2025), Jalloh et al. (2025), Orimadegun et al. (2025), and Supranoto et al. (2025) confirms that stakeholder collaboration, community social capital, a multisectoral approach, national health policies, and improved welfare are crucial to successfully combating stunting. From a health service perspective, a meta-analysis study shows that children in highland areas are at higher risk of stunting due to limited access to health services (Rosyada et al., 2026).

However, several other studies have shown conflicting results. Research by Hamzah et al. (2025) found that village funds and fiscal decentralization in Indonesia had a positive effect on stunting, suggesting weak policy effectiveness at the regional level. In Magelang, Central Java, the national stunting reduction program has not been running optimally due to low maternal knowledge, inappropriate parenting patterns, and weak program coordination (Ashar et al., 2025). Meanwhile, in Indonesia, unmet health care needs were found to be positively correlated with stunting prevalence (Rahardiantoro et al., 2024). From a poverty perspective, in Indonesia, high poverty rates are associated with increased stunting risk (Aswi et al., 2025; Rahardiantoro et al., 2024). It can therefore be concluded that high poverty rates are among the main contributors to stunting, as economic constraints limit community access to nutritious food, healthcare, and adequate sanitation (Pradhan et al., 2023). Jember Regency is among the regions in East Java with relatively high poverty rates compared to other districts and municipalities.

**Table 2. The Five Regencies/Municipalities with the Highest Number of Poor Population in East Java, 2021–2023.**

| Regency/City | Number of Poor Population (in Thousands) | | |
|---|---|---|---|
| | 2023 | 2022 | 2021 |
| Malang | 251,36 | 252,88 | 276,58 |
| Jember | 236,46 | 232,73 | 257,09 |
| Sampang | 221,71 | 217,97 | 237,23 |
| Sumenep | 206,1 | 206,2 | 224,73 |
| Probolinggo | 205,02 | 203,23 | 223,32 |

Source: Statistic Indonesia (2024)

Table 2 shows that the number of poor residents in Jember Regency has fluctuated from year to year. Based on this comparison, Jember consistently ranked second in East Java with the highest number of poor residents. This condition indicates that poverty in Jember Regency is relatively more severe compared to most other regencies/municipalities. The high poverty rate in Jember also has implications for various other development issues, including the high prevalence of stunting, since socioeconomic conditions are among the main contributing factors to stunting in children. This is supported by the findings of Ulfah & Nugroho (2020), which revealed that employment and income problems are key drivers of stunting in Jember Regency.

High poverty levels further increase the risk of stunting in future generations, creating a recurring cycle that is difficult to break without comprehensive interventions. The lower the poverty rate, the higher the population's welfare (Zhao & Zhao, 2025). Low-income families generally face limited access to nutritious food, healthcare services, clean water, and proper sanitation, all of which are essential factors for child growth (Pradhan et al., 2023). In the long term, children born and raised in poverty are at greater risk of experiencing stunting and declining human resource quality. Therefore, stunting alleviation cannot be separated from comprehensive and sustainable poverty reduction efforts.

This study differs from previous research in that it uses a MACTOR analysis, which focuses on the roles and interactions of stakeholders in stunting alleviation rather than solely on health or nutritional interventions. It adopts an actor-based analytical approach to examine stakeholder influence, interests, and coordination, framing stunting as a human resource development and regional development issue. Therefore, this study is crucial for analyzing the roles of actors in stunting alleviation efforts to improve human resource quality in Jember Regency. Accordingly, the findings of this research are expected to provide relevant policy recommendations for the government and stakeholders.

## METHODS

This study employs a mixed-methods approach combining qualitative and quantitative techniques to comprehensively analyze stakeholder roles in stunting alleviation in Jember Regency (Monica & Yaswinda, 2021). The purpose of employing a mixed-methods approach is to obtain numerical data that are subsequently reinforced through in-depth explanatory analysis of the collected and processed data, thereby producing more comprehensive and holistic research findings (Komarolya, 2025). The primary analytical tool used is MACTOR (Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations), which is designed to map stakeholder influence, interests, and interactions within policy implementation (Kadaifci, 2024). The application of MACTOR enables a more systematic analysis of inter-actor relationships, allowing the identification of effective collaborative strategies to reduce the economic impacts of stunting.

The data used in this study consists of both primary and secondary data. Primary data were collected through structured interviews and questionnaires administered to key


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stakeholders involved in stunting reduction programs, including government agencies, health workers, community organizations, and household representatives. The questionnaires were designed to capture actors' perceptions regarding their level of influence, dependency, interests, and attitudes toward stunting alleviation objectives. Secondary data were obtained from official government reports, statistical publications, and relevant policy documents related to stunting, poverty, and human resource development in Jember Regency.

The population in this study comprises all stakeholders involved in stunting-reduction policies in Jember Regency, including government institutions, at-risk families, and stunting-free families. The sampling technique employed is purposive sampling, which involves selecting respondents based on specific criteria considered capable of providing relevant information for the research. Actors from government institutions and community organizations were selected based on their expertise and competence in their respective fields. Meanwhile, several actors, particularly at-risk and stunting-free families, were selected based on being parents of stunted or non-stunted children (aged 0–59 months), with a focus on the district with the highest stunting prevalence in Jember Regency in 2023, namely Kaliwates District.

**Table 3. Actors and Objectives**

| Actors | Objectives |
|---|---|
| Health Agency (HA) | Improving access to and the quality of health services. |
| Food Security and Livestock Agency (FSLA) | Ensuring the availability of and access to nutritious food. |
| Regional Development Planning Agency (RDPA) | To coordinate cross-sectoral planning in accelerating stunting reduction.<br>Integration of stunting alleviation programs into regional development planning and local government budgeting. |
| Women's Empowerment, Child Protection, and Family Planning Agency (WECPFPA) | Education on family planning, parenting practices, and maternal and child health. |
| Institution | Academic support through research and education. |
| Midwives | Early detection and intervention measures to address stunting risk. |
| Posyandu Cadres | Monitoring the growth and development of children, accompanied by nutrition and health education. |
| Family Welfare Empowerment Team (FWET) | Promoting active community participation in stunting prevention efforts. |
| Stunting-Risk Family (SRF) | Enhancing nutritional awareness. |
| Stunting-Free Families (SFF) | Role model in practicing parenting and nutritious food consumption within the community. |

Score Description:
0 = no influence
1 = low influence
2 = moderate influence
3 = strong influence
4 = very strong influence

The data obtained from the questionnaires were subsequently processed and analyzed using the MACTOR method to identify and map the roles, interests, and influence of each actor in stunting reduction efforts in Jember Regency. MACTOR is applied to examine the power relations, interconnections, and patterns of collaboration among actors or stakeholders (Priyono et al., 2025). This method generally reveals each actor's perceptions and preferences regarding the goals to be achieved. Furthermore, the analysis identifies isolated actors or stakeholders with low levels of influence and dependency, as well as bridging actors characterized by high levels of both influence and dependency. In addition, relative strength is used as a basis for comparison to identify the actors or stakeholders with the greatest influence (Yilmaz & Karadayi-Usta, 2025).

The stages of MACTOR analysis consist of several steps, namely: (1) identifying the system actors; (2) determining a set of objectives to be achieved; (3) describing the power relations among actors, measured on a scale from 0 (no influence) to 4 (very strong influence); and (4) assessing the actors' attitudes toward the objectives based on their level of resistance, using a scale of (+) support, (0) neutral, and (–) oppose, as well as evaluating the importance of each objective for the actors on a scale from 0 (not important) to 4 (very important) (Rees & MacDonell, 2017).

**Table 4. Matrix Mactor**

| MDI | Health Agency | FSLA | RDPA | WECPFPA | Institution | Midwives | Posyandu Cadres | FWET | SRF | SFF |
|---|---|---|---|---|---|---|---|---|---|---|
| **Health Agency** | 0 | 3 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 3 |
| **FSLA** | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 |
| **RDPA** | 3 | 1 | 0 | 3 | 2 | 3 | 3 | 2 | 3 | 3 |
| **WECPFPA** | 1 | 3 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 3 |
| **Institution** | 3 | 1 | 2 | 3 | 0 | 3 | 3 | 3 | 1 | 1 |
| **Midwives** | 3 | 2 | 3 | 4 | 3 | 0 | 3 | 3 | 3 | 2 |
| **Posyandu Cadres** | 2 | 3 | 3 | 3 | 3 | 4 | 0 | 3 | 2 | 2 |
| **FWET** | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 0 | 2 | 2 |
| **SRF** | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 0 | 3 |
| **SFF** | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 0 |

Source: Primary data, processed (2025).

Table 4 presents an example of an MACTOR matrix illustrating the level of influence among actors involved in stunting alleviation efforts in Jember Regency. Each cell in the matrix indicates the extent to which one actor influences another, with values ranging from 0 (no influence) to 4 (very strong influence). This matrix identifies key actors with substantial influence over the system, as well as strategic actors to prioritize in collaborative policy planning.


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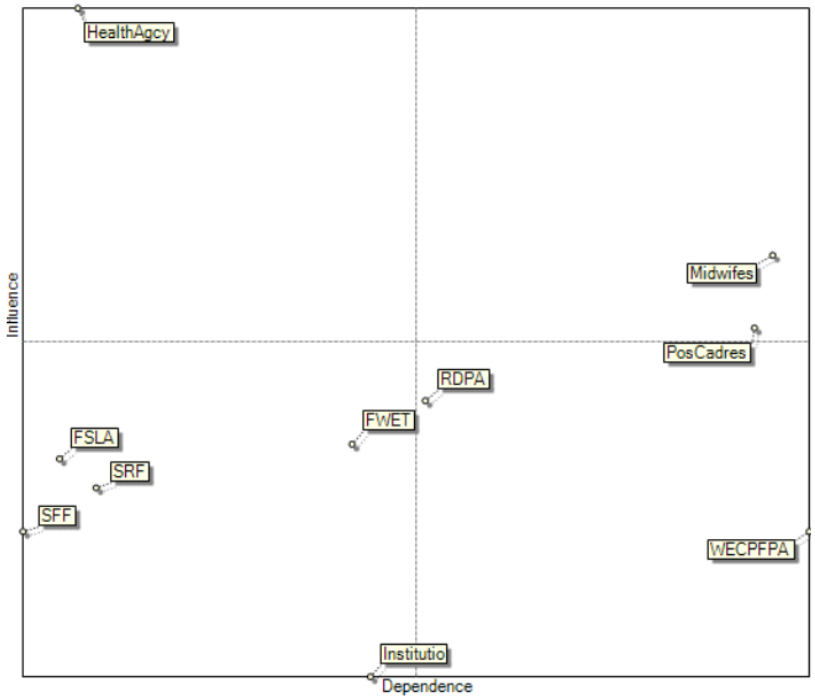
## RESULTS AND DISCUSSION

Based on the MACTOR analysis of stunting alleviation in Jember Regency aimed at improving human resource quality, it can be concluded that the Health Agency holds a high level of influence with low dependency, playing a central role in enhancing and delivering health services. Midwives and Posyandu cadres demonstrate both high influence and high dependency, as they function as key intermediaries between the health service system and the community. Actors characterized by low influence but high dependency include the Regional Development Planning Agency, which is responsible for development planning and policy integration, and the Women's Empowerment, Child Protection, and Family Planning Agency, which focuses on advocacy for stunting-risk families and early marriage education. Meanwhile, actors with both low influence and low dependency include the Food Security and Livestock Agency, which ensures access to nutritious food; the Family Welfare Empowerment Team, which carries out family education and community empowerment; stunting-risk and stunting-free families as program beneficiaries; and higher education institutions that contribute through scientific studies, research data, and policy recommendations.

**Figure 1. Map of Influences and Dependences between Actors**




Source: Primary data, processed (2025)

The figure provides an initial depiction of the relative importance of each actor, distinguishing between dominant actors (high influence) and actors that tend to be dominated (high dependency). Additionally, the figure helps identify stakeholders who are less engaged or isolated (low influence and low dependency), as well as bridging or relay actors (high influence and high dependency) (Wardono et al., 2019). Based on the

results of the actor role mapping analysis within the quadrants, it is evident that Quadrant I, known as dominant actors, includes the Health Agency. This actor is considered the most influential, having high influence but low dependency. The analysis results indicate that the Health Agency has a high influence and low dependency in stunting reduction efforts. The findings align with research by Rahardiantoro et al. (2024), which shows that government interventions aimed at improving education, access to healthcare, and poverty reduction can help reduce stunting in Indonesia.

Furthermore, Sianti et al. (2024) emphasize that the Health Agency plays the most dominant role in implementing specific stunting interventions. In relation to Booth's (1996) poverty theory, the Health Agency addresses personal and physical factors as well as access limitations through various stunting prevention and management programs, improvements in maternal and child nutrition services, and the provision of basic health services that are easily accessible to low-income populations. Limited access to health services, a key factor in poverty, can also be mitigated through the Health Agency's efforts to expand the reach of community health centers, Posyandu, and health insurance programs.

In Quadrant II, referred to as relay actors, there are midwives and Posyandu cadres, who exhibit both high influence and high dependency. Their position indicates that midwives and Posyandu cadres play a crucial role in driving stunting reduction in Jember Regency. The influence of midwives is particularly significant, as they serve as the primary intermediaries between the health care system and the community. These findings align with Irdawati et al.'s (2024) research, which showed that health counseling provided to cadres improved knowledge scores in both the control and treatment groups. Although there were no significant differences, the results showed that the use of media in healthcare services could yield better results than the cadres' knowledge scores. They directly assist pregnant women, monitor child growth, and conduct community nutrition education. By routinely organizing Posyandu activities and distributing supplementary food for at-risk children, they facilitate access to health and nutrition services for low-income communities, thereby improving human capital and helping break the cycle of poverty. This supports Anne Booth's poverty theory, which identifies personal, physical, and access-related factors as key contributors to poverty. Through their efforts, midwives and Posyandu cadres help reduce these barriers to basic health services.

Quadrant III, or dominated actors, includes the Regional Development Planning Agency and the Women's Empowerment, Child Protection, and Family Planning Agency, which have low influence and high dependency. The Regional Development Planning Agency primarily functions as a planner and integrator of development policies, including stunting prevention, through the Regional Medium-Term Development Plan and Regional Government Work Plan documents; however, implementation relies on technical agencies in the field. According to Anne Booth's (1996) poverty theory, the Regional Development Planning Agency addresses access and economic factors. As a planning and coordinating actor, the Regional Development Planning Agency formulates strategies to address stunting and poverty by integrating cross-sectoral programs, ensuring budget availability, prioritizing nutrition and public health, and aligning the efforts of the Health Agency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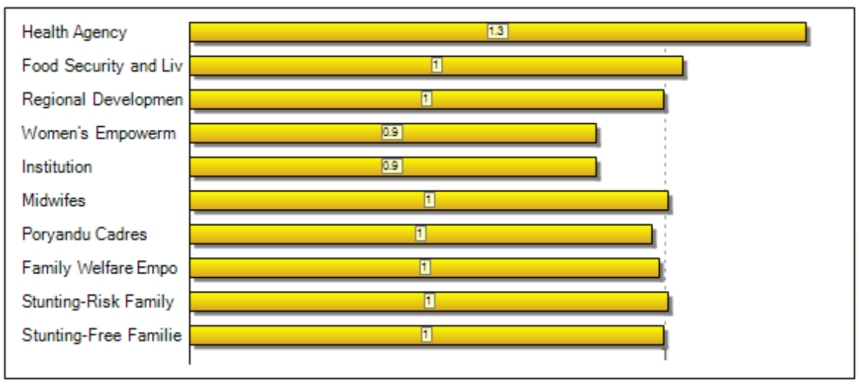
and other stakeholders. By expanding access to health services and strengthening nutrition interventions through effective planning, the Regional Development Planning Agency helps reduce barriers to access and improve the economic conditions of low-income communities, thereby helping break the cycle of poverty.

Meanwhile, the Women's Empowerment, Child Protection, and Family Planning Agency primarily addresses socio-cultural, personal, and physical factors. The agency focuses on family education, women's empowerment, child protection, and family planning services to prevent early marriage and manage high-risk births that contribute to stunting. Through outreach and empowerment programs, Women's Empowerment, Child Protection, and Family Planning Agency seeks to influence community attitudes and behaviors regarding reproductive health, childcare practices, and the importance of nutrition from pregnancy onward. Consequently, the Women's Empowerment, Child Protection, and Family Planning Agency not only contributes to reducing stunting but also strengthens family foundations, promoting healthier, more productive households capable of escaping poverty.

Lastly, Quadrant IV consists of actors with both low influence and low dependency. Their role in stunting reduction remains limited and non-dominant in strategic decision-making or cross-sectoral program coordination. The Food Security and Livestock Agency plays an important role in supporting household food security and nutritional adequacy. However, its direct influence on specific stunting interventions, such as health services and nutrition education, is minimal and supplementary. Similarly, the Family Welfare Empowerment Team's role is primarily promotive and educational through cadres and community activities. However, they are not actively involved in policy design or program formulation at the regency level. At-risk families and stunting-free families are program targets rather than decision-makers, resulting in relatively low influence and dependency on other actors. Meanwhile, universities generally lack direct authority over strategic decision-making, particularly for projects implemented by the government or the private sector.

**Figure 2. Actor Competitiveness Diagram**



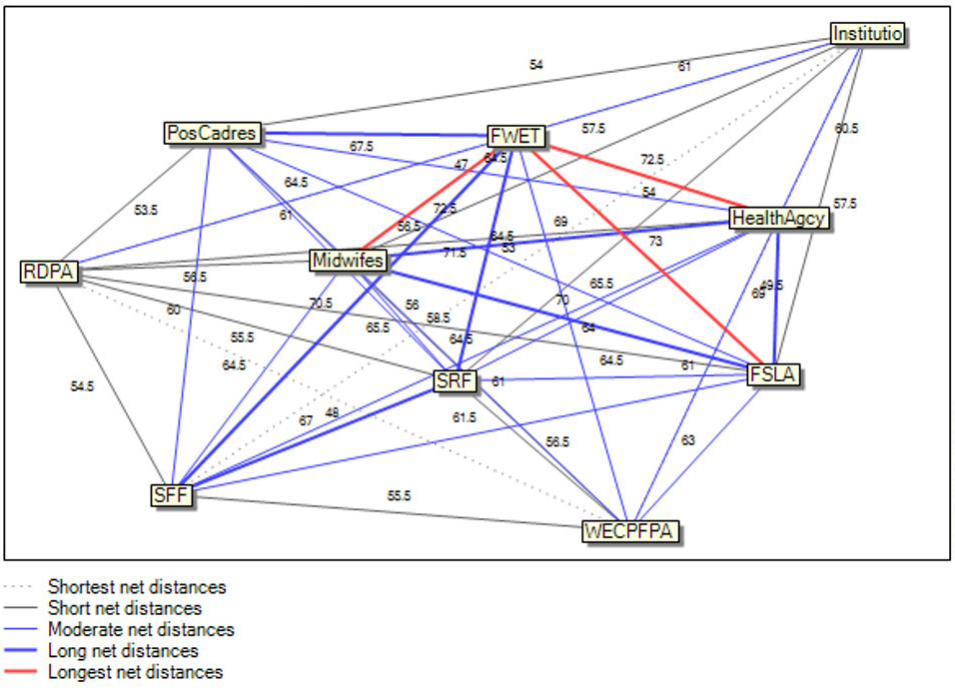

| | Ri |
|---|---|
| HealthAgcy | 1.29 |
| FSLA | 1.04 |
| RDPA | 1.00 |
| WECPFPA | 0.85 |
| Institutio | 0.85 |
| Midwifes | 1.00 |
| PosCadres | 0.97 |
| FWET | 0.99 |
| SRF | 1.01 |
| SFF | 1.00 |

Source: Primary data, processed (2025)

Figure 2 presents a histogram of each actor's competitiveness levels. Actors or stakeholders with a value greater than 1 are categorized as having high competitiveness,

whereas values below 1 indicate low competitiveness. Several actors with significant roles, either through direct or indirect influence, in other words, those with high competitiveness, include the Health Agency, the Food Security and Livestock Agency, and at-risk families. These actors occupy strategic positions in stunting reduction efforts and have the potential to impact economic outcomes positively. The Health Agency has the highest score of 1.29, indicating that it is the most influential actor in decision-making, coordination, and the implementation of stunting reduction strategies. This result aligns with the Health Agency's primary role as the implementer of specific stunting intervention programs. The Food Security and Livestock Agency, for instance, ensures the availability and access to nutritious food, which is a crucial foundation for improving the quality of human capital. Meanwhile, the involvement of at-risk families highlights the importance of community participation in supporting program success. Through the synergy of all these actors, not only can improvements in child nutritional status be achieved, but sustainable enhancement of human capital is also promoted, contributing to long-term economic growth.

**Figure 3. Distance Between Actors**




Source: Primary data, processed (2025)

Figure 3 presents a graph illustrating the relationships among actors, depicting the potential for collaboration among stakeholders. Similar to the inter-objective distance graph, this graph also distinguishes connectivity levels using line colors. Based on the analysis, actors with strong potential for collaboration in stunting reduction include the Health Agency, the Food Security and Livestock Agency, midwives, and the Family Welfare Empowerment Team. This finding aligns with (Apriliani et al., 2023), who stated that the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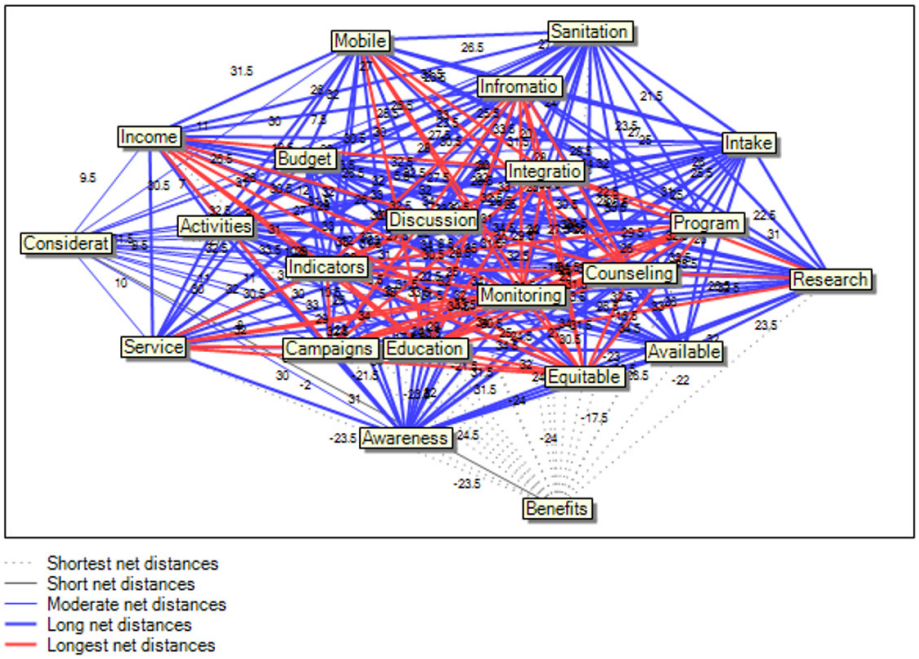
synergy among the Health Agency, the Food Security and Livestock Agency, midwives, and the Family Welfare Empowerment Team demonstrates strong collaborative potential in stunting reduction due to their complementary roles. Their interventions directly target factors contributing to poverty, as described by Anne Booth (1996). According to Booth, poverty is not solely caused by economic limitations but also by socio-cultural, personal, and physical factors, as well as limited access to basic services. These four actors address these issues in different ways: the Health Agency and midwives reduce access barriers and address personal and physical constraints through health and nutrition services; the Food Security and Livestock Agency addresses economic constraints by ensuring the availability of nutritious food and promoting the livestock sector; while Family Welfare Empowerment Team targets socio-cultural aspects and access limitations through family education and community empowerment. Through this cross-actor collaboration, stunting reduction efforts become more comprehensive, encompassing health, nutrition, food access, and community empowerment. Such collaboration ensures that obstacles arising from economic, socio-cultural, or geographic limitations can be simultaneously mitigated.

