**DYNAMIC PANEL DATA ANALYSIS OF INCOME INEQUALITY IN INDONESIAN 2015-2023: GMM-AB**

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**ABSTRACT**

**Research Originality:** The research looks at new relationships and approaches in analyzing income inequality in Indonesia. Previous research has concentrated on income inequality relationships.

**Research Objectives:** This research aims to examine the dynamic variables that affect income inequality in Indonesia.

**Research Methods:** This research uses panel data from 34 provinces in Indonesia at 2015-2023 with the analysis of the Generalized Method of Moments Arellano Bond (GMM-AB). This method was chosen to address endogenousness and heterokedasticity issues that often arise in panel data.

**Empirical Results:** This study reveals that the democracy index and gender inequality index have a significant influence on income inequality. Instead, the ICT development index and the human development index (HDI) did not show a significant impact. These findings reinforce the argument that policies that support increased access to education and gender equality are critical in efforts to reduce income inequality.

**Implications:** It is recommended that the government design inclusive policies that focus on improving the quality of education and empowering women in the economy.

**Keywords:**

income inequality; ICT development index; Indonesia democracy index; human development index**;** gender inequality index

**INTRODUCTION**

Income inequality is one of the global issues that attracts attention for academics, the government and the public. Indonesia is one of the developing countries in Asia that has experienced an increase in income inequality in recent decades. Income inequality can be measured through the gini ratio indicator (Sitthiyot & Holasut, 2020), this indicator shows that there is a significant gap between rich and poor groups of people (Fahmi, 2019). Incrising inequality causes various social problems, such as rising poverty rates, social instability, and slowing economic growth (Cerra, 2021). The World Bank shows that the average length of education, which reflects the quality of human resources, is one of the key factors in efforts to reduce income inequality (Liu et al., 2022). Indonesia the improvement of human resources is based on development efforts in the field of education (Sudarsana, 2015).

Data of theCentral Statistics Agency (BPS) for the 2015-2023 period shows the level of income inequality in Indonesia. The highest level of inequality occurred in 2015 with a gini-ratio value of 0.40, indicating a considerable income gap between the rich and poor groups. In 2023, the Gini ratio value is at 0.38 figures, which is still relatively high and shows significant income inequality.

Figure 1 Indonesia’s Income Inequality 2015-2023

Source : Indonesian BPS Processed data (2024)

High income inequality can hinder inclusive economic growth, increase the potential for social conflict and widen the gap between rich and poor groups (Sutanto et al., 2024). In addition, it can hinder efforts to achieve the Sustainable Development Goals (SDGs), especially in reducing poverty, reducing inequality, and improving people's welfare (Lilis & Badriah, 2019). Income inequality can also worsen the gender inequality index by creating barriers for women to access economic resources, education and employment opportunities (Adeosun & Owolabi, 2021). The Areas with a high Gini Ratio tend to have greater levels of gender inequality (Fisher & Naidoo, 2016). In other words, inequality income distribution results disparities in people quality of life.

Income inequality will not only have an impact on economic growth but will too affect several other development indicators such as the ICT Development Index, the Indonesian Democracy Index (IDI), the Human Development Index (HDI) and the Gender Inequality Index (GII). Study (Kartiasih et al., 2023) explained that the adoption of ICT in Indonesia can help reduce income inequality, because ICT development can improve communication and affect social development. Inequality in society both in the social and economic fields can affect the implementation of democracy, if income inequality increases, it will change the condition of democracy in society (Anyanwu et al., 2016).

(Setyadi et al., 2023) discussed the Development of Digital Technology and Income Inequality in Indonesia. The increasing development of ICT shows that people must develop digital competencies for the use of ICT in various aspects of life. Inclusive, efficient and innovative development can expand information at a lower cost (Wanof, 2023). This creates opportunities for the poor and disadvantaged. ICT development can also reduce income inequality because it increases overall worker productivity (Hernandez et al., 2016). The existence of technology can send information faster and easier so that it can reduce transaction costs. (Mushtaq, 2019) also found that the adoption of ICT improves the well-being of rural communities by providing farmers with market information to increase their bargaining power and income-generating ability (Ma et al., 2023).