**Figure 4. Distance Between Objectives**




Source: Primary data, processed (2025)

Figure 4 presents a graph of distances between objectives, illustrating the degree of connectivity between actors and each objective. Similar to the previous graph, differences in actor relationships are indicated by line colors: gray for weak connections, blue for moderate connections, and red for strong connections. This graph is useful for identifying each actor's position or stance toward specific objectives, whether supportive or not. The visualization also depicts the relationships among objectives based on a scale derived from the differences between convergence and divergence values.

The red color indicates strong connections, where objectives such as regional planning integration, nutritional status monitoring, stunting prevention education, supplementary feeding program, family counseling services, community service, information accessibility, university research, regional development indicators, equitable health services, mobile services, income limitations, and early marriage campaigns are highly interconnected. The close linkage among these objectives suggests that achieving one strategic goal, such as strengthening university research or advancing stunting prevention education, can synergistically support the realization of other objectives. For example, robust research from universities can produce evidence-based policy recommendations to enhance supplementary feeding and family counseling programs. Similarly, increased community awareness through education supports early marriage prevention campaigns and nutritional status monitoring services. This result aligns with Atamou et al. (2023), who stated that maternal knowledge, maternal caregiving practices, parental income, utilization of health services, and household sanitation play a crucial role in reducing stunting.

## CONCLUSION

Based on the MACTOR analysis of stunting reduction in Jember Regency, aimed at improving human capital, the Health Agency has a strong influence, with low dependency. It plays a central role in strategies such as nutritional status monitoring, supplementary feeding programs, mobile and equitable health services, and improving information accessibility. Midwives and Posyandu cadres exhibit high influence and dependency as key actors in stunting prevention education, family counseling services, community service, and early detection of nutritional problems. Actors with low influence but high dependency include the Regional Development Planning Agency (RDPA), which integrates regional planning through regional development indicators, and the Women's Empowerment, Child Protection, and Family Planning Agency, which focuses on early marriage campaigns and addressing income limitations among at-risk families. Actors with low influence and low dependency include the Food Security and Livestock Agency, which supports supplementary feeding; the Family Welfare Empowerment Team, through family education; universities through research-based policy recommendations; and families as program targets. The Jember Regency Government needs to strengthen cross-sector coordination by positioning the Health Office as a central actor, integrating regional planning, strengthening the roles of midwives and Posyandu cadres, providing support to supporting actors, and utilizing university research to achieve effective and sustainable stunting reduction. Overall, regional planning integration, nutritional monitoring, prevention education, supplementary feeding, family counseling, community service, information accessibility, university research, and early marriage prevention are interconnected strategies requiring strong collaboration among key actors in Jember Regency.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https://doi.org/10.15408/sjie.v15i1.48638

## REFERENCES

Apriliani, C., Sadhana, K., & Fristin, Y. (2023). The Role of Government Policies in Preventing and Reducing Stunting. *EAS Journal of Humanities and Cultural Studies*, *5*(01), 9–17. https://doi.org/10.36349/easjhcs.2023.v05i01.002.

Arqam, M. L., Firdaus, A. A., Atmojo, A. M., Saputri, G. Z., Furizal, P., & Sirnopati, R. (2026). Integrating Education-Based Interventions and Machine Learning for Stunting Prevention: A Case Study in East Lombok, Indonesia. *Dialogues in Health*, *8*, 100264. https://doi.org/10.1016/j.dialog.2025.100264.

Ashar, H., Rahfiludin, M. Z., Nugraheni, S. A., Tjandrarini, D. H., Murwani, A., Supadmi, S., Yunitawati, D., Kusumawardani, H. D., Musoddaq, M. A., & Latifah, L. (2025). A Qualitative Study in Magelang, Central Java, Indonesia: Mothers' Knowledge, Parenting Styles, and National Priority Programs Managing of Stunting in Toddlers. *Social Sciences and Humanities Open*, *12*, 101874. https://doi.org/10.1016/j.ssaho.2025.101874.

Astuti, S. J. W., Suindyah Dwiningwarni, S., & Atmojo, S. (2025). Modeling Environmental Interactions and Collaborative Interventions for Childhood Stunting: A Case from Indonesia. *Dialogues in Health*, *6*, 100206. https://doi.org/10.1016/j.dialog.2025.100206.

Aswi, A., Rahardiantoro, S., Kurnia, A., Sartono, B., Handayani, D., & Nurwan, N. (2025). Bayesian spatio-temporal conditional autoregressive localized modeling techniques for socioeconomic factors and stunting in Indonesia. *MethodsX*, *15*(February). https://doi.org/10.1016/j.mex.2025.103464

Atamou, L., Rahmadiyah, D. C., Hassan, H., & Setiawan, A. (2023). Analysis of the Determinants of Stunting among Children Aged below Five Years in Stunting Locus Villages in Indonesia. *Healthcare*, *11*(6), 1–12. https://doi.org/10.3390/healthcare11060810.

Booth, A. (1996). Intergovernmental Relations and Fiscal Policy in Indonesia: The National Impact of Equality in the Provinces. in Fletcher, C (Ed). *Equity and Development across Nations*. Sidney: Allen and Unwin.

Hariani, E., Widyawati, R. F., Muhammad, R. T., Dwimastadji W, M., & Dewa L, B. (2023). Pencegahan Stunting dalam Peningkatan Kualitas Sumber Daya Manusia di 11 Kabupaten Jawa Timur. Jurnal Ekonomi Bisnis, Manajemen dan Akuntansi (JEBMA), *3*(3), 949–956. https://doi.org/10.47709/jebma.v3i3.3187.

Hamzah, M. Z., Sofilda, E., & Kusairi, S. (2025). How Do Socioeconomic Indicators and Fiscal Decentralization Affect Stunting? Evidence from Indonesia. *International Journal of Development Issues*, *24*(2), 264–281. https://doi.org/10.1108/IJDI-05-2024-0150.

Irdawati, I., Arifah, S., Muhlisin, A., Kusumawati, Y., Siti Zulaekah, A., Nugrahwati, E., Putri, N. F., & Syaiful, A. A. (2024). Efforts to Increase Cadre Capacity for Stunting Prevention. *MethodsX*, *13*, 1–6. https://doi.org/10.1016/j.mex.2024.102720.

Jalloh, U. H., Koroma, A. S., Gaffey, M. F., Confreda, E., Peterson, S., Kargbo, A., Islam, M., Keats, E. C., Bhutta, Z. A., & Juneja, S. (2025). A Mixed-Methods Study

of the Drivers of Stunting Reduction Among Children Under-5 in Sierra Leone, 2005–2017. *American Journal of Clinical Nutrition*, *121*, S106–S112. https://doi.org/10.1016/j.ajcnut.2025.02.015.

Kadaifci, C. (2024). A New Approach to MACTOR Considering Interaction Effects: An Example from the Telecommunications Industry in Turkey. *Technological Forecasting and Social Change*, *209,* 123793. https://doi.org/10.1016/j.techfore.2024.123793.

Komarolya, D. V. (2025). Analysis of Stakeholder Power and Convergence for Climate-Resilient Urban Parks: A MACTOR Study in Tabriz. *Environmental and Sustainability Indicators*, *28*, 101019. https://doi.org/10.1016/j.indic.2025.101019.

Ministry of Health. (2019). *Laporan Pelaksanaan Integrasi Susenas dan SSGBI 2019*. Jakarta: Ministry of Health.

Ministry of Health. (2021). *Survei Status Gizi Indonesia*. Jakarta: Ministry of Health.

Ministry of Health. (2022). *Buku Saku: Hasil Survei Status Gizi Indonesia 2022.* Jakarta: Ministry of Health.

Ministry of Health. (2023). *Survei Kesehatan Indonesia*. Jakarta: Ministry of Health.

Monica, M. A., & Yaswinda. (2021). Analisis Implementasi Kurikulum 2013 PAUD di Masa Pandemi Covid-19 di Indonesia. *Jurnal Basicedu, 5*(2), 643–653. https://doi.org/10.31004/basicedu.v5i2.781.

Muflihah, L., Rahmadanik, D., & Widyanto, M. K. (2024). Evaluasi Program Stunting pada Peraturan Bupati No. 6 Tahun 2019 tentang Penurunan Stunting di Kabupaten Bangkalan. *Triwikrama: Jurnal Ilmu Sosial, 3*(12), 7-15.

Orimadegun, A. E., Jegede, A. S., Gaffey, M. F., Olufadewa, I., Confreda, E., Somaskandan, A., Islam, M., Keats, E. C., Ataullahjan, A., Amzat, J., Okonta, P. I., Ezeome, I. V., Farouk, Z., Hamza, A., Adepoju, O. T., Lawanson, A. O., Osungbade, K. O., Akinyemi, J. O., Grange, A., & Bhutta, Z. A. (2025). A Mixed-Methods Study of the Drivers of Stunting Reduction Among Children Under Five in Nigeria, 2008–2018. *American Journal of Clinical Nutrition*, *121*, S86–S94. https://doi.org/10.1016/j.ajcnut.2025.02.022.

Oyenubi, A., & Rossouw, L. (2024). Is the Impact of the South African Child Support Grant on Childhood Stunting Robust? An Instrumental Variable Evaluation. *Children and Youth Services Review*, *164*, 107829. https://doi.org/10.1016/j.childyouth.2024.107829.

Pradhan, I., Pradhan, J., & Kandapan, B. (2023). Caste-Based Analysis of Multidimensional Early Childhood Poverty in India: Patterns and Determinants. *Children and Youth Services Review*, *155*, 107220. https://doi.org/10.1016/j.childyouth.2023.107220.

Prayitno, G., Zuhriyah, L., Efendi, A., Arifin, S., Rahmawati, Auliah, A., & Subagiyo, A. (2025). Community-Powered Environmental Pathways to Reduce Stunting: Food Security, Social Capital, and Open Innovation in Semi-Urban Indonesia. *Environmental Challenges*, *21*, 101350. https://doi.org/10.1016/j.envc.2025.101350.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.48638

Priyono, Priyanti, A., Asnawi, R., Hidayat, Y., Mahendri, I. G. A. P., Yulistiani, D., Daulay, H., Santoso, A. D., Budiharti, U., Unadi, A., Parikesit, A., Yaumidin, U. K., & Irawan. (2025). Mapping Stakeholders' Dynamics for Sustainable PKC Distribution in Cattle Feed: An Integrated MICMAC-MACTOR Analyses. *Environmental Challenges*, *21*, 101376. https://doi.org/10.1016/j.envc.2025.101376.

Rahardiantoro, S., Juhanda, A. R. N., Kurnia, A., Aswi, A., Sartono, B., Handayani, D., Soleh, A. M., Yanti, Y., & Cramb, S. (2024). Spatio-Temporal Modeling to Identify Factors Associated with Stunting in Indonesia using a Modified Generalized Lasso. *Spatial and Spatio-Temporal Epidemiology*, *51*, 100694. https://doi.org/10.1016/j.sste.2024.100694.

Rees, G. H., & MacDonell, S. (2017). Data Gathering for Actor Analyses: A Research Note on the Collection and Aggregation of Individual Respondent Data for MACTOR. *Future Studies Research Journal: Trends and Strategies*, *9*(1), 115–137. https://doi.org/10.24023/futurejournal/2175-5825/2017.v9i1.256.

Rosyada, D. F., Sudargo, T., & Murni, I. K. (2026). Altitude of Area of Residence as a Risk Factor for Stunting in Children aged 0–60 Months: A Systematic Review and Meta-Analysis. *Dialogues in Health*, *8*, 100268. https://doi.org/10.1016/j.dialog.2025.100268.

Saleh, H., Surya, B., Ahmad, D. N. A., & Manda, D. (2020). The Role of Natural and Human Resources on Economic Growth and Regional Development: With Discussion of Open Innovation Dynamics. *Journal of Open Innovation: Technology, Market, and Complexity*, *6*(4), 1–23. https://doi.org/10.3390/joitmc6040103.

Sianti, R. N., Kartasurya, M. I., & Kartini, A. (2024). Analysis Stakeholders: Role in the Implementation of Stunting-Spesific Interventions for Breastfeeding Mothers in Karanganyar Regency. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI), 7*(8), 2078-2084. https://doi.org/10.56338/mppki.v7i8.5582 .

Supranoto, Sasmito, L., Indriastuti, S., Prayitno, H., & Sawir, M. (2025). From Parallel to Partnership Governance: Strengthening Institutional Synergy for Stunting Reduction in Decentralized Indonesia. *Social Sciences and Humanities Open*, *12*, 102051. https://doi.org/10.1016/j.ssaho.2025.102051.

Tim Nasional Percepatan Penanggulangan Kemiskinan [TNP2K]. (2017). 100 Kabupaten/Kota Prioritas untuk Intervensi Anak Kerdil (Stunting). Retrieved from: http://www.tnp2k.go.id/images/uploads/downloads/Binder_Volume1.pdf.

Ulfah, H. R., & Nugroho, F. S. (2020). Hubungan Usia, Pekerjaan dan Pendidikan Ibu dengan Pemberian Asi Eksklusif. *Intan Husada: Jurnal Ilmiah Keperawatan, 8*(1), 9-18. https://doi.org/10.52236/ih.v8i1.171.

Wardono, B., Muhartono, R., Hikmayani, Y., & Apriliani, T. (2019). Analisis Prospektif Peran Aktor Dalam Strategi Formulasi. *Jurnal Sosial Ekonomi Kelautan dan Perikanan, 14*(2), 179–195. https://doi.org/10.15578/jsekp.v14i2.8241.

Wayes, G. (2024). Suatu Kajian Teologis Mikha 6:8 Terhadap Program Kartu Indonesia Pintar (KIP) Sebagai Upaya Pemerintah Mengurangi Kemiskinan dan Pemerataan Pendidikan. *Jurnal Penggerak, 6*(1), 171–204. https://doi.org/10.62042/jtp.v6i1.82.

World Health Organization. (2015). *Stunting in a Nutshell*. Retrieved from: https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell.

Yilmaz, H., & Karadayi-Usta, S. (2025). Social Sustainability through Human-Centered Risks Management in Maritime Industry: A Shipbuilding Case Study with Actors' Analysis. *Ocean Engineering*, *332*, 121398. https://doi.org/10.1016/j.oceaneng.2025.121398.

Zhao, X., & Zhao, R. (2025). Sustainable Poverty Alleviation? The Impact and Mechanisms of Forestry Training on the Economic Welfare of Rural Households Over Time in Southern China. *Forest Policy and Economics*, *178*(2), 103565. https://doi.org/10.1016/j.forpol.2025.103565.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Structural Determinants of Regional Poverty in West Nusa Tenggara

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**ABSTRACT**

**Research Originality:** This study contributes to the existing literature by examining the structural determinants of regional poverty at the regency and municipal levels in West Nusa Tenggara Province using the most recent post-pandemic panel dataset.

**Research Objectives:** This study aims to analyze the effects of minimum wages, open unemployment rates, income inequality, and educational attainment on poverty rates in West Nusa Tenggara Province.

**Research Methods:** The study uses panel data spanning 2018–2024 and covers 10 regencies and municipalities in West Nusa Tenggara Province. The Fixed Effects Model (FEM), selected based on the Chow and Hausman specification tests, is employed to estimate the relationship between poverty rates and the explanatory variables.

**Empirical Results:** The results indicate that the minimum wage has a negative, statistically significant effect on poverty rates, whereas income inequality has a positive effect. In contrast, the open unemployment rate and educational attainment do not demonstrate statistically significant effects on poverty.

**Implications:** These findings suggest that poverty alleviation strategies should prioritize strengthening wage protection frameworks and mitigating income inequality to foster inclusive and sustainable regional development.

**Keywords:**
wage policy; income distribution; labor market dynamics; poverty alleviation; regional disparities

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## INTRODUCTION

Poverty remains one of the most persistent challenges in development economics and continues to occupy a central position in the policy agendas of many developing countries, including Indonesia (Murti & Kurniawan, 2020; Purwono et al., 2021; Sugiharti et al., 2022; Fitriady et al., 2024). Despite the sustained implementation of poverty alleviation programs and fiscal decentralization reforms, substantial regional disparities in poverty reduction persist. Poverty is not solely associated with low income; rather, it reflects multidimensional deprivation, including limited access to education, healthcare services, employment opportunities, and productive assets (Aguilar & Sumner, 2020; Breunig & Majeed, 2020; Hernández & Zuluaga, 2022; Zhu et al., 2022). These conditions constrain human capital formation, reduce productivity, and weaken long-term regional competitiveness.

Contemporary academic debates increasingly emphasize the structural dimensions of poverty. The structuralist perspective posits that poverty is embedded in economic systems characterized by unequal access to resources, labor-market segmentation, and the dominance of low-productivity sectors (Breunig & Majeed, 2020; Amponsah et al., 2023; Fahad et al., 2023). The vicious cycle of poverty theory further suggests that low productivity leads to limited income and savings, thereby constraining capital accumulation and perpetuating underdevelopment (Nguyen & Su, 2021). Similarly, the poverty trap framework highlights how limited human capital, restricted access to credit, and labor market rigidities prevent households from escaping chronic deprivation (Radosavljevic et al., 2021). Collectively, these perspectives underscore that poverty is not merely an outcome of individual characteristics but rather a manifestation of interconnected structural constraints.

Empirically, numerous studies have examined the determinants of regional poverty; however, the findings remain inconclusive and, in some cases, contradictory. Research on minimum wages, for instance, yields mixed results. Some studies find that increases in minimum wages reduce poverty by raising the real income of low-wage workers (Sotomayor, 2021; Démurger et al., 2026). In contrast, other studies report limited or even adverse effects, particularly when minimum wage adjustments suppress labor demand or disproportionately benefit formal-sector workers (Backhaus & Müller, 2023; Hijzen et al., 2026). These divergent findings suggest that the relationship between minimum wages and poverty is highly contingent upon labor market structures and institutional contexts.

The relationship between unemployment and poverty has also been widely examined, although both the magnitude and direction of its impact vary across regions (Ngubane et al., 2023). Income inequality is frequently identified as a structural driver of persistent poverty, particularly when economic growth is not inclusive (Adeleye et al., 2020). Nevertheless, the interplay among economic growth, inequality, and poverty remains contested, particularly regarding whether growth alone is sufficient to reduce poverty in the absence of effective redistributive mechanisms.


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Human capital—particularly education—is widely regarded as a primary pathway out of poverty. Empirical evidence indicates that higher levels of education reduce poverty by enhancing productivity and expanding income opportunities (Hofmarcher, 2021; Spada et al., 2024; Leoni, 2025). However, other studies suggest that education does not automatically alleviate poverty when labor markets are unable to absorb skilled workers productively (Mansi et al., 2020; Yassine & Bakass, 2022). These contrasting findings imply that the effects of structural determinants of poverty vary across different economic structures and institutional settings.

Despite the extensive body of literature, a critical research gap remains in understanding how these structural determinants interact simultaneously within subnational contexts, particularly in regions characterized by pronounced spatial inequality. Existing studies tend to adopt partial approaches—either focusing on single determinants or relying on national-level aggregates—thereby overlooking the complex and interdependent nature of poverty drivers at the local level.

Moreover, prior empirical studies rarely capture the dynamic evolution of poverty determinants across different economic phases, particularly before, during, and after the COVID-19 pandemic. This limitation creates an important gap in understanding whether structural variables—such as minimum wages, unemployment, inequality, and education—exhibit stable or shifting effects under changing macroeconomic conditions. Another notable limitation is the scarcity of panel data analyses at the district and municipal levels, particularly in less developed regions of Eastern Indonesia. Consequently, the existing literature provides limited evidence on how localized economic structures and institutional capacities shape poverty dynamics within a decentralized governance system.

**Table 1. Number and Percentage of the Poor Population in West Nusa Tenggara Province, 2018–2024**

| Year | Number of Poor Population (thousand persons) | Poverty Rate (%) |
|---|---|---|
| 2018 | 737.46 | 14.75 |
| 2019 | 735.96 | 14.56 |
| 2020 | 713.89 | 13.97 |
| 2021 | 746.66 | 14.14 |
| 2022 | 731.94 | 13.68 |
| 2023 | 751.23 | 13.85 |
| 2024 | 709.01 | 12.91 |

Source: Statistics Indonesia (BPS) and One Data West Nusa Tenggara; compiled and processed by the author (2026).

West Nusa Tenggara Province provides a relevant empirical setting for this analysis. Although poverty rates have been declining, they remain above the national average (see Table 1). Fluctuations observed during the pandemic period indicate structural vulnerabilities that cannot be explained solely by cyclical shocks. Moreover, disparities across districts and municipalities—particularly in North Lombok—reflect variations in regional economic capacity and structural characteristics (see Table 2). These features make

West Nusa Tenggara an appropriate case for examining structural poverty dynamics at the subprovincial level.

Building on these gaps, this study introduces a novel element by integrating multiple structural determinants—minimum wages, open unemployment, income inequality, and education—within a single balanced panel data framework at the district and municipal levels. Unlike prior studies that rely on static or partial analyses, this research explicitly captures temporal dynamics over the 2018–2024 period, encompassing pre-pandemic, pandemic, and post-pandemic phases, thereby enabling a more nuanced understanding of structural resilience and vulnerability.

**Table 2. Poverty Rate by Regency/City in West Nusa Tenggara Province, 2018–2024 (%)**

| Regency/City | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|
| West Lombok | 15.20 | 15.17 | 14.28 | 14.47 | 13.39 | 13.67 | 12.65 |
| Central Lombok | 13.87 | 13.63 | 13.44 | 13.44 | 12.89 | 12.93 | 12.07 |
| East Lombok | 16.55 | 16.15 | 15.24 | 15.38 | 15.14 | 15.63 | 14.51 |
| Sumbawa | 14.08 | 13.90 | 13.65 | 13.91 | 13.50 | 13.91 | 12.87 |
| Dompu | 12.40 | 12.25 | 12.16 | 12.60 | 12.40 | 12.62 | 11.59 |
| Bima | 14.84 | 14.76 | 14.49 | 14.88 | 14.50 | 14.39 | 13.88 |
| West Sumbawa | 14.17 | 14.00 | 13.34 | 13.54 | 13.02 | 12.95 | 12.23 |
| North Lombok | 28.83 | 29.03 | 26.99 | 27.04 | 25.93 | 25.80 | 23.96 |
| Mataram City | 8.96 | 8.92 | 8.47 | 8.65 | 8.63 | 8.62 | 8.00 |
| Bima City | 8.79 | 8.60 | 8.35 | 8.88 | 8.80 | 8.67 | 8.12 |

Source: Statistics Indonesia (BPS) and One Data West Nusa Tenggara; compiled and processed by the author (2026).

Furthermore, this study contributes to the literature by focusing on a relatively underexplored regional context—West Nusa Tenggara—thereby providing granular empirical evidence that complements national-level findings and advances the discourse on spatially inclusive development. Specifically, this study examines the effects of minimum wages, open unemployment rates, income inequality, and education levels on poverty rates across districts and municipalities in West Nusa Tenggara Province during the 2018–2024 period. By elucidating the structural mechanisms underlying regional poverty, this research contributes to the development economics literature and provides an evidence-based foundation for designing targeted, inclusive poverty-alleviation strategies tailored to regional characteristics.

## METHODS

This study adopts a quantitative research design employing panel data regression to examine the effects of structural determinants on the poverty rate in Nusa Tenggara Barat Province. The structural variables considered include the minimum wage, the open unemployment rate, income distribution inequality proxied by the Gini ratio, and educational attainment proxied by mean years of schooling. A panel data framework was


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selected because it simultaneously captures cross-sectional variation across regencies or municipalities and temporal variation over time. Compared to purely cross-sectional or time-series approaches, panel data models generate more efficient and consistent parameter estimates (Anser et al., 2020; Baltagi, 2021). Furthermore, panel estimation techniques allow for controlling for unobserved regional heterogeneity that may influence poverty levels but cannot be directly observed or measured.