Study (Lyrra et al., 2025) A strong democracy is expected to encourage a more equitable distribution of income through political participation and government accountability mechanisms. Research (Stoetzer et al., 2023) It is explained that income inequality is a relevant issue in the global social and political context, especially in democratic countries. However, in the research (Ramadhan, 2023) stated that good democracy in Southeast Asia will increase income inequality. On the contrary, when the country is more undemocratic, income inequality will decrease (Saputro & Ulfatun Najicha, 2022). This is cause countries in Southeast Asia have not been able to create a good institution.

Low-income communities tend to have limited access to education and information, which has an impact on low participation in the democratic process (Willeck & Mendelberg, 2025). To improve the economic welfare of the population, it must be balanced with the improvement of the quality of the human development index. Research (Janah, 2022) the human development index has a positive relationship with income inequality. This means that the higher the value of the human development index, the higher the level of income inequality in a region (Hadi Susilo et al., 2020). On the contrary, the low value of the human development index reflects the unsuccess of a region or region in optimizing the resources owned and available, so as to reduce income inequality (Iddrisu & Bhattacharyya, 2015).

Low access to education and information will also have an impact on the Human Development Index resulting in gender inequality, because poor people often do not have equal access (Kling et al., 2020). Increased gender equality is expected to contribute to reducing income inequality (Chung et al., 2021). By providing equal access for women in education and economic participation, household productivity can increase (Jabeen et al., 2020). When women have low access to education and economic participation, their income potential will decrease which will result in income inequality (Sitorus, 2016).

Kuznets' theory of economic growth and income inequality explains that technology has an impact on income inequality. This theory shows that at the beginning of industrialization inequality in developing countries increases and decreases after reaching a certain level of income, this statement is known as the inverted U-curve (Tabash et al., 2024). In relation to ICT development, it can be exogenous and endogenous with its characteristics that can affect public goods or services. Research conducted by Reuveny and LI, looking at the relationship between democracy and income inequality using an OLS analysis tool with a sample of 69 countries from 1960 to 1996, found that the democracy index can reduce income inequality (Ramadhan, 2023).

Empirical studies conducted previously discussed the influence of macroeconomic variables on income inequality. The gap in previous research lies in the use of panel data analyzed using multiple linear equations (Janah, 2022). However, there are still limited studies that discuss the short-term and long-term implications of macroeconomic variables on income inequality. Based on the limitations of previous research on income inequality, further research with a more representative approach is needed. This study updates the approach by using the Generalized Method of Moments Arellano-Bond First Difference analysis to analyze the short-term and long-term effects of income inequality as a dynamic variable, as well as determine the best model for this variable in 34 provinces in Indonesia. The findings in this study are expected to provide more insight into the factors of income inequality and can be used as recommendations in making policies.

**METHODS**

This study uses quantitative secondary data from the Central Statistics Agency. The data is processed from the Gini ratio index as a dependent variable that measures income inequality. Independent variables of ICT development level, Indonesian Democracy Index (IDI), Human Growth Index (HDI) and Gender Inequality Index (GII) in Indonesia. This study assumes that there are independent variables that can reduce income inequality. The dynamic panel data regression method was used to determine the impact of ICT development levels, the indonesian democracy index, the human growth index and the gender inequality index on income inequality in 34 provinces in Indonesia.

In dynamic panel data regression, Arellano-Bond GMM estimation is used to produce parameter estimates that are unbiased, consistent and efficient. This method is used to overcome the problems of endogenity and heteroscedasticity that often arise in panel data. The estimate used by GMM Arellano-Bond with a two-step estimator is as follows.

(1)

Value and to estimate parameters in the dynamic panel data regression model. This parameter calculates the influence of independent variables on dependent variable variables. Simultaneous significance testing to determine the presence or absence of variable relationships in the model was carried out by Arellano-Bond: 1991, using the wald test. The goal is to find out the significance of variables simultaneously in the equation model (1). The hypothesis of simultaneous testing is as follows.