The sample comprises all 10 regencies or municipalities in Nusa Tenggara Barat Province over the period 2018–2024, yielding a balanced panel of 70 observations (10 cross-sectional units × 7 years). The selection of the 2018–2024 period is based on three considerations. First, the period ensures data availability and consistency at the regency or municipal level, as standardized statistics were regularly published during these years. Second, the timeframe captures significant structural dynamics, including pre-pandemic conditions, economic contraction during the COVID-19 pandemic (2020–2021), and the subsequent recovery phase (2022–2024). Incorporating this period enables the model to account for structural shocks and post-shock adjustments in poverty dynamics. Third, the use of recent data enhances the policy relevance of the findings, particularly in the context of regional development planning under fiscal decentralization.

The study relies on secondary data obtained from official and authoritative sources. The primary data source is Statistics Indonesia (BPS), including publications on Poverty Statistics, People's Welfare Indicators, the National Labor Force Survey, Education Indicators, and Income Distribution Statistics. Supplementary data were collected from the official database of the Provincial Government of Nusa Tenggara Barat. All datasets were verified, harmonized in terms of measurement units, and aligned across time to preserve the balanced panel structure. Data collection followed a systematic documentation procedure involving downloading, compiling, and processing quantitative information from official publications and databases (Taherdoost, 2022).

**Table 3. Operational Definitions and Measurement of Variables**

| Variable | Operational Definition | Unit | Source |
|---|---|---|---|
| Poverty Rate | Percentage of the population with average per capita monthly expenditure below the poverty line | Percent | Statistics Indonesia |
| Minimum Wage | Statutory monthly minimum wage is established as the lowest permissible wage for workers in each regency or municipality | Thousand rupiah | Statistics Indonesia |
| Open Unemployment Rate | The percentage of the labor force that is unemployed | Percent | Statistics Indonesia |
| Gini Ratio | Indicator of income distribution inequality | Index (0–1) | Statistics Indonesia |
| Mean Years of Schooling | Average number of years of formal education completed by the population | Years | Statistics Indonesia |

The dependent variable is the poverty rate, defined as the percentage of the population whose average per capita monthly expenditure falls below the official poverty

line in each regency or municipality. The independent variables are defined as follows: (1) the regency or municipal minimum wage, measured in thousand rupiah per month; (2) the open unemployment rate, measured as the percentage of the labor force that is unemployed; (3) the Gini ratio, representing income distribution inequality; and (4) mean years of schooling, measured in years as an indicator of educational attainment. To mitigate potential heteroskedasticity and facilitate elasticity-based interpretation of the coefficients, the poverty rate variable was transformed to its natural logarithm.

The empirical specification was estimated using three panel data approaches: Pooled Ordinary Least Squares (Pooled OLS), the Fixed Effects Model (FEM), and the Random Effects Model (REM). Model selection proceeded sequentially. First, the Chow test was employed to compare Pooled OLS and FEM. Rejection of the null hypothesis of homogeneous intercepts indicated the preference for FEM. Second, the Hausman test was conducted to determine the most appropriate specification between FEM and REM. The null hypothesis of the Hausman test states that the REM estimator is consistent and efficient. Rejection of this hypothesis implies that FEM provides more consistent estimates. This selection procedure ensures that the chosen model appropriately accounts for unobserved regional heterogeneity (Baltagi, 2021). The general regression model is specified as follows:

$$\ln(POV)_{it} = \alpha + \beta_1 WAGE_{it} + \beta_2 OUR_{it} + \beta_3 GR_{it} + \beta_4 MYS_{it} + \varepsilon_{it} \quad (1)$$

Where $\ln(POV)_{it}$ denotes the natural logarithm of the poverty rate in regency or municipality i at time t; $WAGE_{it}$ represents the minimum wage; $OUR_{it}$ denotes the open unemployment rate; $GR_{it}$ refers to the Gini ratio; $MYS_{it}$ indicates mean years of schooling; $\alpha$ is the intercept; $\beta_1$–$\beta_4$ are slope coefficients; and $\varepsilon_{it}$ is the error term.

**Table 4. Multicollinearity Test Results (Correlation Matrix)**

| Variable | WAGE | OUR | GR | MYS |
|---|---|---|---|---|
| WAGE | 1.000 | -0.095 | 0.145 | 0.188 |
| OUR | -0.095 | 1.000 | 0.334 | -0.339 |
| GR | 0.145 | 0.334 | 1.000 | -0.076 |
| MYS | 0.188 | -0.339 | -0.076 | 1.000 |

Notes: All pairwise correlation coefficients are below the conventional threshold of 0.80, indicating no serious multicollinearity.

Source: Processed using EViews 13 (2026).

Following model selection, diagnostic tests were performed to ensure the robustness of the estimations. Multicollinearity was assessed using the Variance Inflation Factor (VIF), while heteroskedasticity was tested using the Glejser procedure. When heteroskedasticity was detected, robust standard errors were applied to ensure consistent statistical inference.


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**Table 5. Heteroskedasticity Test Results (Glejser Test)**

| Variable | Probability |
|---|---|
| WAGE | 0.256 |
| OUR | 0.823 |
| GR | 0.211 |
| MYS | 0.867 |

Notes: All probability values exceed 0.05, indicating that the model does not exhibit heteroskedasticity.
Source: Processed using EViews 13 (2026).

Hypothesis testing involved the F-test to evaluate the joint significance of all explanatory variables and the t-test to assess the partial effects of individual variables at the 1%, 5%, and 10% significance levels. The coefficient of determination ($R^2$) was used to assess the model's ability to capture variation in poverty across regions and over time. All statistical analyses were conducted using EViews 13.

## RESULTS AND DISCUSSION

This study employs panel data regression analysis using three alternative specifications—the Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM)—to examine the effects of minimum wage, open unemployment rate, income distribution inequality, and education level on poverty. The estimation results indicate that the minimum wage and income distribution inequality are statistically significant determinants of poverty. In contrast, the open unemployment rate and average years of schooling do not exhibit statistically significant effects, as shown in Table 7 under the selected Fixed Effects Model.

**Table 6. Model Selection Test Results**

| Test | Test Statistic | Probability | Decision |
|---|---|---|---|
| Chow Test (Pooled OLS vs. FEM) | 370.865 | 0.000*** | FEM selected |
| Hausman Test (FEM vs. REM) | 10.758 | 0.029** | FEM selected |

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10.
Source: Processed using EViews 13 (2026).

Model selection was conducted through a series of specification tests. The Chow test yielded a probability value of 0.000, leading to the rejection of the Pooled OLS in favor of the FEM. Furthermore, the Hausman test yielded a p-value of 0.029, indicating that the FEM is more appropriate than the REM. These findings confirm the presence of unobserved regional heterogeneity correlated with the explanatory variables, thereby justifying the use of a fixed effects specification (see Table 6).

Prior to interpreting the regression coefficients, classical diagnostic tests were performed. The multicollinearity test reported in Table 4 shows that all pairwise correlation coefficients among the independent variables are below 0.80, suggesting the absence of

serious multicollinearity. In addition, the Glejser heteroskedasticity test in Table 5 indicates that all p-values exceed 0.05, suggesting no evidence of heteroskedasticity. Accordingly, the estimated model satisfies the underlying regression assumptions and is suitable for statistical inference.

**Table 7. Panel Data Estimation Results**

| Dependent Variable: ln(POV) | | | |
|---|---|---|---|
| **Variable** | **Coefficient** | | |
| | **Pooled OLS** | **FEM** | **REM** |
| WAGE | -4.036* | -2.406*** | -2.436*** |
| OUR | -1.653*** | 0.100 | 0.079 |
| GR | -34.867*** | 5.571** | 5.299** |
| MYS | -3.256 | 9.666 | 9.536 |
| Constant | 43.279 | 10.083 | 10.399 |
| **Model Summary Statistics** | | | |
| $R^2$ | 0.372 | 0.989 | 0.454 |
| Adjusted $R^2$ | 0.333 | 0.987 | 0.420 |
| F-statistic | 9.623 | 411.342 | 13.503 |
| Prob (F-statistic) | 0.000 | 0.000 | 0.000 |

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10.
Source: Processed using EViews 13 (2026).

Individually, the minimum wage has a negative effect on poverty. This result indicates that increases in the minimum wage are associated with reductions in poverty levels. Within the wage-led growth framework, higher minimum wages enhance the real income of low-wage workers, strengthen purchasing power, and stimulate aggregate demand. This finding is consistent with a broader body of empirical literature. Duncan (2021), Wang et al. (2023), and Démurger et al. (2026) demonstrate that minimum wage policies contribute to poverty reduction, particularly in regions with a relatively high share of formal-sector employment. Similarly, Lv et al. (2023) and Arranz and Garcia-Serrano (2025) argue that minimum wage increases can improve welfare among low-income workers when labor market distortions are limited. However, some studies, such as Chenarides et al. (2025), highlight potential adverse employment effects, suggesting that the net impact depends on labor market conditions and enforcement capacity. From the perspective of efficiency wage theory, higher wages may also improve productivity and job stability, thereby reinforcing poverty-reducing effects. In segmented labor markets characteristic of many developing economies, minimum wage policy serves as a regional redistributive instrument.

In contrast, income inequality has a positive effect on poverty. This finding reinforces the inequality–poverty nexus, indicating that higher levels of inequality diminish the poverty-reducing impact of economic growth. Elevated inequality constrains low-income groups' access to economic opportunities, productive assets, and social services, thereby


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increasing vulnerability. This result is consistent with Wan et al. (2021), Adeleye et al. (2020), and Delgado et al. (2025), who report that rising inequality significantly exacerbates poverty. In addition, Adeleye et al. (2020) and Breunig and Majeed (2020) emphasize that high inequality reduces the elasticity of poverty with respect to growth, meaning that economic expansion becomes less effective in alleviating poverty. The relative deprivation perspective further suggests that structural inequality limits social mobility and undermines the inclusiveness of economic growth. These findings collectively confirm that, without equitable distribution mechanisms, growth alone is insufficient to achieve meaningful poverty reduction.

The open unemployment rate does not exert a statistically significant effect on poverty. This outcome implies that the relationship between unemployment and poverty at the regional level is not necessarily direct. In many developing economies, a substantial share of the labor force is absorbed into the informal sector, which provides alternative—albeit low-productivity—sources of income. Consequently, poverty appears to be more closely associated with income quality and stability rather than open unemployment status per se. This finding aligns with studies such as Benavides et al. (2022) and Misra et al. (2024), which emphasize the dominant role of informal employment in shaping livelihood strategies in developing countries. Although this result differs from Ngubane et al. (2023) and Zaman et al. (2023), who document a significant positive relationship between unemployment and poverty, it supports the argument that conventional employment indicators may not adequately capture household economic vulnerability in economies dominated by informal employment. Therefore, underemployment and vulnerable employment may constitute more appropriate indicators for explaining poverty dynamics.

Similarly, education level, proxied by average years of schooling, does not have a statistically significant effect on poverty. While human capital theory posits that education enhances productivity and income potential, empirical results suggest that improvements in formal education do not automatically translate into poverty reduction in the absence of sufficient labor-market absorption. This finding contrasts with Apergis et al. (2022) and Spada et al. (2024), but is supported by Yassine and Bakass (2022), who argue that education expansion without corresponding job creation may lead to "educated unemployment." Furthermore, Goczek et al. (2021) highlight that the quality of education, rather than years of schooling alone, plays a crucial role in determining economic outcomes. Structural constraints such as skill mismatches, limited industrial diversification, and weak demand for skilled labor further hinder the effective transmission of educational attainment into higher income and sustained poverty alleviation.

Overall, the findings underscore that structural and distributive factors—particularly wage policy and income inequality—play a more decisive role in shaping poverty dynamics than labor quantity indicators or formal educational attainment. This conclusion is consistent with the broader development literature, including Alekhina and Ganelli (2023) and Saher et al. (2024), which emphasizes the importance of inclusive

growth and equitable distribution. The policy implications highlight the need to strengthen minimum-wage enforcement, promote more equitable income distribution, and advance an economic transformation capable of generating productive and decent employment. In addition, complementary policies—such as improving education quality, expanding social protection, and formalizing the informal sector—are crucial to maximizing the effectiveness of poverty reduction strategies. Such an integrated and multidimensional approach is essential for achieving sustainable poverty reduction at the regional level.

## CONCLUSION

This study examines the effects of key structural determinants—namely the minimum wage, open unemployment rate, income inequality, and educational attainment—on regional poverty in West Nusa Tenggara over the 2018–2024 period. The empirical results from the Fixed Effects model indicate that the minimum wage and income inequality are the primary determinants of poverty. The minimum wage exerts a negative effect on poverty, suggesting that higher wage standards contribute to poverty reduction by improving income levels and purchasing power. In contrast, income inequality has a positive effect, indicating that a more unequal income distribution exacerbates poverty. Meanwhile, the open unemployment rate and average years of schooling do not exhibit statistically significant effects, suggesting that poverty is more strongly shaped by income structure than by labor market participation or educational attainment alone.

Based on these findings, several policy recommendations are proposed. The government should strengthen minimum wage policies through consistent enforcement and effective monitoring, particularly in sectors dominated by vulnerable workers, to ensure adequate income protection. In addition, efforts to reduce income inequality should be intensified through the expansion of targeted social protection programs, the implementation of progressive fiscal policies, and support for micro and small enterprises to enhance income distribution. Furthermore, development policies should prioritize the creation of productive and inclusive employment opportunities aligned with regional economic potential, thereby enabling more equitable economic growth and more effective poverty alleviation.

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## REFERENCES

Adeleye, B. N., Gershon, O., Ogundipe, A., Owolabi, O., Ogunrinola, I., & Adediran, O. (2020). Comparative Investigation of the Growth-Poverty-Inequality Trilemma in Sub-Saharan Africa and Latin American and Caribbean Countries. *Heliyon*, *6*(12), e05631. https://doi.org/10.1016/j.heliyon.2020.e05631.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50234

Aguilar, G. R., & Sumner, A. (2020). Who Are The World's Poor? A New Profile of Global Multidimensional Poverty. *World Development*, *126*, 104716. https://doi.org/10.1016/j.worlddev.2019.104716.

Alekhina, V., & Ganelli, G. (2023). Determinants of Inclusive Growth in ASEAN. *Journal of the Asia Pacific Economy*, *28*(3), 1196–1228. https://doi.org/10.1080/13547860.2021.1981044.

Amponsah, M., Agbola, F. W., & Mahmood, A. (2023). The Relationship between Poverty, Income Inequality, and Inclusive Growth in Sub-Saharan Africa. *Economic Modelling*, *126*, 106415. https://doi.org/10.1016/j.econmod.2023.106415.

Anser, M. K., Yousaf, Z., Nassani, A. A., Alotaibi, S. M., Kabbani, A., & Zaman, K. (2020). Dynamic Linkages between Poverty, Inequality, Crime, and Social Expenditures in a Panel of 16 Countries: Two-step GMM Estimates. *Journal of Economic Structures*, *9*(1), 43. https://doi.org/10.1186/s40008-020-00220-6.

Apergis, N., Polemis, M., & Soursou, S. E. (2022). Energy Poverty and Education: Fresh Evidence from a Panel of Developing Countries. *Energy Economics*, *106*, 105430. https://doi.org/10.1016/j.eneco.2021.105430.

Arranz, J. M., & Garcia-Serrano, C. (2025). Assessing the Impact of an Increase in the Minimum Wage on Household Income and Poverty. *Social Science Research*, *127*, 103143. https://doi.org/10.1016/j.ssresearch.2025.103143.

Backhaus, T., & Müller, K. U. (2023). Can a Federal Minimum Wage Alleviate Poverty and Income Inequality? Ex-Post and Simulation Evidence from Germany. *Journal of European Social Policy, 33*(2), 216–232. https://doi.org/10.1177/09589287221144233.

Baltagi, B. H. (2021). *Econometric Analysis of Panel Data (6th ed.)*. Berlin: Springer.

Benavides, F. G., Silva-Peñaherrera, M., & Vives, A. (2022). Informal Employment, Precariousness, and Decent Work: from Research to Preventive Action. *Scandinavian Journal of Work, Environment & Health*, *48*(3), 169. https://doi.org/10.5271/sjweh.4024.

Breunig, R., & Majeed, O. (2020). Inequality, Poverty, and Economic Growth. *International Economics*, *161*, 83–99. https://doi.org/10.1016/j.inteco.2019.11.005.

Chenarides, L., Richards, T. J., Rutledge, Z., & Pender, J. (2025). Dollar Store Impact on Local Labor Markets and Retail Activity. *Food Policy*, *132*, 102827. https://doi.org/10.1016/j.foodpol.2025.102827.

Delgado, I., Dahal, S., Matute, M. I., Rubilar Ramírez, P. A., Mamelund, S. E., & Chowell, G. (2025). Socioeconomic Inequalities in Chile During the COVID-19 Pandemic: A Regional Analysis of Income Poverty. *PLOS ONE*, *20*(5), e0323409. https://doi.org/10.1371/journal.pone.0323409.

Démurger, S., Lin, C., Schmillen, A., & Wang, D. (2026). Falling into Poverty or Escaping from It? The Effect of the Minimum Wage in Urban China. *World Development*, *198*, 107227. https://doi.org/10.1016/j.worlddev.2025.107227.

Duncan, G. J. (2021). A Roadmap to Reducing Child Poverty. *Academic Pediatrics*, *21*(8), S97–S101. https://doi.org/10.1016/j.acap.2021.04.028.

Fahad, S., Nguyen-Thi-Lan, H., Nguyen-Manh, D., Tran-Duc, H., & To-The, N. (2023). Analyzing the Status of Multidimensional Poverty of Rural Households by Using Sustainable Livelihood Framework: Policy Implications for Economic Growth. *Environmental Science and Pollution Research*, *30*(6), 16106–16119. https://doi.org/10.1007/s11356-022-23143-0.

Fitriady, A., Silvia, V., & Suriani, S. (2022). Does Economic Growth Mediate Investment, Inflation, and Human Development Investment on Poverty in Indonesia? *Signifikan: Jurnal Ilmu Ekonomi*, *11*(2), 437–456. https://doi.org/10.15408/sjie.v11i2.26145.

Goczek, Ł., Witkowska, E., & Witkowski, B. (2021). How Does Education Quality Affect Economic Growth? *Sustainability*, *13*(11), 6437. https://doi.org/10.3390/su13116437.

Hernández, J. E., & Zuluaga, B. (2022). Vulnerability to Multidimensional Poverty: An Application to Colombian Households. *Social Indicators Research*, *164*(1), 345–371. https://doi.org/10.1007/s11205-022-02961-2.

Hijzen, A., Montenegro, M., & Pessoa, A. S. (2026). Minimum Wages in a Dual Labor Market: Evidence from the 2019 Minimum-Wage Hike in Spain. *Labour Economics, 98*, 102826. https://doi.org/10.1016/j.labeco.2025.102826.

Hofmarcher, T. (2021). The Effect of Education on Poverty: A European Perspective. *Economics of Education Review*, *83*, 102124. https://doi.org/10.1016/j.econedurev.2021.102124.

Leoni, S. (2025). A Historical Review of the Role of Education: From Human Capital to Human Capabilities. *Review of Political Economy*, *37*(1), 227–244. https://doi.org/10.1080/09538259.2023.2245233.

Lv, X., Yu, Y., Zhao, X., & Si, D. K. (2023). Minimum Wage and Household Economic Vulnerability: Evidence from China. *Economic Analysis and Policy*, *80*, 624–646. https://doi.org/10.1016/j.eap.2023.09.008.

Mansi, E., Hysa, E., Panait, M., & Voica, M. C. (2020). Poverty—A Challenge for Economic Development? Evidence from Western Balkan Countries and the European Union. *Sustainability*, *12*(18), 7754. https://doi.org/10.3390/su12187754.

Misra, A. K., Kumari, M., & Sajid, M. (2024). Role of Informal Sector to Combat Unemployment in Developing Economy: A Modeling Study. *Heliyon*, *10*(13), e33378. https://doi.org/10.1016/j.heliyon.2024.e33378.

Murti, S. A., & Kurniawan, R. (2020). The Linkage of Employment to Poverty in Central Java from 2010 to 2017. *Signifikan: Jurnal Ilmu Ekonomi*, 9(2), 195–206. https://doi.org/10.15408/sjie.v9i2.14466.

Ngubane, M. Z., Mndebele, S., & Kaseeram, I. (2023). Economic Growth, Unemployment and Poverty: Linear and Non-Linear Evidence from South Africa. *Heliyon*, *9*(10), e20267. https://doi.org/10.1016/j.heliyon.2023.e20267.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50234

Nguyen, C. P., & Su, T. D. (2021). The 'Vicious Cycle' of Energy Poverty and Productivity: Insights from 45 Developing Countries. *Environmental Science and Pollution Research*, *28*(40), 56345–56362. https://doi.org/10.1007/s11356-021-14614-x.

Purwono, R., Wardana, W. W., Haryanto, T., & Mubin, M. K. (2021). Poverty Dynamics in Indonesia: Empirical Evidence from Three Main Approaches. *World Development Perspectives*, *23*, 100346. https://doi.org/10.1016/j.wdp.2021.100346.

Radosavljevic, S., Haider, L. J., Lade, S. J., & Schlüter, M. (2021). Implications of Poverty Traps across Levels. *World Development*, *144*, 105437. https://doi.org/10.1016/j.worlddev.2021.105437.

Saher, L., Tabák, L., Lyeonov, S., & Vasa, L. (2024). Inclusive Growth: Literature Review. *Journal of International Studies*, *17*(1), 205–232. https://doi.org/10.14254/2071-8330.2024/17-1/12.

Sotomayor, O. J. (2021). Can the Minimum Wage Reduce Poverty and Inequality in the Developing World? Evidence from Brazil. *World Development*, *138*, 105182. https://doi.org/10.1016/j.worlddev.2020.105182.

Spada, A., Fiore, M., & Galati, A. (2024). The Impact of Education and Culture on Poverty Reduction: Evidence from Panel Data of European Countries. *Social Indicators Research*, *175*(3), 927–940. https://doi.org/10.1007/s11205-023-03155-0.

Sugiharti, L., Purwono, R., Padilla, M. A. E., & Jayanti, A. D. (2022). Poverty Dynamics in Indonesia: The Prevalence and Causes of Chronic Poverty. *Journal of Population and Social Studies*, *30*, 423–447. https://doi.org/10.25133/jpssv302022.025.

Taherdoost, H. (2022). What Are Different Research Approaches? Comprehensive Review of Qualitative, Quantitative, and Mixed Method Research, Their Applications, Types, and Limitations. *Journal of Management Science & Engineering Research*, *5*(1), 53–63. https://doi.org/10.30564/jmser.v5i1.4538.

Wan, G., Hu, X., & Liu, W. (2021). China's Poverty Reduction Miracle and Relative Poverty: Focusing on the Roles of Growth and Inequality. *China Economic Review*, *68*, 101643. https://doi.org/10.1016/j.chieco.2021.101643.

Wang, M., Lin, H., Huang, Y., & Lu, H. (2023). Poverty Alleviation and Firm Productivity: Evidence from China's Minimum Wage System. *International Review of Financial Analysis*, *87*, 102595. https://doi.org/10.1016/j.irfa.2023.102595.

Yassine, A., & Bakass, F. (2022). Do Education and Employment Play a Role in Youth's Poverty Alleviation? Evidence from Morocco. *Sustainability*, *14*(18), 11750. https://doi.org/10.3390/su141811750.