(No variable coefficients have a significant effect on the model)

(2)

Reject  if the value statistic test or p-value  (). To find out the coefficient of variables that have a significant effect on the model, partial testing is carried out using the Z test..

(There are not response lag variables or independent variables that had a significant effect on the model)

(Response lag variables or independent variables that have a significant effect on the model)

dan (3)

Reject if or p-value (). Furthermore, to test the specification of parameters, tests were carried out using the Sargan test and the Arellano-Bond test. The sargan test is used to test whether there is a problem with the validity of the instrument used, meaning that there is no correlation between the instrument and the error component. The Sargan test determines the validity of the use of variable instruments with overindetifying restrictions, which is more than the estimated number of parameters. The sargan test is also to determine homogeneity, i.e. the variation of error is constant. The hypothesis of the Sargan test is as follows

*overidentifying restrictions* in the valid model estimation (variable instrument does not correlate with error)

*overidentifying restrictions* invalid model estimates.

(4)

The Arellano-Bond test is proposed as a test for the absence of first-order serial correlation of errors in the first Difference equation, used to determine the consistency of the estimation results. The Arellano-Bond test is also used to determine the correlation of observation errors to-t with previous observations . The hypothesis of the Arellano-Bond test is as follows.

There is no autocorrelation in the first difference equation

There is an autocorrelation in thefirst difference equation

The consistency of the method is indicated by statistical values significant and statistical values insignificant . The statistics of the Arellano-Bond test for the serial correlation of 1st order components in the first Differencing can be written as follows.

(5)

Where is a vector error in the 1st lag with the order and is a cropped error vector corresponding to sized .

In order to analyze the influence of income distribution, this study uses the gini index coefficient variable as a dependent variable and a number of influential variables such as ICT development index, Indonesian democracy index, human development index**,** andgender inequality index as independent variables. The econometric model used in this study to measure the influence of finance on income distribution is as follows:

The model is adapted from the model developed by Kus (2012) dan Asfar et.al (2014) which is estimated by panel data analysis. All variables used are estimated in the form of linear logs to get an overview of the elasticity.

**RESULT AND DISCUSSION**

**Dynamic Panel Data Regression Model Estimation**

At this stage, the estimation of the panel data regression model is carried out using the first difference GMM two-step estimator approach. This approach was chosen because it is able to produce a valid instrument.

**Table 1** Model Parameter Estimation Arellano-Bond FDGMM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Coefficient | Standard Error | z | p-value |
| Income Inequality | .1658186 | .1268791 | 1.31 | 0.191 |
| ICT Development Index | -.0341413 | .0410435 | -0.83 | 0.406 |
| Indonesian Democracy Index | -.4513132 | .1253987 | -3.60 | 0.000 |
| Human Development Index | -.0628988 | .2214747 | -0.28 | 0.776 |
| Gender Gap | -.1978232 | .0376705 | -5.25 | 0.000 |
| cons | 1.240963 | .9465477 | 1.31 | 0.190 |

Source : data processing results from Stata

Table 1 shows the intercept and slope values for each exogenous variable using the FD-GMM approach model. The p-value can show how much the independent variable has an influence over the dependent variable.

**Estimation GMM Arellano-Bond *(first-difference* GMM*)***

The estimation used in this study uses the GMM Arellano-Bond two-step estimator*.* The siginification test was carried out simultaneously using the Wald test with the following results:

**Table 2** Wald test

|  |  |
| --- | --- |
| Wald value (w) | P-value |
| 46.22 | 0.0000 |

Source : data processing results from Stata

From Table 2, it was decided to reject because the value of the wald obtained 46,22 or p-value ( = 0,05), Thus, it can be concluded that there is at least one independent variable that affects the dependent variable. After the wald test is met, then a partial parameter significance test will be carried out using the Z test, the results of the Z test can be seen as follows.