Zaman, U., Onwe, J. C., Jena, P. K., Anyanwu, O. C., Ebeh, J. E., & Fulu, O. (2023). Unraveling the Intricate Relationship between Unemployment, Population, and Poverty in Sub-Saharan Africa: Does Quality of Life Matter? *Sustainable Development*, *31*(5), 3930–3945. https://doi.org/10.1002/sd.2635.

Zhu, Y., Bashir, S., & Marie, M. (2022). Assessing the Relationship Between Poverty and Economic Growth: Does Sustainable Development Goal can be Achieved? *Environmental Science and Pollution Research*, *29*(19), 27613–27623. https://doi.org/10.1007/s11356-021-18240-5.


http://journal.uinjkt.ac.id/index.php/signifikan
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# Digital Financial Instruments, Financial Inclusion, and Regional Economic Performance in Indonesia

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**ABSTRACT**

**Research Originality**: This study examines the joint effects of digital financial instruments and financial inclusion indicators on regional economic performance during the post-pandemic period of accelerated digital transformation.

**Research Objectives**: The study aims to analyze the impact of electronic money transactions, third-party funds of Rural Banks (BPR), credit card transactions, and household internet access on Gross Regional Domestic Product (GRDP) per capita.

**Research Methods**: Using panel data from 38 provinces over the 2020–2024 period, this study employs panel regression analysis. Based on the Chow and Hausman tests, the Fixed Effects Model (FEM) is selected as the most appropriate estimator.

**Empirical Results**: The findings indicate that electronic money transactions, credit card transactions, and household internet access have a positive effect on GRDP per capita. In contrast, third-party funds of Rural Banks do not demonstrate a significant relationship with regional economic performance.

**Implications**: The results underscore the importance of strengthening digital financial ecosystems and expanding digital infrastructure to foster inclusive and sustainable regional economic growth in emerging economies.

**Keywords:**
digital finance; GRDP per capita; panel data; regional economy; financial inclusion; emerging economies

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## INTRODUCTION

Digital transformation in the financial sector has emerged as a major driver of structural change in modern economies, including those of developing countries (Barroso & Laborda, 2022; Dakwal et al., 2024). The rapid expansion of financial technology (fintech), electronic payment systems, and internet-based financial services has fundamentally reshaped patterns of access to and utilization of financial services by households and firms (Bollaert et al., 2021; Nugraha et al., 2022). From a development economics perspective, digital financial transformation not only reflects technological advancement but also functions as a structural mechanism that deepens financial intermediation, reduces transaction costs, and promotes more inclusive economic growth.

In Indonesia, the acceleration of digital payment systems has been actively promoted by both the monetary authority and the government. Bank Indonesia has designated electronic money, the Quick Response Code Indonesian Standard (QRIS), and various non-cash payment instruments as central pillars of the national digital economic architecture (Muchtar et al., 2024). The digitalization of payment systems aims to integrate formal and informal economic actors, expand financial inclusion, and reduce interregional disparities—particularly in provinces with limited access to conventional banking services (Widarwati et al., 2022). The post–COVID-19 pandemic period further accelerated this transformation, as mobility restrictions stimulated the widespread adoption of digital transactions across sectors.

The development economics literature consistently demonstrates that inclusive financial systems play a critical role in promoting economic growth and reducing inequality (Omar & Inaba, 2020; Menyelim et al., 2021). Access to financial services enables households and firms to manage risk, accumulate capital, and expand productive activities (Hasan et al., 2021). However, empirical evidence on the growth effects of financial inclusion remains inconclusive. Some studies report that fintech integration and enhanced financial inclusion positively contribute to economic growth and financial system stability (Rossi & Scalise, 2022; Azmeh & Al-Raeei, 2024; Sant'Anna & Figueiredo, 2024). Others argue that the magnitude and direction of these effects depend on institutional quality, financial system depth, and socio-economic readiness (Liu et al., 2021; Xi & Wang, 2023; Yakubi et al., 2022; Chinoda & Kapingura, 2024; Meniago, 2025). These divergent findings suggest that the economic impact of financial digitalization is neither automatic nor uniform across regions.

Alongside advances in digital technology, the determinants of financial inclusion are no longer confined to the presence of formal financial institutions; they also encompass digital infrastructure and digital financial literacy (Kass-Hanna et al., 2022; Choung et al., 2023). Indonesia exhibits substantial interprovincial heterogeneity in infrastructure quality, internet penetration, and financial intermediation capacity. This heterogeneity implies that the economic effects of digital transformation are likely to be asymmetric across provinces. Therefore, a macro-regional analytical framework is required to integrate multiple dimensions of the digital financial ecosystem within a unified empirical model.


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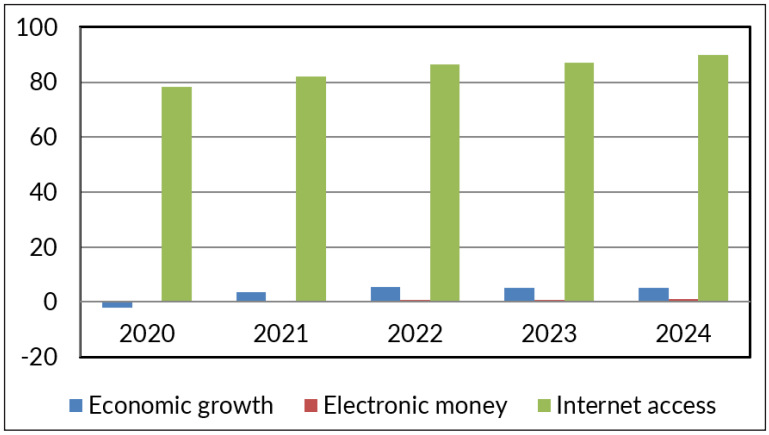
Figure 1 illustrates that economic growth moved in parallel with increases in electronic money transactions and household internet access during the post-pandemic period. The rising intensity of digital transactions coincided with economic recovery and improved performance across provinces. This co-movement suggests a potential structural linkage between digital economic development and regional economic performance. However, the observed relationship remains descriptive. The causal associations among electronic money transactions, financial intermediation indicators, digital access, and regional economic output have not yet been comprehensively examined within an interprovincial panel data framework in Indonesia.

**Figure 1. Trends in Digital Economy Indicators and Indonesia's Economic Performance, 2020–2024**




Source: Badan Pusat Statistik and Bank Indonesia; authors' calculations (2026).

Empirical studies in Indonesia generally conclude that fintech and digital payment systems enhance financial inclusion and transaction efficiency (Nugraha et al., 2022; Setiawan et al., 2021; Muchtar et al., 2024). However, most of these studies adopt micro-level or sectoral perspectives, focusing separately on household behavior, MSMEs, or financial institution performance. At the global level, Tay et al. (2022) observe that research on digital finance remains dominated by micro-level and cross-country analyses, with limited subnational investigation within a single developing country context.

Moreover, prior research tends to examine components of digital finance in isolation—such as financial literacy, fintech adoption, electronic money, or non-cash payments—without integrating these instruments into a unified empirical framework. In contrast, a combined analysis of digital payment intensity (electronic money and credit cards), financial intermediation depth (measured by third-party funds of regional financial institutions), and digital access (proxied by household internet access) more accurately reflects the structural complexity of the digital financial ecosystem. Such an integrated perspective is essential because multidimensional interactions among these components may generate heterogeneous economic effects across regions.

Rather than merely addressing the lack of regional-level evidence, this study departs conceptually from prior literature by positioning digital financial transformation as a

systemic regional growth driver, rather than solely as a financial inclusion instrument. By simultaneously modeling the digitalization of payments, banking intermediation capacity, and digital access within a unified provincial panel framework, this research captures the structural complementarity among digital infrastructure, financial depth, and transactional intensity. This specification enables an assessment of whether digital finance functions as an independent growth catalyst or as a reinforcing mechanism that amplifies existing regional economic capacity.

Based on this framework, the study analyzes the role of digital financial instruments and financial inclusion indicators in explaining regional economic performance across 38 provinces in Indonesia during the 2020–2024 period. Specifically, it examines the effects of electronic money transactions, third-party funds of regional financial institutions, credit card usage, and household internet access on Gross Regional Domestic Product (GRDP) per capita.

The novelty of this research lies not only in its empirical aspects but also in its structural and contextual dimensions. Structurally, it develops an integrated macro-regional model that treats digital payment systems, financial intermediation, and digital access as interrelated components of a unified digital financial ecosystem. Contextually, it exploits the 2020–2024 post-pandemic acceleration phase as a quasi-natural period of digital shock and structural adjustment, thereby capturing transformation dynamics rather than steady-state relationships. Methodologically, the use of a balanced interprovincial panel covering all 38 provinces allows for the identification of heterogeneous regional effects within a single national institutional setting. This design minimizes cross-country institutional bias while preserving meaningful regional variation.

Accordingly, this study advances the development economics literature by providing a meso-level empirical bridge between micro-level digital finance research and cross-country growth analyses. It offers evidence on how digital financial transformation reshapes regional growth structures within a large developing economy and generates policy-relevant insights for designing territorially differentiated digital financial strategies that support inclusive and sustainable economic development in Indonesia.

## METHODS

This study employs an explanatory quantitative design to examine the causal relationships among digital financial instruments, financial inclusion indicators, and regional economic performance in Indonesia. This approach is appropriate because it aims to test theoretically grounded hypotheses and explain causal linkages among variables based on established theoretical frameworks and prior empirical evidence (Taherdoost, 2022). Through this design, the study not only describes observable phenomena but also statistically evaluates the influence of independent variables on the dependent variable.

The study utilizes secondary panel data that combine cross-sectional and time-series dimensions. The unit of analysis consists of 38 provinces in Indonesia, observed over the period 2020–2024, yielding a balanced panel of 190 observations (38 provinces over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five years). Panel data are employed because they increase the number of observations and degrees of freedom, mitigate potential multicollinearity, and control for unobserved heterogeneity across provinces (Ocharive & Iworiso, 2024) The selected time frame captures the phase of accelerated digital financial transformation following the COVID-19 pandemic.

The data were obtained from official publications of the Central Statistics Agency (Badan Pusat Statistik), Bank Indonesia, and the Financial Services Authority (Otoritas Jasa Keuangan). Data collection was conducted through documentary analysis by compiling consistently and systematically published annual provincial-level statistics (Sardana et al., 2023). The use of official institutional sources enhances data validity, reliability, and cross-regional comparability.

The dependent variable is Gross Regional Domestic Product (GRDP) per capita at current prices, which serves as a proxy for regional economic performance. GRDP per capita reflects the average income level of a region's population and its productive capacity. The independent variables include: (1) the value of electronic money transactions as an indicator of digital payment intensity; (2) third-party funds of conventional Rural Banks (BPR) as a measure of local financial intermediation; (3) the value of credit card transactions as a proxy for formal consumer credit activity; and (4) the percentage of households with internet access as an indicator of digital infrastructure readiness.

**Table 1. Operational Definitions and Measurement of Research Variables**

| Variable | Operational Definition | Unit | Data Source |
|---|---|---|---|
| GRDP per Capita | The total value of final goods and services produced in a province in one year, divided by the total population at current prices | Million rupiah per capita | BPS |
| Electronic Money Transactions | Total annual value of electronic money transactions at the provincial level | Billion rupiah | Bank Indonesia |
| Third-Party Funds of Rural Banks (BPR) | Total public funds collected by conventional Rural Banks in a province | Billion rupiah | OJK |
| Credit Card Transactions | Total annual value of credit card transactions at the provincial level | Million rupiah | Bank Indonesia |
| Households with Internet Access | Percentage of households that accessed the internet within the last three months | Percent | BPS |

The econometric specification is formulated as follows:

$$GRDP_{it} = \alpha + \beta_1 EM_{it} + \beta_2 BPR_{it} + \beta_3 CC_{it} + \beta_4 INT_{it} + \varepsilon_{it} \quad (1)$$

Where $GRDP_{it}$ denotes GRDP per capita of province i in year t; $EM_{it}$ represents the value of electronic money transactions; $BPR_{it}$ denotes third-party funds of conventional Rural Banks; $CC_{it}$ represents the value of credit card transactions; $INT_{it}$ denotes the percentage of households with internet access; $\alpha$ is the intercept term; $\beta_1$–$\beta_4$ are the regression coefficients; and $\varepsilon_{it}$ is the error term.

Panel data regression is estimated using three alternative specifications: the Common Effects Model (CEM), the Fixed Effects Model (FEM), and the Random Effects Model

(REM) (Baltagi, 2021). Model selection is conducted sequentially. The Chow test is used to compare the CEM and FEM, while the Hausman test is used to determine which model is most appropriate between the FEM and REM. The selected specification forms the basis for subsequent inferential analysis. Hypothesis testing is conducted using the F-test to assess the joint significance of all independent variables on GRDP per capita and the t-test to evaluate the partial effect of each independent variable. Statistical significance is assessed at the 1%, 5%, and 10% levels. The coefficient of determination ($R^2$) is used to evaluate the model's explanatory power in accounting for variations in regional economic performance.

**Table 2. Multicollinearity Test Results**

| Variance Inflation Factor (VIF) Analysis | |
|---|---|
| **Variable** | **VIF** |
| Electronic Money (EM) | 3.59 |
| Rural Bank Third-Party Funds (TPF) | 3.50 |
| Credit Cards (CC) | 1.22 |
| Internet Access (INT) | 1.17 |
| Mean VIF | 2.37 |

Note: The VIF values for all explanatory variables are below the conventional threshold of 10, indicating that multicollinearity does not pose a serious concern in the estimated model.

Source: Authors' calculations based on data from Statistics Indonesia (Badan Pusat Statistik), Otoritas Jasa Keuangan, and Bank Indonesia, processed using Stata 17 (2026).

To ensure the validity of the estimators, classical diagnostic tests are performed, including a multicollinearity test using the Variance Inflation Factor (VIF) and a heteroskedasticity test using the Glejser procedure. If heteroskedasticity is detected, the model is re-estimated using robust standard errors to obtain consistent and efficient parameter estimates. All statistical analyses are conducted using Stata version 17.

**Table 3. Heteroskedasticity Test Results**

| Heteroskedasticity Test | | | |
|---|---|---|---|
| **Test** | **Statistic** | **p-Value** | **Conclusion** |
| Glejser Test | 2.54 | 0.111 | No heteroskedasticity detected |

Note: The Glejser test produces a p-value of 0.111, which exceeds the 5% significance level. Accordingly, the null hypothesis of homoskedasticity cannot be rejected, indicating that the regression model is not heteroskedastic.

Source: Authors' calculations based on data obtained from Statistics Indonesia (Badan Pusat Statistik), Otoritas Jasa Keuangan, and Bank Indonesia, processed using Stata 17 (2026).

## RESULTS AND DISCUSSION

The estimation results indicate that digital finance–related variables—namely, electronic money transactions, credit card usage, and the percentage of households with internet access—positively affect GDP per capita in Indonesia. In contrast, third-party funds of conventional Rural Banks (BPR) do not exhibit a statistically significant impact. Based on the Chow test (p-value = 0.000) and the Hausman test (p-value = 0.000),


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the Fixed Effects Model (FEM) was selected as the most appropriate specification (see Table 4). These results confirm the presence of time-invariant unobserved provincial heterogeneity that is correlated with the explanatory variables. Accordingly, structural characteristics, institutional capacity, and socio-economic conditions across provinces contribute systematically to variations in regional economic performance. The classical assumption tests presented in Tables 2 and 3 indicate that the model satisfies the standard econometric adequacy criteria. No serious multicollinearity is detected, as reflected by an average VIF of 2.37, and there is no evidence of heteroskedasticity (p-value = 0.111).

Individually, electronic money transactions have a positive effect on GDP per capita. An increase in digital payment intensity is associated with higher regional income levels. This finding suggests that digital payment systems enhance transaction efficiency, reduce transaction costs, and accelerate the velocity of money, thereby stimulating aggregate economic activity. Beyond efficiency gains, digital payments reduce information asymmetries and expand financial inclusion—particularly among previously unbanked populations—thereby enlarging the effective market size and stimulating productivity-enhancing investments. From an endogenous growth perspective, improvements in payment technology generate spillover effects by facilitating the diffusion of innovation and strengthening market integration across regions.

**Table 4. Fixed Effects Model Estimation Results**

| **Dependent Variable: Gross Regional Domestic Product (GRDP) per Capita** | | | |
|---|---|---|---|
| **Variable** | **Coefficient** | **t-Statistic** | **p-Value** |
| Electronic Money (EM) | 2,852.449 | 6.44 | 0.000*** |
| Rural Bank Third-Party Funds (BPR) | 228.040 | 0.93 | 0.353 |
| Credit Cards (CC) | 337,688.100 | 3.95 | 0.000*** |
| Internet Access (INT) | 2,320.131 | 3.37 | 0.001*** |
| Constant | 111,906.400 | 1.73 | 0.085 |
| **Model Diagnostics** | | | |
| Statistic | **Value** | | |
| Adjusted R-squared | 0.867 | | |
| F-statistic | 42.79 | | |
| Prob > F | 0.000 | | |
| Number of Observations | 190 | | |
| **Model Selection Tests** | | | |
| **Test** | **Probability** | **Decision** | |
| Chow Test | 0.000*** | FEM | |
| Hausman Test | 0.000*** | FEM | |

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10.

Source: Authors' calculations based on data obtained from Statistics Indonesia (Badan Pusat Statistik), the Financial Services Authority (Otoritas Jasa Keuangan), and Bank Indonesia, processed using Stata 17 (2026).

This result is consistent with Wasiaturrahma and Kurniasari (2021), who argue that the development of digital finance strengthens regional economic growth through

improved financial access and transaction efficiency. Chen and Xiao (2025) further demonstrate that digital payment ecosystems integrate formal and informal sectors, thereby expanding the production base and income-generating capacity. Additional evidence from Koomson et al. (2020) and Djahini-Afawoubo et al. (2023) indicates that mobile money adoption significantly increases household income and facilitates poverty reduction through enhanced risk-sharing mechanisms. Oanh and Dinh (2024) also find that digital finance deepens financial systems and enhances economic stability in emerging economies, while Verma et al. (2023) document that ICT-driven financial development stimulates long-term economic growth in developing countries. In light of these studies, the present study provides further empirical evidence that digital transaction instruments function not merely as substitutes for conventional payment methods but also as catalysts of regional structural transformation, particularly in provinces with expanding digital ecosystems.

Credit card use likewise exhibits a positive effect on GDP per capita. Credit-based non-cash instruments help sustain aggregate demand and support economic circulation, particularly in more urbanized provinces. From a development economics perspective, credit cards facilitate consumption smoothing and short-term liquidity management, thereby enhancing regional demand stability. In Keynesian terms, expanded access to consumer credit increases the marginal propensity to consume, amplifying the short-run multiplier effect on output. Moreover, higher credit card penetration may signal greater financial sophistication and institutional maturity, thereby indirectly supporting private-sector expansion.

These findings are consistent with Kredina et al. (2022), who report a positive relationship between non-cash transactions and regional economic growth through the consumption channel. Luo and Zhu (2025) similarly find that credit card expansion increases economic output, particularly in regions with higher levels of financial literacy. Eichengreen et al. (2024) further argue that deeper consumer credit markets support aggregate demand and accelerate economic recovery in emerging markets. Meanwhile, Yang and Zhang (2020) demonstrate that broader financial access enhances economic growth by relaxing liquidity constraints faced by households and firms. However, in contrast to digital payment instruments—which promote long-term structural efficiency—credit cards appear to function primarily as demand stabilizers rather than as agents of production-structure transformation. This distinction reinforces the argument that not all forms of financial deepening exert identical growth effects; their developmental impact depends on whether they expand productive capacity or predominantly stimulate short-term consumption.

Household internet access positively affects GDP per capita, underscoring the critical role of digital infrastructure in boosting regional economic performance. Internet penetration strengthens connectivity, broadens access to digital financial services, and encourages participation in e-commerce and platform-based economic activities (De Clercq et al., 2023; Okolo et al., 2025). More importantly, digital infrastructure reduces geographic barriers, facilitates knowledge diffusion, and improves labor market matching efficiency, thereby increasing total factor productivity at the regional level. From the perspective of new economic geography, enhanced digital connectivity mitigates spatial inequality by integrating peripheral regions into broader economic networks.


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Zhang et al. (2021) show that digital infrastructure significantly improves regional economic performance. Further Trinugroho et al. (2022) document that internet penetration in Indonesia accelerates digital financial adoption and promotes economic growth, particularly in more urbanized provinces. Supporting this view, Briglauer et al. (2025) find that broadband infrastructure significantly increases GDP growth across OECD countries, while Verma et al. (2023) demonstrate that ICT expansion exerts a measurable positive impact on economic growth in developing economies. Compared with these studies, the present study strengthens the argument by empirically integrating digital finance and digital infrastructure variables within a unified panel data framework, thereby highlighting their complementary and mutually reinforcing roles in explaining regional income disparities.

Conversely, third-party funds of conventional Rural Banks (BPR) do not exert a statistically significant effect on GDP per capita. Although the estimated coefficient is positive, it lacks sufficient explanatory power at the macro-regional level. This finding suggests that increased fund mobilization by local microfinance institutions has not been fully translated into higher aggregate output. A deeper interpretation suggests that financial intermediation at the micro level may remain concentrated in low-productivity sectors, with limited spillover effects on industrial upgrading or technological innovation. In addition, the relatively small asset base of BPRs may constrain their capacity to finance scalable, productivity-enhancing investments.

This result aligns with Konstantakopoulou (2023), who argues that the growth impact of local financial intermediation depends critically on the quality of credit allocation and its linkages to productive sectors. Sirag et al. (2025) similarly contend that finance–growth relationships are nonlinear and conditional on the stage of financial development. However, this finding contrasts with Putra et al. (2026), who identify a positive contribution of BPR funds to regional growth in areas characterized by strong MSME ecosystems and supportive local policies. Asante et al. (2023) further emphasize that small financial institutions can stimulate growth when institutional quality and regulatory frameworks are robust. These differences suggest that the effectiveness of microfinance institutions depends on regional structural conditions, institutional capacity, and the degree of integration with digital financial systems.

Overall, the empirical evidence indicates that digital financial instruments and digital infrastructure exert a more consistent and robust influence on regional economic performance than conventional financial intermediation. The strengthened analysis demonstrates that technology-based financial deepening contributes not only through demand stimulation but also through structural efficiency gains, productivity enhancement, and market integration. Digitalization, therefore, emerges as a central driver of regional economic transformation in Indonesia during the period under study. These findings reinforce and extend the growing empirical consensus that digital finance and digital connectivity constitute key determinants of regional growth dynamics. Accordingly, regional development strategies should prioritize strengthening the digital ecosystem, enhancing digital financial literacy, improving institutional quality, and

integrating conventional financial institutions into technology-based economic networks to foster inclusive and sustainable regional growth.

## CONCLUSION

This study examines the contribution of digital financial instruments and financial inclusion to regional economic performance in Indonesia at the provincial level during the post-pandemic phase of digital acceleration. Using panel data estimated through a Fixed Effects Model (FEM), the research objectives have been systematically addressed. The results indicate that digital financial variables—namely, electronic money transactions, credit card usage, and the proportion of households with internet access—positively affect Gross Regional Domestic Product (GRDP) per capita. These findings confirm that the deepening of digital finance and the expansion of digital infrastructure make a substantive contribution to strengthening regional economic performance. In contrast, third-party funds mobilized by Rural Banks (BPR) do not exhibit a significant effect on GRDP per capita. This finding suggests that conventional financial intermediation at the regional level has not yet translated into broader productivity gains, particularly in an increasingly digitalized economy. Accordingly, the effectiveness of financial inclusion appears to be enhanced when embedded within a robust digital financial ecosystem rather than when reliant solely on traditional banking mechanisms.