**Table 3** Partial Parameter Significant test

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Coefficient | Standard Error | z | p-value |
| Income Inequality | .1658186 | .140192 | 1.18 | 0.237 |
| ICT Development Index | -.0341413 | .0349875 | -0.98 | 0.329 |
| Indonesian Democracy Index | -.4513132 | .1099028 | -4.11 | 0.000 |
| Human Development Index | -.0628988 | .2223908 | -0.28 | 0.777 |
| Gender Gap | -.1978232 | .0454879 | -4.35 | 0.000 |
| cons | 1.240963 | 1.090683 | 1.14 | 0.255 |

Source : data processing results from Stata

From Table 3 it can be decided to reject on the variable Indonesian democracy index and gender inquality index because the value of probability <0.05 while failing to reject on the variable ICT development index and human development index because of its probable value >0.05

Furthermore, a model specification test was carried out on all variables that had a significant influence on the model. The best dynamic panel data model estimation can be seen from the criteria, namely the variables of the instrument used are valid and the estimates obtained are consistent. The test of the variable of the instrument uses the Sargan test and the estimation consistency test uses the Arellno-Bond test. Sargan test results can be seen as follows.

**Table 4** Sargan test

|  |  |
| --- | --- |
| Statistical Value(S) | P-value |
| 33.6773 | 0.1756 |

Source : data processing results from Stata

From Table 4, it can be concluded that the p-value value (0,1756) greater than the level of significance. (0,05), then fail to reject . The sargan test is also used to look at residues that undergo heterokedasticity. So it can be decided that it fails to reject, which means that there is no heterokedasticity or residual from the estimate of GMM Arellano-Bond homogeneous.

Next, the Arellano-Bond test will be carried out, the results of the Arellano-Bond test can be seen as follows.

**Table 5** Uji Arellano-Bond

|  |  |
| --- | --- |
| Nilai Statistik(S) | P-value |
| -.58366 | 0.5595 |

Source : data processing results from Stata

From Table 5, it can be decided that the rejection fails Because the p-value is much greater than the 5% significance level, this means that there is no autocorrelation in the First Difference error so that the estimate has been consistent.

**Regression Elasticity Coefficient**

**Table 6** Short-Term and Long-Term Parameters test

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Short-Term Elasticity  Coefficient | p-value | Long-Term Elasticity  Coefficient | p-value |
| Income Inequality | - | - | - | - |
| ICT Development Index | -.0341413 | 0.329 | -.0409279 | 0.344 |
| Indonesian Democracy Index | -.4513132 | 0.000 | -.5410253 | 0.000 |
| Human Development Index | -.0628988 | 0.777 | -.0754019 | 0.775 |
| Gender Gap | -.1978232 | 0.000 | -.2371465 | 0.001 |

Source : data processing results from Stata

Table 6 is the test result of the short-term and long-term effects of income inequality on the variables of the ICT Development Index, the Indonesian Democracy Index, the Human Development Index and the Gender Inequality Index. Based on the above data processing, it can be explained as follows:

The test results in Table 6 show the short-term elasticity value of the ICT development index variable of -.0341413 and the p-value of 0.329. In this case, ICT does not have a significant negative influence in the short term on the level of income inequality. Thus, it can be interpreted that an increase in ICT by 1% will reduce income inequality, but it partially does not have a significant influence on income inequality because the probability value in the short and long term > the level of significance (p-value) = 5% or 0.05.

The short-term elasticity coefficient in the Indonesian Democracy Index variable of -.4513132 with a probability value of 0.000 indicates that a 1% increase in the Indonesian democracy index will cause a statistically significant decrease in the dependent variable, both in the short and long term.

The Human Development Index with a short-term elasticity value of -.0628988 and a p-value of 0.777. This does not have a significant negative impact on income inequality. Meanwhile, the long-term elasticity value is -.0754019 and the p-value is 0.775. It also does not have a significant negative influence. Therefore, it can be concluded that every 1% increase in the human development index will reduce income inequality by 0.62% in the short term and 0.75% in the long term. However, the effect is not partially significant.

The probability value of the gender inequality index is small from a significance level of 0.05 in the short and long term of (0.000 and 0.001) with its elasticity (-.1978232 and -.2371465). This means that every 1% increase in the gender inequality index will cause a partially significant decrease in the dependent variables, both in the short and long term.