From a policy perspective, these findings underscore the importance of prioritizing the development of a comprehensive digital financial ecosystem within regional development strategies. The government should accelerate the equitable expansion of digital infrastructure, particularly in provinces with low internet penetration, to mitigate interregional digital disparities. The regulatory framework should also promote the integration of local financial institutions, including Rural Banks, into digital platforms in order to enhance efficiency, expand service outreach, and strengthen competitiveness. In addition, digital financial literacy programs should be scaled up to ensure that increased access to digital financial services translates into productive economic activity rather than remaining confined to transactional use. Effective coordination among monetary authorities, financial regulators, and regional governments is essential to foster innovation while safeguarding financial system stability. Providing targeted incentives for the adoption of digital payment systems among micro, small, and medium enterprises (MSMEs), alongside integrating digital finance into local value chains, may further amplify the growth effects identified in this study.

This study has several limitations. The analysis relies primarily on macro-level quantitative indicators and therefore does not fully capture qualitative dimensions of digital finance usage, such as service efficiency, depth of utilization, and user capability. Moreover, institutional quality and financial literacy were not explicitly incorporated as moderating variables, although both may influence the magnitude and transmission of the relationship between digital finance and economic performance. Future research should incorporate institutional indicators, measures of digital financial literacy, nonlinear modeling frameworks, and spatial econometric approaches to more comprehensively


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capture interregional spillover effects and structural heterogeneity. Overall, this study provides empirical evidence that digital financial transformation constitutes a strategic driver of regional economic growth in Indonesia. Strengthening digital financial inclusion—supported by adequate infrastructure, institutional integration, and enhanced literacy—represents a critical prerequisite for fostering inclusive, resilient, and sustainable regional development.

## REFERENCES

Asante, G. N., Takyi, P. O., & Mensah, G. (2023). The Impact of Financial Development on Economic Growth in Sub-Saharan Africa: Does Institutional Quality Matter? *Development Studies Research*, *10*(1), 2156904. https://doi.org/10.1080/21665095.2022.2156904.

Azmeh, C., & Al-Raeei, M. (2024). Exploring the Dual Relationship Between Fintech and Financial Inclusion in Developing Countries and Their Impact on Economic Growth: Supplement or Substitute? *PLOS ONE*, *19*(12), e0315174. https://doi.org/10.3886/E209535V1.

Baltagi, B. H. (2021). *Econometric Analysis of Panel Data (6th ed.)*. Berlin: Springer.

Barroso, M., & Laborda, J. (2022). Digital Transformation and The Emergence of the Fintech Sector: Systematic Literature Review. *Digital Business*, *2*(2), 100028. https://doi.org/10.1016/j.digbus.2022.100028.

Bollaert, H., Lopez-de-Silanes, F., & Schwienbacher, A. (2021). Fintech and Access to Finance. *Journal of Corporate Finance*, *68*, 101941. https://doi.org/10.1016/j.jcorpfin.2021.101941.

Briglauer, W., Cambini, C., Gugler, K., & Sabatino, L. (2025). Economic Benefits of New Broadband Network Coverage and Service Adoption: Evidence from OECD Member States. *Industrial and Corporate Change*, *34*(4), 696–721. https://doi.org/10.1093/icc/dtae043.

Chen, B., & Xiao, J. (2025). Digital Payments Enhance Both Formal and Informal Credit Access for Rural Households: Evidence from China. *Frontiers in Sustainable Food Systems*, *9*, 1676462. https://doi.org/10.3389/fsufs.2025.1676462,

Chinoda, T., & Kapingura, F. M. (2024). Digital Financial Inclusion and Economic Growth in Sub-Saharan Africa: The Role of Institutions and Governance. *African Journal of Economic and Management Studies*, *15*(1), 15–30. https://doi.org/10.1108/ajems-09-2022-0372.

Choung, Y., Chatterjee, S., & Pak, T. Y. (2023). Digital Financial Literacy and Financial Well-Being. *Finance Research Letters*, *58*, 104438. https://doi.org/10.1016/j.frl.2023.104438.

Dakwal, S. M., Okwanya, I., & Ogiri, A. I. (2024). The Effects of Digital Economy on Inclusive Growth in Selected African Countries. *Signifikan: Jurnal Ilmu Ekonomi*, *13*(2), 311–326. https://doi.org/10.15408/sjie.v13i2.41545.

De Clercq, M., D'Haese, M., & Buysse, J. (2023). Economic Growth and Broadband Access: The European Urban–Rural Digital Divide. *Telecommunications Policy*, *47*(6), 102579. https://doi.org/10.1016/j.telpol.2023.102579.

Djahini-Afawoubo, D. M., Couchoro, M. K., & Atchi, F. K. (2023). Does Mobile Money Contribute to Reducing Multidimensional Poverty? *Technological Forecasting and Social Change*, *187*, 122194. https://doi.org/10.1016/j.techfore.2022.122194.

Eichengreen, B., Park, D., & Shin, K. (2024). Economic Resilience: Why Some Countries Recover More Robustly than Others from Shocks. *Economic Modelling*, *136*, 106748. https://doi.org/10.1016/j.econmod.2024.106748.

Hasan, M., Le, T., & Hoque, A. (2021). How Does Financial Literacy Impact on Inclusive Finance? *Financial Innovation*, *7*(1), 40. https://doi.org/10.1186/s40854-021-00259-9.

Kass-Hanna, J., Lyons, A. C., & Liu, F. (2022). Building Financial Resilience through Financial and Digital Literacy in South Asia and Sub-Saharan Africa. *Emerging Markets Review*, *51*, 100846. https://doi.org/10.1016/j.ememar.2021.100846.

Konstantakopoulou, I. (2023). Financial Intermediation, Economic Growth, and Business Cycles. *Journal of Risk and Financial Management*, *16*(12), 514. https://doi.org/10.3390/jrfm16120514.

Koomson, I., Villano, R. A., & Hadley, D. (2020). Effect of Financial Inclusion on Poverty and Vulnerability to Poverty: Evidence Using a Multidimensional Measure of Financial Inclusion. *Social Indicators Research*, *149*(2), 613–639. https://doi.org/10.1007/s11205-019-02263-0.

Kredina, A., Nurymova, S., Satybaldin, A., & Kireyeva, A. (2022). Assessing the Relationship between Non-Cash Payments and Various Economic Indicators. *Banks and Bank Systems*, *17*(1), 67–79. https://doi.org/10.21511/bbs.17(1).2022.06.

Liu, Y., Luan, L., Wu, W., Zhang, Z., & Hsu, Y. (2021). Can Digital Financial Inclusion Promote China's Economic Growth? *International Review of Financial Analysis*, *78*, 101889. https://doi.org/10.1016/j.irfa.2021.101889.

Luo, J., & Zhu, J. (2025). Credit Card Usage and Its Effects on Financial Literacy as a Channel for Entrepreneurship. *Finance Research Letters*, *73*, 106672. https://doi.org/10.1016/j.frl.2024.106672.

Meniago, C. (2025). Digital Financial Inclusion and Economic Growth: The Moderating Role of Institutions in SADC Countries. *International Journal of Financial Studies*, *13*(1), 4. https://doi.org/10.3390/ijfs13010004.

Menyelim, C. M., Babajide, A. A., Omankhanlen, A. E., & Ehikioya, B. I. (2021). Financial Inclusion, Income Inequality, and Sustainable Economic Growth in Sub-Saharan African Countries. *Sustainability*, *13*(4), 1780. https://doi.org/10.3390/su13041780.

Muchtar, E. H., Trianto, B., Maulana, I., Alim, M. N., Marasabessy, R. H., Hidayat, W., Junaedi, E., & Masrizal. (2024). Quick Response Code Indonesia Standard (QRIS) E-Payment Adoption: Customers' Perspective. *Cogent Business & Management*, *11*(1), 2316044. https://doi.org/10.1080/23311975.2024.2316044


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50225

Nugraha, D. P., Setiawan, B., Nathan, R. J., & Fekete-Farkas, M. (2022). FinTech Adoption Drivers for Innovation for SMEs in Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(4), 208. https://doi.org/10.3390/joitmc8040208.

Oanh, T. T. K., & Dinh, L. Q. (2024). Digital Financial Inclusion, Financial Stability, and Sustainable Development: Evidence from a Quantile-On-Quantile Regression and Wavelet Coherence. *Sustainable Development*, *32*(6), 6324–6338. https://doi.org/10.1002/sd.3021.

Ocharive, A., & Iworiso, J. (2024). The Impact of Digital Financial Services on Financial Inclusion: A Panel Data Regression Method. *International Journal of Data Science and Analysis*, *10*(2), 20–32. https://doi.org/10.11648/j.ijdsa.20241002.11.

Okolo, C. V., Susaeta, A., & Okorie, D. I. (2025). On the Relationship Between Internet Usage and Technological Innovation: Insight from World Panel Data. *Sustainable Futures*, *9*, 100403. https://doi.org/10.1016/j.sftr.2024.100403.

Omar, M. A., & Inaba, K. (2020). Does Financial Inclusion Reduce Poverty and Income Inequality in Developing Countries? A Panel Data Analysis. *Journal of Economic Structures*, *9*(1), 37. https://doi.org/10.1186/s40008-020-00214-4.

Putra, R. D., Haryanto, H., Nelvirita, N., Raga, R. A., Hayati, D. I., & Fitra, H. (2026). The Impact of Financial Intermediation by BPRS, Commercial Banks, and Fintech P2P Lending on Per Capita Consumption, MSME Production, and GRDP in Indonesia. *International Journal of Data and Network Science*, *10*(1), 163–178. https://doi.org/10.5267/j.ijdns.2025.10.005.

Rossi, P., & Scalise, D. (2022). Financial Development and Growth in European Regions. *Journal of Regional Science*, *62*(2), 389–411. https://doi.org/10.1111/jors.12572.

Sant'Anna, D. A., & Figueiredo, P. N. (2024). Fintech Innovation: Is It Beneficial or Detrimental to Financial Inclusion and Financial Stability? A Systematic Literature Review and Research Directions. *Emerging Markets Review*, *60*, 101140. https://doi.org/10.1016/j.ememar.2024.101140.

Sardana, N., Shekoohi, S., Cornett, E. M., & Kaye, A. D. (2023). Qualitative and Quantitative Research Methods. In: Kaye, A. D., Urman, R. D., Cornett, E. M., & Edinoff, A. N (Eds). *Substance Use and Addiction Research* (pp. 65–69). London: Academic Press. https://doi.org/10.1016/B978-0-323-98814-8.00008-1.

Setiawan, B., Nugraha, D. P., Irawan, A., Nathan, R. J., & Zoltan, Z. (2021). User Innovativeness and Fintech Adoption in Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(3), 188. https://doi.org/10.3390/joitmc7030188.

Sirag, A., Ali, H. S., Lacheheb, Z., Ahmed, O. S., & Omer, E. E. (2025). Financial Development, FDI, and Economic Growth in Low- and Middle-Income Countries: A Dynamic Panel Threshold. *Journal of Human, Earth, and Future*, *6*(1), 203–218. https://doi.org/10.28991/HEF-2025-06-01-013.

Taherdoost, H. (2022). What are Different Research Approaches? Comprehensive Review of Qualitative, Quantitative, and Mixed Method Research, Their Applications, Types,

and Limitations. *Journal of Management Science & Engineering Research*, *5*(1), 53–63. https://doi.org/10.30564/jmser.v5i1.4538.

Tay, L. Y., Tai, H. T., & Tan, G. S. (2022). Digital Financial Inclusion: A Gateway to Sustainable Development. *Heliyon*, *8*(6), e09766. https://doi.org/10.1016/j.heliyon.2022.e09766.

Trinugroho, I., Pamungkas, P., Wiwoho, J., Damayanti, S. M., & Pramono, T. (2022). Adoption of Digital Technologies for Micro and Small Business in Indonesia. *Finance Research Letters*, *45*, 102156. https://doi.org/10.1016/j.frl.2021.102156.

Verma, A., Dandgawhal, P. S., & Giri, A. K. (2023). Impact of ICT Diffusion and Financial Development on Economic Growth in Developing Countries. *Journal of Economics, Finance and Administrative Science*, *28*(55), 27–43. https://doi.org/10.1108/JEFAS-09-2021-0185.

Wang, D., He, B., & Hu, Z. (2024). Financial Technology and Firm Productivity: Evidence from Chinese Listed Enterprises. *Finance Research Letters*, *63*, 105405. https://doi.org/10.1016/j.frl.2024.105405.

Wasiaturrahma, W., & Kurniasari, A. L. (2021). Electronic Payment and Economic Growth in Indonesia. *Journal of Developing Economies*, *6*(2), 286–307. https://doi.org/10.20473/jde.v6i2.24923.

Widarwati, E., Solihin, A., & Nurmalasari, N. (2022). Digital Finance for Improving Financial Inclusion Indonesians' Banking. *Signifikan: Jurnal Ilmu Ekonomi*, *11*(1), 17–30. https://doi.org/10.15408/sjie.v11i1.17884.

Xi, W., & Wang, Y. (2023). Digital Financial Inclusion and Quality of Economic Growth. *Heliyon*, *9*(9), e19731. https://doi.org/10.1016/j.heliyon.2023.e19731.

Yakubi, Y. A. Y., Basuki, B., Purwono, R., & Usman, I. (2022). The Impact of Digital Technology and Business Regulations on Financial Inclusion and Socio-Economic Development in Low-Income Countries. *SAGE Open*, *12*(3), 21582440221116112. https://doi.org/10.1177/21582440221116112.

Yang, L., & Zhang, Y. (2020). Digital Financial Inclusion and Sustainable Growth of Small and Micro Enterprises—Evidence based on China's New Third Board Market Listed Companies. *Sustainability*, *12*(9), 3733. https://doi.org/10.3390/su12093733.

Zhang, W., Zhao, S., Wan, X., & Yao, Y. (2021). Study on the Effect of Digital Economy on High-Quality Economic Development in China. *PLOS One*, *16*(9), e0257365. https://doi.org/10.1371/journal.pone.0257365


http://journal.uinjkt.ac.id/index.php/signifikan
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# Dynamic Determinants of Risk-Taking in Islamic Banking: Evidence from Indonesia

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## ABSTRACT

**Research Originality:** This research is original in its focus on the long-run structural determinants of risk-taking in Indonesian Islamic banking.

**Research Objectives:** The study aims to analyze how liquidity, profit-and-loss sharing (PLS), financing growth, financing-to-deposit ratio (FDR), economic growth, and inflation influence risk-taking behavior in Islamic banks.

**Research Methods:** This study employs ARDL and Error Correction Model (ECM) techniques. The study investigates quarterly data from 2015 to 2024 to assess short-run and long-run relationships. The ECM framework provides insights into the adjustment mechanism toward equilibrium.

**Empirical Results:** In the short run, liquidity, PLS, and financing growth significantly affect risk-taking. In the long run, liquidity has a significant negative effect, whereas PLS and Z-score exhibit a positive effect. Other variables are not statistically significant. The ECM confirms a strong adjustment mechanism, indicating that approximately 33.5% of short-run deviations are corrected toward long-run equilibrium each quarter.

**Implications:** Policymakers and practitioners should design risk management strategies that differentiate between short-run operational adjustments and long-run macroeconomic anticipation.

**Keywords:**
liquidity management; profit and loss sharing; ARDL; error correction model; financing growth

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## INTRODUCTION

Islamic banking has grown rapidly worldwide, supported by asset accumulation and increasing customer demand, positioning it as a strategic player in the financial industry (Aslam & Haron, 2021; Banna & Alam, 2021). In Indonesia, the sector contributes significantly to financial inclusion and economic recovery (Fauzi et al., 2023). Financing growth, particularly through profit-loss sharing (PLS) contracts, strengthens the role of Islamic banks, though high financing-to-deposit ratios (FDRs) pose challenges in managing non-performing financing (Widarjono, 2020). To further explain these structures, the theoretical foundations justify the selection of variables and frame the empirical analysis.

Theoretical foundations also guide the selection of variables. Systemic Financial Stability Theory emphasizes liquidity and FDR as indicators of resilience under macroeconomic shocks (Warjiyo & Juhro, 2022; Zigrand, 2014). Contingency Theory justifies the inclusion of GDP growth and inflation, as organizational strategies must adapt to external conditions (Sajko et al., 2021). Risk-Based Decision Making and Prospect Theory explain behavioral tendencies under uncertainty, supporting the use of Z-Score as a dependent variable and highlighting the role of PLS contracts in shaping managerial choices (Hu & Wang, 2023; Louhichi et al., 2022). Islamic Financial Resilience Theory further reinforces the normative foundation for including Sharia-compliant variables, such as PLS and FDR, by emphasizing risk-sharing and the prohibition of interest as distinctive resilience mechanisms (Mutamimah & Saputri, 2023).

Empirical findings remain diverse. Liquidity has been associated with increased exposure in some contexts (Abbas & Ali, 2022), while other studies suggest it reduces vulnerability by strengthening buffers (Smaoui et al., 2020). PLS contracts also demonstrate varying effects: musharakah tends to stabilize risk, whereas mudharabah may amplify it depending on governance quality (Danlami et al., 2022; Widarjono & Mardhiyah, 2022). Inflation likewise produces contrasting impacts; Indonesian banks often increase risk-taking under inflationary pressure, while banks in MENA countries adopt more cautious strategies (Danlami et al., 2022; Moudud-Ul-Huq et al., 2023). Governance quality further shapes these outcomes, with stronger institutions amplifying stabilizing effects and weaker ones exacerbating asymmetric information (Ashraf, 2021). Another important consideration is risk measurement. While many studies rely on Non-Performing Loans (NPL) or Return on Equity (ROE), these indicators are often criticized for failing to capture systemic stability. Recent research advocates the use of Z-Score as a more comprehensive measure, since it reflects insolvency risk and long-term resilience (Hu & Wang, 2023; Louhichi et al., 2022). By adopting the Z-score, this study contributes methodologically to the literature, offering a more robust framework for analyzing the structural drivers of risk-taking in Indonesian Islamic banking.

Prior studies also highlight differences in resilience between Islamic and conventional banks. Some evidence suggests that Islamic banks are more stable during financial crises due to their reliance on asset-backed financing and risk-sharing principles (Athari et al., 2023; Vuong et al., 2024). Other studies, however, indicate that Islamic banks may be


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more vulnerable to macroeconomic shocks because of limited liquidity instruments and stricter regulatory constraints (Fakhrunnas et al., 2021). Methodological differences further complicate conclusions: cross-country panel studies often find that Islamic banks are more resilient, while single-country analyses yield mixed results, depending on macroeconomic shocks and regulatory frameworks (Rahman et al., 2023). These variations suggest that risk-taking structures are highly context-dependent and require country-specific analysis.

Numerous studies have examined risk-taking in Islamic banking; most focus on static relationships, single-period analyses, or cross-country comparisons. Evidence on Indonesia remains limited, particularly in distinguishing short-run and long-run effects under unique regulatory and Sharia frameworks. This study addresses these gaps by applying the Autoregressive Distributed Lag (ARDL) and Error Correction Model (ECM) approaches to capture structural drivers of risk-taking between internal indicators (liquidity, PLS, financing growth, FDR) and macroeconomic factors (GDP growth, inflation). The novelty lies in combining methodological rigor with Sharia-based operational principles, while adopting Z-Score as a more comprehensive measure of risk-taking. Accordingly, the purpose of this study is to provide empirical insights into the structural drivers of risk-taking in Indonesian Islamic banking, thereby contributing to the academic literature and to policy formulation by highlighting strategies for effective risk management.

## METHODS

This study employs a quantitative approach to examine the structural drivers of risk-taking in Indonesian Islamic banking. The dependent variable is risk-taking, proxied by the Z-score. In contrast, the independent variables include liquidity, profit-and-loss sharing (PLS), financing growth, financing-to-deposit ratio (FDR), inflation, and economic growth. Quarterly data from 2015 to 2024 were selected because 2015 marks the implementation of key regulatory reforms in Islamic banking, ensuring consistency in reporting standards, while 2024 provides the most recent post-pandemic observations. Bank-level data were obtained from the *Islamic banking statistics* published by the Financial Services Authority (OJK), complemented by macroeconomic indicators from Bank Indonesia and the Central Bureau of Statistics (BPS).

The AutoRegressive Distributed Lag (ARDL) model was chosen as the primary analytical tool because it is suitable for time series data with mixed integration orders (I(0) and I(1)) and allows simultaneous estimation of short-run and long-run effects without requiring pre-testing for cointegration (Ahmed & Delin, 2019; Faudzi & Asmara, 2021). Once cointegration is confirmed through bounds testing, the model is re-specified into an Error Correction Model (ECM) to capture the adjustment mechanism. The ECM framework identifies how short-term deviations are corrected toward long-term equilibrium, with the error correction term (ECT) serving as an indicator of adjustment speed (David et al., 2019).

Robustness was ensured through diagnostic tests for serial correlation, heteroskedasticity, and normality, while parameter stability was examined using CUSUM and CUSUMSQ

tests. These procedures confirm that the estimated relationships are statistically reliable and structurally stable across the sample period. Overall, the ARDL–ECM framework enables the study to capture both the short- and long-run structural drivers of risk-taking. At the same time, diagnostic and stability checks strengthen the credibility of the findings for academic and policy purposes. Table 1 presents the more detailed information about the operational variables.

**Table 1. Operational Variables**

| No. | Variable | Definition | Symbol | Formula | References |
|---|---|---|---|---|---|
| 1 | Risk-taking (ZSC) | Inverse of stability, proxied by Z-score | ZSC | $\frac{ROA - (EQ/Total\ Aset)}{\sigma ROA}$ | Danlami et al., (2022)<br>Smaoui et al., (2020) |
| | Return on Assets (ROA) | Profitability ratio | ROA | Profit before tax / Total assets | |
| | Capital Adequacy Ratio (CAR) | Equity ratio | CAR | Equity / Total assets | |
| | Standard deviation of ROA | Risk volatility | σ ROA | ∑ (x_i - mean)^2}{n} | |
| 2 | Liquidity | Ratio of short-term obligations coverage | LIK | Short-term liabilities / Short-term deposits | Jedidia & Salah, (2022)<br>Smaoui et al., (2020) |
| 3 | Profit-Loss Sharing (PLS) | Ratio of PLS financing | PLS | (Mudharabah + Musharakah) / Total financing | Bilgin et al., (2021)<br>Danlami et al., (2022) |
| 4 | Financing Growth (PPE) | % increase in financing | PPE | Financing(t) / Financing(t-1) | Bilgin et al., (2021) |
| 5 | Financing-to-Deposit Ratio (FDR) | Ratio of financing to third-party funds | FDR | Total financing / Total deposits | Darma & Afandi, (2021)<br>Suripto et al. (2023) |
| 6 | Inflation (INF) | % change in CPI | INF | $\frac{IHK_t - IHK_{it-1}}{IHK_{t-1}}$ | Danlami et al., (2022)<br>Lestari & Suprayogi, (2020)<br>Shareef & Prabheesh, (2022) |
| 7 | Economic Growth (PEK) | % change in GDP | PEK | $\frac{Nil\ Ek\ t - Nil\ Ek\ t\text{-}1}{Nil\ Ek\ t\text{-}1}$ | Danlami et al., (2022)<br>Lestari & Suprayogi, (2020)<br>Moudud-Ul-Huq et al., (2023) |
| 8 | Economic Policy Uncertainty (WUI) | Frequency-based index of uncertainty in EIU reports | WUI | (Occurrences of "uncertainty"/ Total words) × 1000, normalized to base period | Ahir et al., (2020)<br>Chand et al., (2024)<br>Ashraf, (2021) |

This study employs the Autoregressive Distributed Lag–Error Correction Model (ARDL–ECM) to examine both the short-run dynamics and the long-run equilibrium relationship between risk-taking (Z-Score) and its determinants. This approach is particularly suitable because it can accommodate variables with different orders of integration (I(0) or


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I(1)) and provides a unified framework to capture persistent long-run effects as well as short-run adjustments. The first step is to estimate the long-run equilibrium relationship between risk-taking and its explanatory variables. The cointegration equation is specified as follows: (Sandia et al., 2025)

$$\text{Z-Score}_t = \alpha_0 + \alpha_1 \cdot \text{FDR}_t + \alpha_2 \cdot \text{INF}_t + \alpha_3 \cdot \text{LIK}_t + \alpha_4 \cdot \text{PEK}_t + \alpha_5 \cdot \text{PLS}_t + \alpha_6 \cdot \text{PPE}_t + \mu_t$$

Where:

- $\alpha_0$ = long run constanta
- $\alpha_{1-6}$ = coefisien
- $\mu_t$ = residual cointegration as error correction term

Once the long-run relationship is established, the residuals ($\mu_t$) are used to construct the ECT, which is then incorporated into the short-run dynamics. The short-run equation is expressed as: (Sandia et al., 2025)

$$\Delta \text{ Z-Score } t = \alpha_0 + \alpha_1 \Delta \text{ FDR}t + \alpha_2 \Delta \text{ INF}_t + \alpha_3 \Delta \text{ LIK}_t + \alpha_4 \Delta \text{ PEK}t + \alpha_5 \Delta \text{ PLS}_t + \alpha_6 \Delta \text{ PPE}_t + \varphi ECT_{t-1} + \mu_t$$

Where.:

- $\Delta$ (Delta) = the change (difference) in a variable between one period and the next.
- $\alpha_0$ = the constant term in the short-run equation.
- $\alpha_{1-6}$ = coefisien
- $\varphi$ = the adjustment coefficient
- $\mu_t$ = residual cointegration as error correction term

The ARDL–ECM framework is applied sequentially to capture both long-run equilibrium and short-run dynamics, with the long-run equation establishing the relationship between risk-taking and its determinants, and the short-run specification incorporating the error correction mechanism to adjust deviations back toward equilibrium; this dual approach enables clear differentiation between temporary effects and persistent influences, offering a comprehensive view of risk-taking behavior in Islamic banking under economic uncertainty.

## RESULTS AND DISCUSSION

Liquidity emerges as the most consistent structural driver of risk-taking behavior in Indonesian Islamic banks, exerting a stabilizing influence by reducing risk exposure and strengthening overall bank resilience. Profit and loss sharing (PLS) also plays a significant role, simultaneously enhancing growth and stability while increasing risk if not properly managed, reflecting its ambivalent nature. Economic growth shows only temporary effects, influencing risk-taking in the short run but losing significance in the long run, while financing growth similarly heightens short-run vulnerabilities without structural impact. In contrast, the financing-to-deposit ratio (FDR) and inflation remain insignificant across estimations, underscoring their limited direct role in shaping the drivers of risk-taking

structure. However, inflation may exert an indirect influence through liquidity. Overall, the findings highlight that risk-taking in Islamic banking is primarily driven by internal factors such as liquidity and PLS, with macroeconomic variables exerting only short-lived or indirect effects.

Table 2 summarizes the descriptive statistics of the variables used. Liquidity shows moderate variation, indicating adequate liquid assets across periods. The Financing to Deposit Ratio reflects a consistently aggressive financing stance with low dispersion. Financing growth displays wider variability, highlighting differences in portfolio expansion capacity. Profit-Loss Sharing confirms the dominance of profit-sharing contracts, though its application shifts over time. At the macro level, inflation fluctuates moderately, while economic growth captures both contractionary and recovery phases. Z-Score, as a proxy for risk-taking, suggests overall strong stability, though risk profiles differ across periods. These descriptive results provide an initial overview of the internal and external conditions shaping risk-taking behavior and serve as the basis for further ARDL–ECM analysis to distinguish short-run dynamics from long-run equilibrium effects.

**Table 2. Summary Statistics**

| Variabel | Obs | Mean | Std. Dev | Minimum | Maksimum |
|---|---|---|---|---|---|
| LIK (%) | 40 | 25,48 | 5,34 | 16,61 | 38,74 |
| FDR (%) | 40 | 84,27 | 3,63 | 76,33 | 96,52 |
| PPE (%) | 40 | 2,62 | 1,58 | 0,23 | 6,52 |
| PLS (%) | 40 | 44,.69 | 6,79 | 32,66 | 53,00 |
| INF (%) | 40 | 3,31 | 1,77 | 1,33 | 7,26 |
| PEK (%) | 40 | 4,90 | 2,03 | -5,32 | 7,08 |
| Z-score | 40 | 39,98 | 6,73 | 26,20 | 50,80 |

Stationarity testing is a crucial preliminary step in time series analysis to ensure that the variables used do not contain unit roots, which could lead to spurious regression results. The Augmented Dickey-Fuller (ADF) test was applied to all variables at the first-differencing level (I(1)), except for financing growth (PPE), which was already stationary at the level (I(0)).

**Table 3. Stationarity Test Result**

| Variable | Probability | Result |
|---|---|---|
| Inflation (INF) | 0.0000 | p < 0.05 (Stationary) |
| Financing to Deposit Ratio (FDR) | 0.0000 | p < 0.05 (Stationary) |
| Liquidity (LIK) | 0.0000 | p < 0.05 (Stationary) |
| Economic Growth (PEK) | 0.0007 | p < 0.05 (Stationary) |
| Profit-Loss Sharing (PLS) | 0.0228 | p < 0.05 (Stationary) |
| Financing Growth (PPE) | 0.0000 | p < 0.05 (Stationary at I(0)) |
| Risk-Taking (Z-Score) | 0.0003 | p < 0.05 (Stationary) |


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The ADF test results show that most variables, namely inflation, Financing to Deposit Ratio, liquidity, economic growth, Profit-Loss Sharing, and risk-taking (Z-Score), are non-stationary at the level but become stationary after first differencing (I(1), while financing growth is stationary at the level (I(0)). This confirms that the Autoregressive Distributed Lag (ARDL) model is appropriate, as it accommodates variables integrated at both levels and in first differences, provided none are integrated at order 2 (I(2)) (Menegaki, 2019). Consequently, internal factors and macroeconomic indicators can be consistently examined in relation to Z-Score, with stationarity ensuring the avoidance of spurious regression and supporting robust short-run and long-run estimations. Stationarity testing provided the foundation for determining the appropriate lag length in the model. The Akaike Information Criterion (AIC) was employed to select the optimal lag structure, as it identifies the best model based on the lowest information value (Khim & Venus, 2004). Lag selection is critical to capture both short-run dynamics and long-run relationships among the variables. The ARDL(1,2,2,1,3,0,3) specification emerged as the most representative model, producing the lowest AIC value. This structure balances the inclusion of sufficient lags to reflect dynamic adjustments while avoiding over-parameterization.

The cointegration test within the ARDL framework, conducted using the Bounds Testing approach, confirms the existence of a long-run equilibrium relationship among the variables. The calculated F-statistic of 6.427 (sample size 35) exceeds the upper bound critical values at the 10%, 5%, and 1% significance levels, leading to the rejection of the null hypothesis of no cointegration. This finding validates the ARDL model for analyzing both short-run dynamics and long-run relationships (Mohammed, 2024). It further indicates that internal factors, along with external indicators, are jointly associated with risk-taking behavior (Z-Score) in Indonesian Islamic banking. The confirmation of cointegration strengthens the reliability of subsequent ARDL estimations and supports the robustness of the study's empirical results.

The classical assumption tests confirm that the ARDL model satisfies the key statistical requirements. The Jarque-Bera test ($p = 0.445$) indicates that the residuals are normally distributed (Da et al., 2023), while the Breusch-Godfrey test ($p = 0.837$) provides no evidence of autocorrelation, indicating independence across time. The Breusch-Pagan test ($p = 0.901$) suggests homoskedasticity, meaning residual variance is constant. Multicollinearity is not a concern, as the highest VIF value (4.283) is well below the critical threshold of 10. Furthermore, the CUSUM and CUSUMSQ tests confirm structural stability of the ARDL model within critical bounds. Collectively, these results indicate that the model is robust, with unbiased and efficient coefficient estimates, thereby validating its capacity to capture both short-run dynamics and long-run equilibrium in Islamic banks' risk-taking behavior.

To capture immediate effects, the ARDL model was first estimated in its short-run form, in which lagged variables indicate how past financing, liquidity, and macroeconomic conditions influence current risk-taking. In contrast, the ARDL–ECM framework identifies the long-run equilibrium, with coefficients reflecting the persistent impact of these internal and external factors on risk-taking behavior.

The ARDL estimation results in Table 4 highlight both short and long-run effects of internal and macroeconomic variables on risk-taking in Indonesian Islamic banks. Liquidity consistently shows a negative relationship with stability, indicating that higher liquidity reduces risk-taking. Profit-Loss Sharing exerts a strong positive effect, confirming that greater reliance on profit-sharing contracts increases exposure. The Z-Score itself reflects significant dynamics, showing sensitivity of stability to past risk behavior. Economic growth and financing growth display notable short-run impacts, suggesting that lagged macroeconomic conditions and portfolio expansion contribute to fluctuations. By contrast, the Financing-to-Deposit Ratio and inflation are not significant, underscoring the dominant roles of liquidity and profit-loss sharing in shaping Islamic bank stability.

**Table 4. ARDL and Long-Run Estimation Results**

| Variable | ARDL Coefficient | Probability ARDL | Variable | Long-Run Coefficient | Probability Long Run |
|---|---|---|---|---|---|
| Financing to Deposit Ratio (FDR-2) | -0.1857 | 0.2670 | Financing to Deposit Ratio (FDR) | -0.2841 | 0.2175 |
| Inflation (INF-2) | -0.2087 | 0.1751 | Inflation (INF) | -0.3193 | 0.6053 |
| Liquidity (LIK) | -0.2391 | 0.0097 | Liquidity (LIK) | -0.3658 | 0.0097 |
| Economic Growth (PEK-3) | -0.0306 | 0.0018 | Economic Growth (PEK) | -0.0468 | 0.8229 |
| Profit-Loss Sharing (PLS) | 0.5152 | 0.0040 | Profit-Loss Sharing (PLS) | 0.7883 | 0.0040 |
| Financing Growth (PPE-2) | 0.0475 | 0.0462 | Financing Growth (PPE) | 0.0727 | 0.7846 |
| Z-score (-1) | -0.6543 | 0.0214 | Z-score | -0.1501 | 0.0312 |
| Constant | 56.9814 | 0.0072 | Constant | 87.2223 | 0.0072 |

The ECM estimation results in Table 5 confirm short-run dynamics and the speed of adjustment toward long-run equilibrium in the ARDL framework. Liquidity shows a significant negative effect on risk-taking, underscoring its dominant role in short-run mitigation. The error-correction term (–0.3348, $p = 0.0002$) is negative and highly significant, validating cointegration and indicating that deviations from long-run equilibrium are corrected at about 33 percent per period. Other short-run variables, such as Financing to Deposit Ratio, inflation, economic growth, Profit-Loss Sharing, and financing growth, display expected signs but are statistically insignificant, suggesting weaker immediate effects or absorption through liquidity. Overall, the ECM results reinforce the robustness of the ARDL–ECM framework, with liquidity as the key short-run stabilizer and the error correction term ensuring reliable long-run adjustment.

The comparison of variable significance across ARDL, the long-run form, and the ECM highlights the consistency of each variable's role in influencing risk-taking (as measured by Z-scores). This summary allows us to identify which variables exert dominant effects in the short-run dynamics, in the long-run equilibrium, or through the adjustment mechanism. The results are presented in Table 6.


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**Table 5. ECM Estimation Results**

| Variable | Coefficient | Probability |
|---|---|---|
| DFDR | −0.1339 | 0.2657 |
| DINF | 0.4279 | 0.2861 |
| DLIK | −0.1789 | 0.0445 |
| DPEK | −0.1945 | 0.1884 |
| DPLS | 0.4099 | 0.1997 |
| DPPE | −0.0813 | 0.5460 |
| ECT | −0.3348 | 0.0002 |

**Table 6. Comparison of Variable Significance in ARDL–ECM**

| Variable | Significant in ARDL | Significant in Long-run Form | Significant in ECM | Dominant Role |
|---|---|---|---|---|
| LIK | Yes | Yes | Yes | Short-run & long-run |
| PLS | Yes | Yes | No | Long-run |
| PEK | Yes | No | No | Lagged short-run effect |
| PPE | Yes | No | No | Lagged short-run effect |
| FDR | No | No | No | Not dominant |
| INF | No | No | No | Not dominant |
| ECT | — | — | Yes | Equilibrium correction |

Liquidity emerges as the most consistent and significant determinant of risk-taking behavior in Indonesian Islamic banks. Across ARDL, long-run, and ECM estimations, liquidity shows a negative and statistically significant effect on the Z-Score, confirming its stabilizing role. Higher liquidity reduces risk-taking and strengthens bank stability (Widarjono & Afandi, 2025). This finding is reinforced by Dahir et al. (2018), who argue that liquidity risk reduces banks' risk-taking, and Anis and Hamdi (2022), who show that economic uncertainty increases liquidity risk in Islamic banks. However, Abbas and Ali (2022) find that liquidity funding increases risk-taking in U.S. commercial banks. In Islamic banking, liquidity serves as a safeguard that enhances stability, whereas in conventional banking it can amplify risk, reflecting structural and regulatory differences between the two systems.

Profit-loss sharing (PLS) also emerges as a strong and significant factor. The ARDL and long-run models confirm that greater reliance on profit-sharing contracts increases risk exposure, with consistently high coefficients. At the same time, PLS financing contributes positively to Indonesia's economic growth (Masrizal & Trianto, 2022) and strengthens Islamic bank stability (Widarjono & Mardhiyah, 2022). However, Widarjono et al. (2020) caution that a high proportion of PLS contracts can increase financing risk. Thus, PLS is ambivalent: beneficial for growth and stability, but excessive reliance without proper monitoring can heighten financing risk, making a balanced application crucial for sustainable Islamic banking performance.

Economic growth (PEK) shows significant short-run lagged effects, particularly at the third lag (PEK-3), but loses significance in the long run. This result suggests that growth influences risk-taking only temporarily. Supporting evidence indicates that economic growth enhances resilience in Islamic banking (Solikhin, 2024), while Suprayitno et al. (2024) argue that macroeconomic factors do not exert a major long-run influence on financing risk, explaining the lack of long-run significance. In Islamic banks, growth provides short-term support for stability, but its impact fades over time, leaving internal factors as the main drivers of long-run risk behavior.

Financing growth (PPE) shows significant short-run effects at the second lag, indicating that rapid expansion temporarily increases risk exposure but does not persist structurally in the long run. This study supports Saleem et al. (2021), who highlight the positive role of Islamic banking in sustaining economic growth, and aligns with Widarjono and Afandi (2025), who find that sectoral concentration and higher financing volumes raise default risks, consistent with short-run vulnerabilities. However, these results contrast with those of Razali et al. (2024), who argue that extraordinary financing negatively affects performance in both the short- and long-run. In contrast, the present evidence suggests its impact is cyclical and temporary rather than permanent. In Islamic banks, financing growth can expose them to short-term risks, but these effects fade over time, highlighting the need for prudent monitoring during rapid expansion.

The financing-to-deposit ratio (FDR) is insignificant across all estimations, showing its limited role in risk-taking behavior. Although often seen as a measure of efficiency, evidence indicates it does not directly affect Islamic bank stability (Suprayitno et al., 2024). In contrast, Haryanto et al. (2024) find that higher FDR is associated with greater non-performing financing (NPF), suggesting context-specific risks. Overall, FDR's influence on Islamic bank stability in Indonesia is minimal, with internal management and structural factors proving more decisive. FDR has little long-run impact, making internal governance more critical for managing risk in Islamic banks.

Inflation (INF) shows no significant effects in ARDL or long-run models, indicating a limited direct role in risk-taking. (Solikhin, 2024) also finds that inflation does not strengthen Islamic bank stability. At the same time, Anis and Hamdi (2022) note its negative impact on liquidity risk, and Fakhrunnas (2023) highlights a non-linear link between liquidity risk and stability. Thus, inflation is insignificant in the short term but still relevant indirectly through liquidity. For Islamic banks, inflation has a minimal direct impact on risk, yet its indirect effects via liquidity make careful liquidity management essential.

The Z-Score shows significant short and long-run dynamics, with negative coefficients indicating that past risk behavior affects current stability and drives correction toward equilibrium. This study supports Solikhin (2024), who finds Islamic banks resilient in crises, but contrasts with Purbayanto et al. (2022), who note excessive risk-taking among Indonesian Islamic banks. The Z-Score highlights Islamic banks' resilience, yet also signals that stronger risk management is needed to prevent excessive risk-taking from undermining long-term stability.


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## CONCLUSION

Internal structural factors, especially liquidity and profit-loss-sharing (PLS) contracts, are the main drivers of risk-taking in Islamic banks, while macroeconomic variables such as inflation and economic growth play a limited role. Liquidity consistently serves as a stabilizing factor, reducing risk in both the short and long run. In contrast, PLS contracts tend to increase long-term risk exposure. Financing growth and economic growth have only short-run lagged effects and do not persist in the long-run equilibrium, while variables such as FDR and inflation remain insignificant. The significant error correction term indicates a stable long-run relationship, highlighting the resilience of Islamic banks in managing risk. Therefore, regulators and bank managers should prioritize strong liquidity management to maintain stability. Enhancing liquidity buffers can reduce short-term shocks and support long-term resilience, while careful monitoring of PLS contracts is necessary to balance their benefits and associated risks.

## REFERENCES

Abbas, F., & Ali, S. (2022). Economics of Loan Growth, Credit Risk, and Bank Capital in Islamic Banks. *Kybernetes*, *51*(12), 3591–3609. https://doi.org/10.1108/K-03-2021-0232.

Ahir, H., Bloom, N., & Furceri, D. (2020). *Our New Index Provides Novel Insights Into an Amorphous Concept*. Retrieved from: www.worlduncertaintyindex.com.

Ahmed, Y. N., & Delin, H. (2019). Current Situation of Egyptian Cotton: Econometrics Study Using the ARDL Model. *Journal of Agricultural Science*, *11*(10), 88. https://doi.org/10.5539/jas.v11n10p88.

Anis, M., & Hamdi, B. (2022). Liquidity Risk in Economic Uncertainty: Evidence from Indonesian Islamic Banks. *Jurnal Ekonomi & Keuangan Islam*, *8*(1), 32–46. https://doi.org/10.20885/jeki.vol8.iss1.art3.

Ashraf, B. N. (2021). Is Economic Uncertainty a Risk Factor in Bank Loan Pricing Decisions? International Evidence. *Risks*, *9*(5), 81. https://doi.org/10.3390/risks9050081.

Aslam, E., & Haron, R. (2021). Corporate Governance and Risk-taking of Islamic Banks: Evidence from OIC Countries. *Corporate Governance (Bingley)*, *21*(7), 1460–1474. https://doi.org/10.1108/CG-08-2020-0311.

Athari, S. A., Irani, F., & AlAl Hadood, A. (2023). Country Risk Factors and Banking Sector Stability: Do Countries' Income and Risk-Level Matter? Evidence from the Global Study. *Heliyon*, *9*(10), e20398. https://doi.org/10.1016/j.heliyon.2023.e20398.

Banna, H., & Alam, M. R. (2021). Does Digital Financial Inclusion Matter for Bank Risk-Taking? Evidence from the Dual-Banking System. *Journal of Islamic Monetary Economics and Finance*, *7*(2), 401–430. https://doi.org/10.21098/jimf.v7i2.1320.

Bilgin, M. H., Danisman, G. O., Demir, E., & Tarazi, A. (2020). Economic Uncertainty and Bank Stability: Conventional vs. Islamic Banking. *Journal of Financial Stability, 56,* 100911. https://doi.org/10.1016/j.jfs.2021.100911.

Chand, S. A., Kumar, R. R., Stauvermann, P. J., & Shahbaz, M. (2024). Determinants of Bank Profitability—Do Institutions, Globalization, and Global Uncertainty Matter for Banks in Island Economies? The Case of Fiji. *Journal of Risk and Financial Management*, *17*(6), 218. https://doi.org/10.3390/jrfm17060218.

Dahir, A. M., Mahat, F. B., & Ali, N. A. Bin. (2018). Funding Liquidity Risk and Bank Risk-Taking in BRICS Countries: An Application of System GMM Approach. *International Journal of Emerging Markets*, *13*(1), 231–248. https://doi.org/10.1108/IJoEM-03-2017-0086.

Danlami, M. R., Abduh, M., & Abdul Razak, L. (2022). CAMELS, Risk-Sharing Financing, Institutional Quality and Stability of Islamic Banks: Evidence from 6 OIC Countries. *Journal of Islamic Accounting and Business Research, 13*(8), 1155–1175. https://doi.org/10.1108/JIABR-08-2021-0227.

Darma, E. S., & Afandi, A. (2021). The Role of Islamic Corporate Governance and Risk Toward Islamic Banking Performance: Evidence from Indonesia. *Journal of Accounting and Investment*, *22*(3), 517–538. https://doi.org/10.18196/jai.v22i3.12339.

David, S. A., Inácio, C. M. C., & Machado, J. A. T. (2019). Ethanol Prices and Agricultural Commodities: An Investigation of Their Relationship. *Mathematics*, *7*(9), 774. https://doi.org/10.3390/math7090774.

Fakhrunnas, F. (2023). Non-linear Effect of Islamic Banks' Liquidity Risk to Financial Stability: Evidence from the Indonesian Banking Industry. *Muqtasid: Jurnal Ekonomi Dan Perbankan Syariah*, *4*(1), 1–15.

Fakhrunnas, F., Tumewang, Y. K., & Anto, M. B. H. (2021). The Impact of Inflation on Islamic Banks' Home Financing Risk: Before and During the COVID-19 Outbreak. *Banks and Bank Systems*, *16*(2), 78–90. https://doi.org/10.21511/bbs.16(2).2021.08.

Faudzi, M., & Asmara, G. D. (2021). Analisis Neraca Perdagangan Indonesia: Pendekatan ARDL. *Journal of Macroeconomics and Social Development, 1*(1), 1-16. https://doi.org/10.47134/jmsd.v1i1.17.

Fauzi, F., Abdinagoro, S. B., Kartono, R., Furinto, A., & Hamsal, M. (2023). Extracting Public Opinion and Popularity of Islamic Bank in Indonesia: A Big Data of Social Media and Google Trends Approach. *E3S Web of Conferences*, *426*. https://doi.org/10.1051/e3sconf/202342602019.

Haryanto, S., Safriliana, R., Ridloah, S., Ariefudin, M. U., & Khotimah, L. K. (2024). Determinants of Risk in Indonesian Islamic Banking: An Empirical Investigation. *Share: Jurnal Ekonomi dan Keuangan Islam*, *13*(1), 24–40. https://doi.org/10.22373/share.v13i1.20758.

Hu, J., & Wang, T. (2023). Strategies of Participants in the Carbon Trading Market—An Analysis Based on the Evolutionary Game. *Sustainability*, *15*(14), 807. https://doi.org/10.3390/su151410807.

Jedidia, K. Ben, & Salah, I. Ben. (2022). Asymmetric Causal Linkages Between Liquidity and Profitability for MENA Islamic Banks. *Journal of Islamic Monetary Economics and Finance*, *8*(4), 501–516. https://doi.org/10.21098/jimf.v8i4.1546.


http://journal.uinjkt.ac.id/index.php/signifikan
https://doi.org/10.15408/sjie.v15i1.50328

Lestari, D. R., & Suprayogi, N. (2020). Pengaruh Faktor Internal dan Faktor Makroekonomi terhadap Stabilitas Bank Umum Syariah di Indonesia Periode 2012-2018. *Jurnal Ekonomi Syariah Teori dan Terapan*, *7*(11), 2062-2073. https://doi.org/10.20473/vol7iss202011pp2062-2073.