**Data Interpretation**

Based on the Arellano-Bond approach in table 4, the Arellano-Bond security is obtained as follows:

1. The Constant value of 1.240963 indicates that when the variables of the ICT Development Index, the Indonesian Democracy Index, the Human Development Index and the Gender Inequality Index are equal to zero, then the Income Inequality will increase by 1.240963.
2. ICT Development Index, this variable shows the influence of the level of information and communication technology development on innovation capabilities. A negative coefficient of -0.0341413 indicates that the higher the ICT development index, the lower the innovation capability. This may happen for several reasons, such as over-reliance on existing technology or lack of innovation in the use of technology.
3. The Indonesian Democracy Index, a negative coefficient of -0.4513132 indicates that the higher the democracy index, the lower the innovation ability. This could happen because political instability or frequent policy changes in areas with high levels of democracy can hinder investment in innovation. In another study conducted (Nazirou et al., 2022) which is seen using OLS analysis, the results are obtained that the level of democracy can reduce the level of income inequality.
4. The Human Development Index, a negative coefficient of -0.0628988 indicates that an increase in the human development index is not always accompanied by an increase in innovation capabilities. This may be because the human development index focuses more on social welfare aspects, while the ability to innovate is more related to productivity and efficiency aspects. A high human development index provides a good opportunity for a region, where each individual will make more money, so that they can meet their individual needs.
5. Gender Inequality Index, a negative coefficient of -0.1978232 indicates that the higher the gender inequality, the lower the innovation ability. This could be due to the lack of women's participation in economic and social activities which can hinder the emergence of innovative ideas. In the research conducted (Yuniar & Yuniasih, 2022) stated that the relationship between education inequality and income inequality was significantly positive. This states that the existence of educational inequality will affect the emergence of gender inequality (Baten et al., 2021).

**The Relationship of the ICT Development Index to Income Inequality**

The results show that ICT variables have a significant negative relationship with inequality. Similar research was also conducted by (Khan & Kazim, 2020) shows that ICT development in 28 member countries of the Organization for Economic Co-operation and Development (OECD) has a negative and significant relationship with income inequality. In other words, it can be interpreted that countries with higher ICT development tend to have low income inequality levels (Wijayanti et al., 2023).

The widespread use of digital technology gives hope for a reduction in economic inequality in Indonesia (Barata, 2019). Technological developments have created a digital marketplace that connects service providers with users in various aspects of life, such as health, education, trade, transportation, and others (Wang et al., 2024). In Schumpeter's Theory Phase I, which is characterized by creative destruction, innovation and new technology will open up greater opportunities for new players to enter the market and challenge old players so that there is an expansion of opportunities (Stephan Isaiah & Konyefa Dickson, 2024). New technologies give rise to various innovations, product development, and new processes. The value of monopolies and technological barriers from innovations made by old players will fall so that the competitive advantage of established companies will be eroded. In this process, technology helps facilitate equity.

The findings in this study emphasize the importance for the government to improve its capabilities in technological innovation. Furthermore, the government needs to conduct an in-depth analysis related to technological developments in remote areas. With the equitable distribution of technology in each region, it is hoped that the community can get equal information and economic opportunities. This emphasizes the importance of investing in digital technology infrastructure to expand people's access to the job market and overall economic opportunities.

**The Relationship of the Indonesian Democracy Index to Income Inequality**

The results of the study show that democracy has a significant effect on income inequality. This is in line with the research of Reuveny and Li, who used the OLS method with a sample of 69 countries in the period 1960-1996. They found that better democracies tend to reduce income inequality through more equitable political participation mechanisms and redistribution policies. In other words, a strong democracy allows for a more equitable distribution of income due to public involvement in the policy-making process and increased transparency of government (Vicent et al, 2021). Dalam penelitian (Acemoglu et al., 2015) dijelaskan ketika ketimpangan pendapatan menurun maka akan meningkatkan kualitas demokrasi di masyarakat, sebaliknya ketimpangan pendapatan meningkat maka kualitas demokrasi di masyarakat akan menurun.

Research (Trinugroho et al., 2023) found that democracy actually has a negative impact on economic growth, although it can help reduce income inequality between provinces. Democracy can play a role in reducing income inequality, but at the same time it can slow down economic growth if not balanced with the right policies Income inequality factors in Indonesia do not directly affect the implementation of democracy in Indonesia, because there are variables of human development interventions that measure the quality of human resources (Fadly & Chandra, 2024).

The implications of the findings of this study show that good democracy can reduce income inequality, by increasing community involvement in economic policies and ensuring a more equitable distribution of resources. The government needs to strive to improve the quality of democracy with inclusive economic policies so that it can reduce income inequality. With community involvement, the government can better understand the real needs of the community. So that the resulting policy can be inclusive.

**The Relationship of the Human Development Index to Income Inequality**

The results of the study show that the human development index does not have a significant effect on income inequality. However, other studies show different results. According (Janah, 2022), the human development index actually has a positive relationship with income inequality. This means, the higher the human development index value of a region, the greater the level of income inequality. On the contrary, a low human development index value reflects the unsuccess of a region or region in optimizing the resources owned and available. This can be attributed to the fact that despite human development on the rise, access to quality education and health services remains unequal, which causes poor groups to remain behind.

Research (Sarkodie & Adams, 2020) it was found that income inequality will interfere with the success of human resource development carried out by the government. (Moyo et al., 2022) Human capital development and income inequality have a positive relationship, indicating unequal economic opportunities and inequality in the education system. Higher human resources are seen from higher education, indicating that there is a greater possibility of being accepted into the job market and earning an income (Suhendra & Wicaksono, 2016). Becker stated that a good human development index will affect labor productivity so that the impact will reduce income inequality (Azim et al., 2022) .

The implication is that the human development index can theoretically reduce income inequality, but in practice the impact of the human development index is not significant because of the uneven distribution of development benefits, especially in access to education and quality health services. It is important for the government to make more targeted policies in such access, so that the increase in the human development index can contribute directly to income inequality. With targeted policies and equitable development, an increase in the human development index can have a significant impact on reducing income inequality.

**The Relationship of the Gender Inequality Index to Income Inequality**

The results of the study show that the gender inequality index has a significant effect on income inequality. The lower the gender inequality, the lower the income inequality. Research (Rofatunnisa & Usman, 2024) it also shows that areas with high income inequality tend to have greater levels of gender inequality. High gender inequality can create barriers for women to access economic resources, education, and decent work, ultimately exacerbating overall income inequality.

Gender inequality often results in women having limited access to education and skills training. However, in the research (Hamzah, 2017) stated that gender inequality does not have a significant effect on the level of education. This is because the education system has given equal priority between men and women in Indonesia. In research (Reiss et al., 2023) shows that the income inequality between men and women will be greater over time for the upper class. Social class greatly influences the objective career success of men and women differently.

The implication is that reducing gender gaps can help reduce income inequality, because increasing equal access to economic resources and employment contributes to equitable distribution of income. It is important for the government to maintain the same education for men and women. With equal educational opportunities, it is hoped that it can prevent income inequality between men and women.

**CONCLUSIONS**

The conclusion of this study highlights the importance of understanding income inequality in Indonesia, especially in the context of the development of information and communication technology (ICT), democracy index, human development index and gender inequality index. High income inequality can hinder inclusive economic growth and worsen people's quality of life, especially for the underprivileged. Income inequality has a wide impact on various aspects of social and economic development. This research shows that income inequality can increase the potential for social conflict and widen the gap between rich and poor groups. In addition, income inequality can also hinder the achievement of the Sustainable Development Goals (SDGs), especially in reducing poverty and improving people's welfare. Income inequality also contributes to unequal access to education and employment opportunities, which negatively impacts the gender inequality indx. Tthis study confirms that income inequality in Indonesia is a complex issue that requires serious attention from various parties. The understanding the factors that affect income inequality, including the role of ICT and the human development index, it is hoped that effective solutions can be found to create more inclusive and sustainable economic growth in the future. These findings have important implications for policymakers in designing effective strategies to reduce income inequality in Indonesia. Government policies are needed to solve this problem by considering the factors of technological development and human resources.

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