Louhichi, R., Pelletan, J., & Sallak, M. (2022). Application of Prospect Theory in the Context of Predictive Maintenance Optimization Based on Risk Assessment. *Applied Sciences*, *12*(22), 11748. https://doi.org/10.3390/app122211748.

Masrizal., & Trianto, B. (2022). The Role of PLS Financing on Economic Growth: Indonesian Case. *Journal of Islamic Monetary Economics and Finance*, *8*(1), 49–64. https://doi.org/10.21098/jimf.v8i1.1378.

Menegaki, A. N. (2019). The ARDL Method in the Energy-Growth Nexus Field: Best Implementation Strategies. *Economies*, *7*(4), 105. https://doi.org/10.3390/economies7040105.

Mohammed, M. G. A. (2024). Analyzing GDP Growth Drivers in Saudi Arabia: Investment or Consumption: An Evidence-Based ARDL-Bound Test Approach. *Sustainability*, *16*(9), 3786. https://doi.org/10.3390/su16093786.

Moudud-Ul-Huq, S., Halim, M. A., Sobhani, F. A., Karim, Z., & Nesa, Z. (2023). The Nexus of Competition, Loan Quality, and Ownership Structure for Risk-Taking Behaviour. *Risks*, *11*(4), 68. https://doi.org/10.3390/risks11040068.

Mutamimah, M., & Saputri, P. L. (2023). Corporate Governance and Financing Risk in Islamic Banks in Indonesia. *Journal of Islamic Accounting and Business Research*, *14*(3), 436–450. https://doi.org/10.1108/JIABR-09-2021-0268.

Purbayanto, M. A. H., Faturohman, T., Yulianti, & Aliludin, A. (2022). Do Islamic Banks in Indonesia Take Excessive Risk in Their Financing Activities? *Journal of Islamic Monetary Economics and Finance*, *8*(1), 149–160. https://doi.org/10.21098/jimf.v8i1.1431.

Rahman, A. A. A., Rahiman, H. U., Meero, A., & Amin, A. R. (2023). Fintech Innovations and Islamic Banking Performance: Post-Pandemic Challenges and Opportunities. *Banks and Bank Systems*, *18*(4), 281–292. https://doi.org/10.21511/bbs.18(4).2023.23.

Razali, R., Haryono, S., Abdou, O. S., Jailani, M. R., & Imamuddin, I. (2024). Revisiting the Nexus among Bank-Specific Factors, Macroeconomic Factors, and Islamic Banking Performance: Three Measurement Models. *Shirkah: Journal of Economics and Business*, *10*(1), 78–96. https://doi.org/10.22515/shirkah.v10i1.748.

Sajko, M., Boone, C., & Buyl, T. (2021). CEO Greed, Corporate Social Responsibility, and Organizational Resilience to Systemic Shocks. *Journal of Management*, *47*(4), 957–992. https://doi.org/10.1177/0149206320902528.

Saleem, A., Setiawan, B., Bárczi, J., & Sági, J. (2021). Achieving Sustainable Economic Growth: Analysis of Islamic Debt and the Islamic Equity Market. *Sustainability*, *13*(15), 8319. https://doi.org/10.3390/su13158319.

Sandia, S., Ascarya, A., & Sulaeman, S. (2025). Examining Profit-Sharing Financing Dynamics in Indonesian Islamic Banking: ECM and ARDL Approaches. *Jurnal Ekonomi & Keuangan Islam*, *11*(1), 211–226. https://doi.org/10.20885/jeki.vol11.iss2.art4.

Shareef, A. O., & Prabheesh, K. P. (2022). Does International Monetary Policy Influence the Bank Risk? Evidence from India. *Buletin Ekonomi Moneter dan Perbankan*, *25*(2), 135–154. https://doi.org/10.21098/bemp.v25i2.1867.

Smaoui, H., Mimouni, K., Miniaoui, H., & Temimi, A. (2020). Funding liquidity risk and banks' risk-taking: Evidence from Islamic and conventional banks. *Pacific Basin Finance Journal*, *64,* 101436. https://doi.org/10.1016/j.pacfin.2020.101436.

Solikhin, M. Y. (2024). Analysis of Macroeconomic Variable Changes to The Resilience of Islamic Banking in Indonesia. *Airlangga International Journal of Islamic Economics and Finance, 7*(2), 72–88. https://doi.org/10.20473/aijief.v7i02.55212.

Suprayitno, A., Susanto, A. A., & Hawariyuni, W. (2024). Sustainability of Islamic Bank Financing across Macroeconomic and Internal Factors. *Journal of Sustainable Economics*, *2*(2), 83–93. https://doi.org/10.32734/jse.v2i2.18433.

Suripto, Sugiono, A., & Dasuki, H. (2023). Comparing the Resilience of Sharia and Conventional Banking to the Financial Crisis in the Association of Southeast Asian Nations. *Banks and Bank Systems*, *18*(3), 192–204. https://doi.org/10.21511/bbs.18(3).2023.16.

Vuong, G. T. H., Nguyen, Y. D. H., Nguyen, M. H., & Wong, W. K. (2024). Assessing the Impact of Macroeconomic Uncertainties on Bank Stability: Insights from ASEAN-8 countries. *Heliyon*, *10*(11), e31711. https://doi.org/10.1016/j.heliyon.2024.e31711.

Warjiyo, P., & Juhro, S. M. (2022). *Central Bank Policy Mix: Issues, Challenges, and Policy Responses: Handbook of Central Banking Studies*. Berlin: Springer Nature.

Widarjono, A. (2020). Stability of Islamic banks in Indonesia: Autoregressive Distributed Lag Approach. *Jurnal Keuangan dan Perbankan*, *24*(1), 40–52. https://doi.org/10.26905/jkdp.v24i1.3932.

Widarjono, A., & Afandi, A. (2025). Sectoral Diversification and Financing Risks in Indonesian Islamic Banks. *Share: Jurnal Ekonomi dan Keuangan Islam*, *14*(1), 121–144. https://doi.org/10.22373/share.v14i1.24510.

Widarjono, A., Anto, M. B. H., & Fakhrunnas, F. (2020). Financing Risk in Indonesian Islamic Rural Banks: Do Financing Products Matter? *Journal of Asian Finance, Economics and Business*, *7*(9), 305–314. https://doi.org/10.13106/JAFEB.2020.VOL7.NO9.305.

Widarjono, A., & Mardhiyah, Z. (2022). Profit-Loss Sharing Financing and Stability of Indonesian Islamic Banking. *International Journal of Islamic Business and Economics (IJIBEC)*, *6*(1), 1–16.

Zigrand, J.-P. (2014). Systems and Systemic Risk in Finance and Economics. *SRC Special Paper No. 1*. Systemic Risk Centre, The London School of Economics and Political Science.


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# Human Development and Income Inequality in D-8 Countries: A Maqashid Sharia Perspective

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## ABSTRACT

**Research Originality**: This study is original in applying a Maqashid Sharia-based human development index to examine the short- and long-run effects of human development on income inequality in D-8 countries.

**Research Objectives**: This study aims to analyze whether human development based on the Maqashid Sharia framework can effectively reduce income inequality in D-8 countries in both the short run and the long run.

**Research Methods**: Using panel data from eight D-8 countries during 2003–2022, income inequality is measured by the Gini index and the Palma ratio, while human development is represented by the Maqashid Sharia Index (MSI). The analysis employs a Panel ARDL model with the Pooled Mean Group estimator to capture short-run and long-run relationships.

**Empirical Results**: The results show that Maqashid Sharia-based human development significantly reduces income inequality in the long run across D-8 countries, reflecting the maslahah-oriented approach of Islamic economic development. In the short run, it reduces inequality in Indonesia and Turkey but increases inequality in Bangladesh, Egypt, and Nigeria.

**Implications**: These findings suggest that human development policies should incorporate moral and value-based dimensions. Policymakers in D-8 countries need to promote not only education, health, and income, but also ethical values to ensure more equitable income distribution.

**Keywords:**
Islamic economics; maslahah-oriented development; panel ARDL; income distribution

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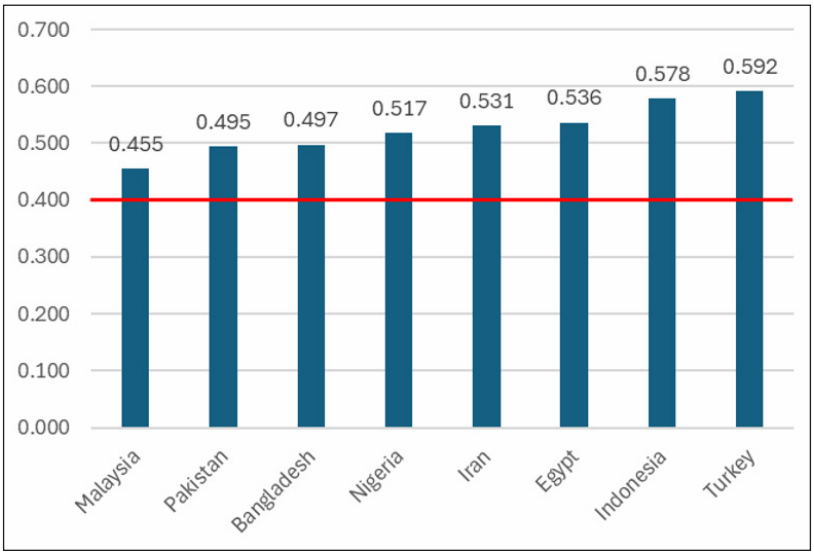
## INTRODUCTION

Income inequality has long been recognized as a significant contributor to other forms of inequality and poverty (Vo et al., 2024; Kuznets, 1955). Income inequality refers to the gap between the richest and poorest members of society, where a wider gap indicates greater inequality (George et al., 2016). This issue is specifically addressed in Sustainable Development Goal 10.1, which aims to increase the incomes of the bottom 40 percent of the population so that they grow faster than the national average by 2030 (World Bank, 2016). Over the past decade, developing countries have experienced economic growth without corresponding improvements in income inequality (Kebalo & Zouri, 2024; Batuo et al., 2022; Bicaba et al., 2017).

Furthermore, one of the associations of countries with the largest Muslim population is the D-8. The D-8 (Developing Eight Countries) is an economic cooperation organization consisting of eight developing countries: Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey. It was officially formed in 1997. At the Fifth D-8 Summit in Bali in 2006, several main objectives of the organization were established. Member states are committed to reducing economic disparities and promoting development. Despite the noble vision and the predominance of a Muslim population, which ought to prioritize socio- economic justice and welfare, income disparity remains a significant concern in the D-8 countries. According to the World Inequality Database 2023, the wealthiest individuals in the D-8 countries have long controlled over 50% of the total income, and this proportion has not shown steady improvement over the past two decades. Only 10 out of 100 people in the D-8 countries account for approximately 50% of the national income.

**Figure 1. Gini Coefficient of D-8 Countries in 2024**




Moreover, income inequality in D-8 countries has reached a warning level. According to the UN classification, a Gini coefficient above 0.4 is considered a global warning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threshold. Most D-8 countries fall within the range of 0.5 to 0.6, which indicates severe income inequality. Figure 1 presents the Gini coefficient across D-8 member countries in 2024. Turkey records the highest Gini index value at 0.59, followed by Indonesia at 0.58 and Egypt at 0.54. These underscore that income inequality in D-8 countries remains a critical development concern that requires urgent policy attention.

On the other hand, human development is a significant factor influencing reductions in income inequality across various studies (Vo et al., 2024; Kamalu & Ibrahim, 2023; Theyson & Heller, 2015). Additionally, human capital, a crucial component of human development, is also a determinant of income inequality (Furceri & Ostry, 2019; Moyo et al., 2022; Sehrawat & Singh, 2019). Moreover, the HDI is a commonly used indicator to assess human development in a country (Ngoc & Hai, 2022; Nogueira, 2021). This index has been developed by the United Nations Development Program (UNDP) since 1994 and consists of three core dimensions: healthy and long life, knowledge, and a decent standard of living. However, despite its widespread use as an indicator of human development, researchers have criticized the UNDP index for not fully capturing the quality of human development. Among these criticisms is that the HDI is considered value-neutral (Aydin, 2017). Additionally, the HDI does not account for moral factors and may exclude social indicators, such as cultural values. Therefore, this index is deemed inadequate from an Islamic economic perspective because it does not emphasize the moral and spiritual aspects of human beings (Aydin, 2017).

Some studies have attempted to refine and modify the HDI to obtain a concept and dimensions that fully describe human development (Salas-Bourgoin, 2014). One of these HDI modifications is the human development index from an Islamic perspective, formulated on the basis of the concept of maqashid sharia. Maqashid al-Sharia is the goal of advancing human well-being, achieved by safeguarding five aspects: religion (din), posterity (nasl), life (nafs), intellect ('aql), and wealth (maal). These five aspects have been used by various researchers (Widiastuti et al., 2022; Jatmiko & Azizon, 2021; Mili, 2014) as indicators of human development from an Islamic perspective. This concept of human development from the perspective of maqashid sharia has a broader scope than the conventional concept, as it integrates moral values (Chapra, 2008). From an Islamic perspective, human development involves not only material aspects such as economics, education, and health but also moral, social, and ethical dimensions (Aydin, 2017). Human resource development should not only focus on improving skills and technical aspects, but should also include spiritual and moral guidance, which is the foundation of human development (Mahri et al., 2021).

In addition, human development grounded in the objectives of Islamic law is considered capable of preventing inequality and poverty, as one of the orientations of Islamic economic development, namely *maslahah* (Mahri et al., 2021). The *maslahah* orientation is an advanced stage of human development. Human development will bring widespread benefits and prosperity for the entire community (*maslahah*), not just protect a few, and will not cause harm to other groups (Mahri et al., 2021). Additionally, one of the four main objectives based on the maqashid sharia is to ensure the long-term survival

of humanity (Mahri et al, 2021). From the perspective of Islamic economic development, the focus of development is not limited to meeting immediate or short-term needs, but also includes long-term needs (Mahri et al, 2021). Therefore, the tendency for income inequality to change will occur in the long run, leading this study to use both short- and long-term estimations.

Based on the discussion above, addressing income inequality in Muslim countries requires human development measures grounded in the Islamic perspective, which is the concept of maqashid sharia. As in Islam, the issues of inequality and injustice in society are of primary concern. Therefore, the question arises whether human development grounded in the objectives of Islamic law can truly help developing Islamic countries overcome income inequality in the short and long term.

This study is positioned at the intersection of development economics, income distribution, and Islamic economic thought by examining income inequality through a Maqashid Sharia-based human development framework. This study remains relevant as income inequality in D-8 countries has shown limited improvement over time, and the Gini coefficient exceeds the UN's warning level of 0.4. Previous studies have discussed the impact of human development on income inequality (Vo et al., 2024; Theyson & Heller, 2015; Kamalu & Ibrahim, 2023). But these studies largely rely on conventional human development measures that overlook moral, ethical, and value-based dimensions. They did not consider the Islamic perspective, which has broader dimensions. Previous studies examining human development from a maqashid sharia perspective have not addressed its impact on income inequality; they have focused only on its influence on poverty (Widiastuti et al., 2022), happiness and life satisfaction (Jatmiko & Azizon, 2021), and human well-being (Mili, 2014).

Unlike previous studies that focus on conventional human capital or HDI measures, this research employs the maqashid sharia-based development, thereby offering a more holistic and value-oriented explanation. Discussion of how it can affect income inequality remains limited. Thus, this study aims to fill these research gaps. This study contributes to the literature by extending the maqashid sharia-based human development framework to the analysis of income inequality in D-8 countries, an underexplored area. Using a dynamic panel approach, this research examines both the short-run and long-run effects of maqashid sharia-based human development on income inequality. Accordingly, the purpose of this study is to analyze the short-term and long-term impacts of maqashid sharia-based human development on income inequality across D-8 member countries.

## METHODS

This study uses annual secondary panel data from eight D-8 countries covering the period 2003–2022, comprising 160 observations. However, because first-difference variables are included, the total number of observations is 152. The data period is limited to 2003– 2022 due to data availability constraints for several key variables used in this study. In particular, some components of the independent variables are not yet


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consistently available for all D-8 countries for 2023 and 2024 across the respective data sources. Therefore, the 2003–2022 period represents the most recent dataset, ensuring methodological robustness and comparability across countries.

This study employs quantitative data, with income inequality as the dependent variable and human development, measured by the Maqashid Sharia Index (MSI), as the main independent variable. MSI is constructed from five dimensions, each represented by a specific indicator (see Table 1). In addition, control variables included are GDP, inflation, and unemployment (Vo et al., 2024; Moyo, 2022; Sehrawat & Singh, 2019). The regression model follows previous studies examining the effect of human development on income inequality (Vo et al., 2024; Ngoc & Hai, 2022; Moyo et al., 2022; Sehrawat & Singh, 2019). The regression models are specified as follows:

$$Gini_{i,t} = \alpha_i + \beta_1 MSI_{i,t} + \beta_2 lnGDP_{i,t} + \beta_3 (lnGDP)^2{}_{i,t} + \beta_4 INF_{i,t} + \beta_5 UNEMP_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$PALMA_{i,t} = \alpha_i + \beta_1 MSI_{i,t} + \beta_2 lnGDP_{i,t} + \beta_3 (lnGDP)^2{}_{i,t} + \beta_4 INF_{i,t} + \beta_5 UNEMP_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where:

| | |
|---|---|
| $GINI_{it}$ | : Gini index |
| $PALMAit$ | : Palma ratio |
| $MSIit$: | : Maqashid Sharia Index, |
| $ln(GDP)_{it}$ | : natural logarithm of GDP |
| $INF_{it}$ | : inflation rate |
| $UNEMPit$ | : unemployment rate |
| $\alpha_i$ | : intercept for each country. |

The analysis method used in this study is the Panel Autoregressive Distributed Lag (ARDL) method. The Panel ARDL (Autoregressive Distributed Lag) model is an econometric approach used to analyze the short- and long-term relationships between variables in panel data, which is data that includes multiple individuals observed over a specific period. Since the analysis will be based on the Pooled Mean Group model, the regression model is transformed into an ARDL (p,q) model, which is specified as follows:

$$\Delta y_{i,t} = \theta\left(y_{i,t-1} + \beta x_{i,t}\right) + \sum_{j=1}^{p} \alpha_j \Delta y_{i,t-j} + \sum_{k=1}^{q} y_k \Delta x_{i,t-k} + \varepsilon_{i,t}$$

Where: $\Delta$y: dependent variable, θ: error correction term, β: vector of long-run coefficients, $x_{i,t}$: vector of independent variables, $\alpha$j: short-run coefficient (to be estimated) of the lagged dependent variable, $Y_k$: short-run coefficient (to be estimated) of the lagged independent variable, $\varepsilon_{i,t}$: error term, j and k: optimal number of lags of the dependent and independent variable.

The MSI is constructed following the simple weighted approach of Widiastuti (2022) and Kasri and Ahmed (2015), assigning equal weights to all indicators for simplicity and interpretability. Indicators for each maqashid sharia dimension are normalized using the minimum–maximum method to obtain values between 0 and 1. The MSI is calculated

as the average of the five equally weighted dimensions—religion, life, intellect, posterity, and wealth. MSI values range from 0 to 1 and are classified into low (<0.550), medium (0.550–0.699), high (0.700–0.799), and very high (≥0.800) human development levels, following the UNDP classification.

The research framework of this study is described as follows. The study begins with the construction of the Maqashid Sharia Index, followed by descriptive analysis and a series of diagnostic tests, including cross-sectional dependence tests, slope homogeneity tests, and stationarity tests to determine whether variables are stationary. The analysis then proceeds with a cointegration test to identify long-run relationships, lag selection, the Hausman test, and, finally, panel ARDL estimation and discussion.

## RESULTS AND DISCUSSION

The results indicate that maqashid sharia-based human development reduces income inequality across all D-8 countries in the long run, supporting Islamic development theory that emphasizes *maslahah*-oriented outcomes. In the short run, it reduces income inequality in Indonesia and Turkey, suggesting that development benefits in these countries are more evenly distributed across income groups. In contrast, human development increases income inequality in Bangladesh, Egypt, and Nigeria in the short run, as development gains tend to be concentrated among higher-income groups. No significant short-run effects are observed in Iran, Malaysia, and Pakistan. Furthermore, GDP exhibits a U-shaped relationship with income inequality, initially reducing inequality before increasing it, while inflation and unemployment are found to exacerbate income inequality in the long run.

To provide context for these findings, the following subsection presents the descriptive statistics, preliminary diagnostic tests, and discussion of estimation results. Table 1 shows the descriptive statistics of the indicators used to construct MSI. The control of corruption indicator averages −0.639 on the WGI scale, ranging from −2.5 to +2.5, indicating weak corruption control across D-8 countries with limited variation (SD = 0.464). Life expectancy averages about 69 years, which is below the global average and suggests relatively poor health outcomes with substantial variation (SD = 7.511). The mean years of schooling is around 7, indicating low educational attainment with modest variation (SD = 1.958). The fertility rate averages 2.961, exceeding the replacement level and indicating potential population growth (SD = 1.258), while GNI per capita averages USD 11,433.61 and reflects considerable income disparities across D-8 countries (SD = 7,564.22).

Using the Simple Weighted Index method, which assigns equal weight to each dimension of maqashid sharia (20%), MSI values for each D-8 country were obtained. Figure 1 shows the average MSI trend in D-8 countries from 2003-2022. Overall, MSI values increased over time in most D-8 countries, indicating improvements in maqashid sharia- based human development despite year-to-year fluctuations. Malaysia consistently recorded the highest MSI, approaching 0.8 in the final years, while Bangladesh, Pakistan, Nigeria, and Indonesia remained below the D-8 average. Turkey, Iran, and Egypt recorded


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higher and steadily rising MSI values. Although the average MSI across D-8 countries increased over the past two decades, progress remains uneven across member states.

**Table 1. Descriptive Statistics of MSI Indicators**

| Dimensions | Indicators | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Religion | Control of Corruption | -0.639 | 0.464 | -1.597 | 0.397 |
| Life | Life Expectancy | 68.593 | 7.511 | 48.441 | 78.475 |
| Intellect | Mean Years of Schooling | 7.413 | 1.958 | 4.035 | 10.748 |
| Posterity | Fertility rate | 2.961 | 1.258 | 1.550 | 6.100 |
| Wealth | GNP per capita | 11433.610 | 7564.219 | 2551.600 | 32833.540 |

**Figure 2. Trend of the D-8 Countries' Maqashid Sharia Index**

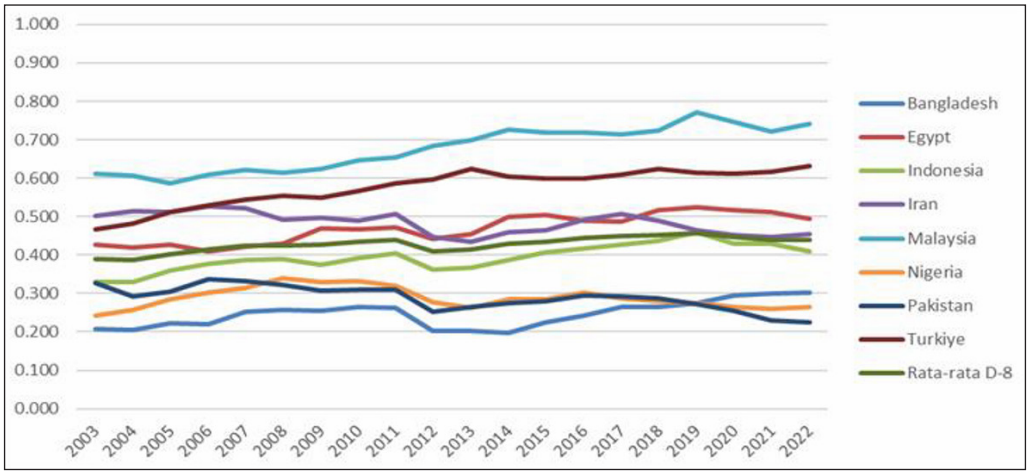


Table 2 summarizes the descriptive statistics for all variables used in the analysis. The average Gini index of 0.541 indicates that income inequality in these 8 countries is generally quite high. The average MSI of 0.452 shows that, overall, human development based on maqashid sharia is at a low level (i.e., less than 0.55), according to MSI categorization in the methods section.

**Table 2. Summary Statistics**

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Gini | 0.541 | 0.035 | 0.486 | 0.627 |
| Palma | 3.994 | 0.827 | 2.912 | 6.861 |
| MSI | 0.452 | 0.136 | 0.205 | 0.734 |
| lnGDP | 26.627 | 0.546 | 25.281 | 27.809 |
| lnGDP_square | 709.319 | 29.113 | 639.153 | 773.322 |
| inf | 10.871 | 11.269 | -5.992 | 96.036 |
| unemp | 6.555 | 3.695 | 0.398 | 14.026 |

Table 3 shows the correlations among the independent variables in the model. Of all the available variables, the correlations between them are mostly weak to moderate, indicating that these factors are interconnected but not highly or perfectly correlated. Therefore, there is no multicollinearity problem in the data.

**Table 3. Correlation Matrix**

| | MSI | lnGDP | inf | unemp |
|---|---|---|---|---|
| MSI | 1.000 | | | |
| lnGDP | 0.385 | 1.00 | | |
| Inf | 0.082 | 0.202 | 1.00 | |
| Unemp | 0.399 | 0.359 | 0.380 | 1.00 |

Table 4 shows the results of the cross-sectional dependence test. Since the p-value is greater than 0.05, the null hypothesis that the cross-sections are independent fails to be rejected. Thus, there is no cross-sectional dependence in this data. Table 5 shows the results of the slope homogeneity test. The null hypothesis of slope homogeneity is rejected by the Delta test at the 5 percent level and by the adjusted test at the 1 percent level, indicating heterogeneous slope coefficients across the model. Because there is heterogeneity, the Mean Group or Pooled Mean Group method is suitable.

**Table 4. Results of Cross-Sectional Dependence Test**

| Test | Test statistic | P-value |
|---|---|---|
| Cross-sectional dependence | -0.953 | 0.341 |

**Table 5. Results of Slope Homogeneity Test**

| | | |
|---|---|---|
| Slope homogeneity | 5.494*** | 0.000 |
| Adj. | 6.567*** | 0.000 |

Note: ***, **, and * are each significant at 0.01, 0.05, and 0.1, respectively.

**Table 6. Results of the Unit Root Test**

| Variables | P-value from IPS test | | P-value from the LLC test | |
|---|---|---|---|---|
| | At level | At first difference | At level | At first difference |
| Gini | 0.034 | 0.000 | 0.003 | 0.000 |
| Palma | 0.032 | 0.000 | 0.005 | 0.000 |
| MSI | 0.056 | 0.000 | 0.000 | 0.000 |
| lnGDP | 0.971 | 0.000 | 0.171 | 0.000 |
| lnGDP_square | 0.984 | 0.000 | 0.290 | 0.000 |
| Inf | 0.597 | 0.000 | 0.892 | 0.000 |
| Unemp | 0.066 | 0.000 | 0.013 | 0.000 |

Note: ***, **, and * are each significant at 0.01, 0.05, and 0.1, respectively.


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Since there is no cross-sectional dependence in the data, first-generation unit root tests, namely Im-Pesaran-Shin (IPS) and Levin-Lin-Chu (LLC), were used to assess whether the model data are stationary. Testing was conducted to ensure that no variables exceeded the order of integration I(1) or first difference, as ARDL estimation is not valid if the variables have an integration order of I(2) or second difference (Mendy & Widodo, 2018). The results of the unit root test are presented in Table 6.

According to the IPS unit root test, the Gini index and Palma ratio variables are stationary at the level and do not contain a unit root. Therefore, both variables are stationary at I(0). By contrast, the MSI variable, the natural logarithm of GDP (lnGDP) and its square, the inflation and unemployment rates, are all non-stationary at the level or contain unit roots. However, after testing the first difference, all the mentioned variables became stationary at the 1% level. Therefore, these variables are stationary at I(1). The results of the LLC unit root test showed that the Gini index variable, the Palma ratio, and the MSI were stationary at the level, while the other variables were stationary at the first difference. Because the combination of variables is stationary at the level and in first differences, and none is second-differenced, the panel ARDL method is suitable.

Table 7 shows the results of the cointegration test using the Kao method. The null hypothesis is that there is no cointegration among all variables, while the alternative hypothesis is that there is cointegration. The p-value is less than the significance level of 0.05. Because the test results showed significant findings, the null hypothesis stating no cointegration was rejected, and the alternative hypothesis was accepted. The variables are cointegrated, indicating a stable long-term relationship among all variables in the model.

**Table 7. Results of Cointegration Tests**

| | Cointegration Tests | Statistic | p-value |
|---|---|---|---|
| Kao | Modified Dickey-Fuller | -2.096** | 0.018 |
| | Dickey Fuller | -2.436*** | 0.007 |
| | Augmented Dickey-Fuller | -2.282** | 0.011 |
| | Unadjusted Modified Dickey-Fuller | -2.776*** | 0.002 |
| | Unadjusted Dickey-Fuller | -2.707*** | 0.003 |

Note: ***, **, and * are each significant at 0.01, 0.05, and 0.1, respectively

The next step is determining the optimal lag. The lag selection process uses the Bayesian Information Criterion (BIC) method, with a maximum lag of 1. Based on this method's results, the lag for all variables is 1. Thus, the model is ARDL (1, 1, 1, 1, 1, 1). Before moving to the regression stage, a Hausman test was conducted to determine which model was more efficient among the three types of panel ARDL models: between Mean Group (MG) and Pooled Mean Group (PMG), and between Dynamic Fixed Effects (DFE) and PMG. Based on the Hausman test results, the selected model was the PMG model. Table 8 presents the PMG estimation results.

**Table 8. Results of Pooled Mean Group Estimation**

| | Model 1 (Gini Index) | | Model 2 (Palma Ratio) | |
|---|---|---|---|---|
| | **Long-run results** | **Short-run results** | **Long-run results** | **Short-run results** |
| Error correction term | | -0.326*** (0.127) | | -0.345** (0.138 |
| MSI | -0.643*** (0.199) | -0.095 (0.140) | -14.054*** (2.277) | -2.614 (3.857) |
| lnGDP | -3.688*** (0.888) | 12.826 (8.858) | -85.844*** (21.116) | 484.039 (428.142) |
| lnGDP_square | 0.071*** (0.017) | -0.239 (0.165) | 1.669*** (0.402) | -9.050 (7.997) |
| Inflation | 0.0008*** (0.000) | -0.0003 (0.000) | 0.021*** (0.005) | -0.006* (0.003) |
| Unemployment | 0.0097*** (0.001) | -0.002* (0.001) | 0.209*** (0.028) | -0.043 (0.030) |
| Constant | | 15.626*** (6.085) | | 382.887*** (152.709) |
| Observation | 152 | 152 | 152 | 152 |

Note: Numbers in parentheses are standard errors.
***, **, and * are each significant at 0.01, 0.05, and 0.1, respectively.

In both models, ECT is negative and significant. The ECT shows that the model's variables have adjustment speeds of 32.6% and 34.5%. The ECT coefficient must be negative and significant to indicate that the system returns to long-term equilibrium after experiencing a shock or disturbance. The adjustment speed indicates that the system will return to its long-term equilibrium more quickly following short-term shocks, thereby facilitating faster convergence to the long-term equilibrium (Ramos-Herrera, 2025).

In both models, the short-term MSI coefficient is negative but not significant. This implies that, on average, the effects of maqashid sharia-based human development on income inequality have not immediately appeared in the short term. However, the long-term MSI coefficient is negative and significant at the 1% level in both models. Similar results were also found in model 2, with the Palma ratio as the dependent variable, where the long-term MSI coefficient is negative and significant at the 1% level, indicating robustness.

Two points are estimated to be the cause of these findings. First, the short-term coefficient here only describes the average results across the D-8 countries. Methodologically, these results may be insignificant because the influence in each country can move in different directions in the short term, as the PMG model assumes that short-term coefficients can differ across countries (Pesaran, 2004). For more details on short-term results by country, please refer to the next section. Second, strengthening human development in a country is a long-term investment process whose impact is not immediately visible in a short period (Deming, 2022). Investment in human development requires time to produce a significant impact on income distribution. These results are consistent with studies by Vo et al. (2024) and Moyo et al. (2022),


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which also did not provide significant evidence for human development variables in the short term. Based on the results of both models, the MSI variable is negative and significant in the long term. This result aligns with studies by Vo et al. (2024), Kamalu and Ibrahim (2023), and Ngoc and Hai (2022), which show that long-term human development can reduce income inequality. As human development based on the objectives of Islamic law increases, income distribution becomes more equitable. This finding confirms the validity of the maqashid sharia theory, which is oriented toward the public good.

This is because MSI emphasizes the holistic development of human potential, encompassing moral, educational, health, intergenerational sustainability, and material aspects. This means that the benefits of this increased development are felt by the general public in the D-8 countries, not just a select few. The increase in MSI reflects an improvement in people's quality of life through the fulfillment of these five aspects, which can benefit the entire community, ultimately reducing income inequality in the D-8 countries. The benefits of maqashid sharia-based human development are inclusive and prioritize collective interests and shared prosperity (*maslahatul ummah*). Additionally, these results show that human development, when implemented with maqashid sharia principles, is more effective at reducing income inequality in society than conventional measures. Compared with previous studies using conventional measures (Vo et al., 2024), MSI showed a greater influence on income inequality. This may be due to MSI's broader scope, which includes not only material aspects but also non-material ones, such as moral values and heritage.

This result is similar to the findings of Widiastuti et al. (2022), who found that the maqashid sharia-based human development index can significantly reduce poverty levels in Muslim countries. Similarly, Jatmiko and Azizon (2021) found that the MSI is better at reflecting the achievement of happiness and life satisfaction (as a measure of falah) than the HDI. This proves that using a holistic measure of human development, such as maqashid sharia, is important, especially for addressing poverty and income inequality in D-8 countries. On the other hand, the logarithm of GDP has a negative long-term coefficient and a positive squared term, and is significant in both models at the 1% level. This indicates a U- shaped effect. This result contradicts Kuznets' theory, which posits that the relationship between economic growth and income inequality is an inverted U-shaped curve. However, these results are consistent with the findings of Nam and Ryu (2025) and Vo et al. (2024), which show a U-shaped relationship between economic growth and income inequality.

Meanwhile, in both models, the inflation variable has a positive and significant long- term coefficient, indicating that inflation can worsen income inequality. This result is consistent with the study by Sehrawat and Singh (2019). Inflation reduces purchasing power, and its impact is felt more heavily by the middle and lower classes because they cannot adjust to rising prices, while the wealthy are less likely to be significantly affected, thereby widening the income gap. The long-term coefficient for the unemployment rate variable is positive and significant at the 1% level in both models. This shows that high

unemployment rates can lead to greater income inequality in the long run. This result is consistent with the research by Furceri and Ostry (2019).

The short-term results above are general regression results, with the coefficients for each country simply being averages. The PMG method assumes that the short-run coefficients differ across units of analysis (countries). Therefore, a more detailed explanation of MSI's short-term impact on income inequality in each country is presented in Table 9.

**Table 9. Results of Short-Term Pooled Mean Group Estimation by Country**

| | Short-run results | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Bangladesh** | **Mesir** | **Indonesia** | **Iran** | **Malaysia** | **Nigeria** | **Pakistan** | **Turki** |
| ECT | -0.278*** | -0.545*** | -1.042*** | -0.399*** | -0.301*** | -0.069*** | -0.133*** | 0.158* |
| | (0.097) | (0.101) | (0.217) | (0.109) | (0.054) | (0.019) | (0.044) | (0.081) |
| MSI | 0.163*** | 0.148* | -0.751*** | 0.256 | 0.036 | 0.042* | 0.048 | -0.702*** |
| | (0.053) | (0.082) | (0.345) | (0.159) | (0.067) | (0.023) | (0.087) | (0.226) |
| lnGDP | -2.074 | 0.955 | 13.598 | 71.841*** | 12.542*** | -0.914 | 12.783*** | -6.118 |
| | (2.755) | (5.429) | (20.334) | (20.250) | (3.059) | (0.995) | (4.548) | (3.740) |
| lnGDP_ square | 0.040 | -0.018 | -0.247 | -1.343*** | -0.236*** | 0.017 | -0.241*** | 0.109 |
| | (0.053) | (0.103) | (0.369) | (0.379) | (0.058) | (0.019) | (0.086) | (0.069) |
| Inflation | -0.0001* | -0.0003*** | -0.001 | -0.00003 | -0.001*** | -0.0001** | -0.0004 | 0.0006*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Unemp | -0.003*** | -0.003*** | -0.009 | 0.001 | -0.0007 | 0.0006 | -0.0008 | -0.004* |
| | (0,001) | (0.001) | (0.009) | (0.003) | (0.005) | (0.000) | (0.001) | (0.002) |
| Constant | 13.311*** | 26.142*** | 49.837*** | 19.115*** | 14.463*** | 3.333*** | 6.363** | -7.554** |
| | (3.796) | (7.858) | (15.559) | (6.492) | (3.863) | (1.069) | (2.518) | (3.716) |

Note: Numbers in parentheses are standard errors.
***, **, and * are each significant at 0.01, 0.05, and 0.1, respectively.

The ECT variable is negative and significant across all countries, indicating a stable long-term relationship between the variables. The largest ECT coefficient is in Indonesia (- 1.042), and the smallest is in Nigeria (-0.069). Indonesia has a faster rate of adjustment compared to other countries. This may be due to the rapid policy response from the Indonesian government to mitigate short-term inequality, for example, through the Direct Cash Assistance program, which directly increases the incomes of low-income communities (Yusuf, 2018), making them more resilient to economic shocks. Meanwhile, Nigeria experienced a slower pace of adjustment, possibly due to low economic stability (Raji, 2023), which slowed Nigeria's response to short-term shocks.

The MSI variable was found to be significant in several countries, namely Bangladesh, Egypt, Indonesia, Nigeria, and Turkey. Negative MSI coefficients were


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observed in Indonesia and Turkey, indicating that MSI reduced income inequality in these two countries in the short term. This means that within a shorter timeframe, the benefits of development can be more evenly distributed among the people of Indonesia and Turkey. Health and education aspects in Indonesia and Turkey are evenly distributed, not just felt by the wealthiest groups, which can improve the capabilities of low-income communities in both countries in the short term. This can increase the likelihood that someone will be accepted into the labor market and earn a higher income, thereby worsening income inequality (Suhendra, 2020). The MSI variable is positive and significant in Bangladesh, Egypt, and Nigeria in the short term. This means that human development initially worsened income inequality in Bangladesh, Egypt, and Nigeria. This is likely because the increased human development, such as education and health, present in the country more directly benefits high-income groups who tend to have greater access to resources. Consequently, the initial benefits of human development investments are enjoyed more by them, leading to a widening of income inequality in the short term. However, over the long term, human development grounded in the maqashid sharia will overcome income inequality across all D-8 countries.

## CONCLUSION

The research results show that human development based on maqashid sharia reduces income inequality problems in all D-8 countries in the long run. This result proves the validity of the theory of development in Islamic economics, which is oriented toward *maslahah*. In the short term, human development based on maqashid sharia reduces income inequality in Indonesia and Turkey. These results show that human development in Indonesia and Turkey is evenly distributed, so both low- and high-income communities can feel the benefits of development. Meanwhile, in Bangladesh, Egypt, and Nigeria, human development increases income inequality.

This study offers several policy recommendations for the government to implement. The government needs to expand access to human development in line with the objectives of Islamic law. The government needs to ensure that access to education and healthcare services is accessible to all segments of society. Additionally, in long-term development planning, the government needs to incorporate values (morality and heritage) into its development metrics to realize the common good for all its citizens. Several limitations must be acknowledged. This study only used one indicator to describe each dimension of the MSI variable. To enrich the research findings, future studies could use more comprehensive indicators for each dimension. Additionally, this study did not include trade openness as a control variable, so future studies are advised to include it.

## REFERENCES

Aydin, N. (2017). Islamic vs conventional Human Development Index: Empirical evidence from ten Muslim countries. *International Journal of Social Economics*, *44*(12), 1562–1583. https://doi.org/10.1108/IJSE-03-2016-0091.

Batuo, M. E., Kararach, G., & Malki, I. (2022). The Dynamics of Income Inequality in Africa: An Empirical Investigation on The Role of Macroeconomic and Institutional Forces. *World Development, 157*, 105939. https://doi.org/10.1016/j.worlddev.2022.105939.

Bicaba, Z., Brixiová, Z., & Ncube, M. (2017). Can Extreme Poverty in Sub-Saharan Africa be Eliminated by 2030? *Journal of African Development, 19*(2), 93–110. https://doi.org/10.5325/jafrideve.19.2.0093.

Camacho, M., & Ramos-Herrera, M. D. C. (2025). Does Tourism Reduce Income Inequality?. *Tourism Economics, 31*(3), 381–401. https://doi.org/10.1177/13548166241262349.

Chapra, M. U. (2008). The Islamic Vision of Development in the Light of Maqasid al-Shari'ah. *The American Journal of Islamic Social Sciences*, *16*(4), 17–38.

Deming, D. J. (2022). Four Facts about Human Capital. *Journal of Economic Perspectives, 36*(3), 75–102.

Furceri, D., & Ostry, J. D. (2019). Robust Determinants of Income Inequality. *Oxford Review of Economic Policy, 35*(3), 490-517. https://doi.org/10.1093/oxrep/grz014.

George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and Tackling Societal Grand Challenges through Management Research. *Academy of Management Journal, 59*(6), 1880-1895.

Hu, R., Wang, J., Yang, Y., & Zheng, Z. (2024). Inflation and Income Inequality in an Open- Economy Growth Model with Liquidity Constraints on R&D. *Journal of International Money and Finance, 147*, 103127. https://doi.org/10.1016/j.jimonfin.2024.103127.

Jatmiko, W., & Azizon, A. (2022). Can Religious Values Reinvigorate the Links between Development and Falāh?". *Journal of Islamic Accounting and Business Research*, *13*(1), 32–53. https://doi.org/10.1108/JIABR-08-2020-0234.

Kamalu, K., & Ibrahim, W. H. B. W. (2023). The Effect of Islamic Financial Development and Human Development on Income Inequality: Does Islamic Finance Kuznets Curve Valid in the OIC Countries?. *Journal of Islamic Monetary Economics and Finance, 9*(4), 661- 684. https://doi.org/10.21098/jimf.v9i4.1903.

Kasri, R. A., & Ahmed, H. (2015). Assessing Socio-Economic Development Based on Maqasid Shariah Principles: Normative Frameworks, Methods, and Implementation in Indonesia. *Islamic Economic Studies, 23*(1), 73-100.

Kebalo, L., & Zouri, S. (2024). Income Inequality in Developing Countries: Fiscal Policy's Role amid Uncertainty. *Journal of Applied Economics, 27*(1), 2316969. https://doi.org/10.1080/15140326.2024.2316969

Kuznets, S. (1955). Economic Growth and Income Inequality. *The American Economic Review*, *45*, 1–28.

Mahri, A. J. W., Cupian, Al Arif, M. N. R., Arundina, T., Widiastuti, T., Mubarok, F., Fajri, M., Azizon, & Nurasyiah, A. (2021). *Ekonomi Pembangunan Islam*. Jakarta: Departemen Ekonomi dan Keuangan Syariah - Bank Indonesia.


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Mendy, D., & Widodo, T. (2018). Do Education Levels Matter on Indonesian Economic Growth?. *Economics & Sociology, 11*(3), 133–146.

Mili, M. (2014). A Structural Model for Human Development: Does Maqasid al-Shariah Matter? *Islamic Economics Studies*, *22(*2), 47–64.

Moyo, C., Mishi, S., & Ncwadi, R. (2022). Human Capital Development, Poverty and Income Inequality in the Eastern Cape Province. *Development Studies Research*, *9*(1), 36– 47. https://doi.org/10.1080/21665095.2022.2032236.

Nam, H. J., & Ryu, D. (2025). Does International Trade Moderate Economic Development's Impact on Income Inequality in the EU?. *Journal of International Financial Markets, Institutions and Money, 99*, 1-14. https://doi.org/10.1016/j.intfin.2024.102107.

Ngoc, B. H., & Hai, L. M. (2024). Time-Frequency Nexus Between Tourism Development, Economic Growth, Human Capital, and Income Inequality in Singapore. *Applied Economics Letters*, 31(4), 259–264. https://doi.org/10.1080/13504851.2022.2130865.

Nogueira, M., & Madaleno, M. (2021). Are International Indices Good Predictors of Economic Growth? Panel Data and Cluster Analysis for European Union Countries. *Sustainability*, *13*(11), 6003. https://doi.org/10.3390/su13116003.

Pesaran, M. H. (2021). General Diagnostic Tests for Cross-Section Dependence in Panels. *Empirical Economics,* 60, 13–50. https://doi.org/10.1007/s00181-020-01875-7.

Rama, A., & Yusuf, B. (2019). Construction of the Islamic Human Development Index. *Journal of King Abdulaziz University, Islamic Economics, 32*(1), 43–64. https://doi.org/10.4197/Islec.32-1.3.

Ramos-Herrera, M. D. C. (2025). Economic Growth and Deviations from the Equilibrium Exchange Rate: A Panel ARDL and Panel NARDL Approach. *Applied Economic Analysis*, *33*(98), 118-139. https://doi.org/10.1108/AEA-02-2024-0065.

Salas-Bourgoin, M. A. (2014). A Proposal for a Modified Human Development Index. *CEPAL Review*, *112,* 29–44.

Sehrawat, M., & Singh, S. K. (2019). Human Capital and Income Inequality in India: Is There a Non-linear and Asymmetric Relationship? *Applied Economics, 51*(39), 4325–4336. https://doi.org/10.1080/00036846.2019.1591605.

Suhendra, I., Istikomah, N., Ginanjar, R. A. F., & Anwar, C. J. (2020). Human Capital, Income Inequality, and Economic Variables: A Panel Data Estimation from a Region in Indonesia. *The Journal of Asian Finance, Economics and Business, 7*(10), 571–579. Vo DH, Vo AT, Ho CM. (2024). The Short- and Long-Run Effect of Human Capital on Income Inequality: Empirical Evidence in the ASEAN region. *PLoS ONE, 19*(7), 1-18. https://doi.org/10.1371/journal.pone.0304678.

Widiastuti, T., Mawardi, I., Zulaikha, S., Herianingrum, S., Robani, A., Al Mustofa, M. U., & Atiya, N. (2022). The Nexus between Islamic Social Finance, Quality of Human Resource, Governance, and Poverty. *Heliyon*, *8*(12), 1-10. https://doi.org/10.1016/j.heliyon.2022.e11885.

Yusuf, A.A. (2018). The Direct and Indirect Effect of Cash Transfers: The Case of Indonesia, *International Journal of Social Economics, 45*(5), 793-807. https://doi.org/10.1108/IJSE- 03-2017-0072.


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**Table 1. Quality of Life Index (Selected Countries)**

| Countries | 2010 | 2020 |
|---|---|---|
| **ASEAN Countries** | | |
| Indonesia | 5,814 (71) | 5,54 (71) |
| Malaysia | 6,608 (36) | 6,62 (36) |
| Thailand | 6,436 (42) | 5,96 (50) |
| Filipina | 6,403(44) | 5,71 (63) |
| Singapura | 7,719 (11) | 8,00 (6) |
| Vietnam | 6,080 (61) | 5,64 (68) |

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