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Dynamic Analysis on The Determinants of Prevalence of Undernourishment in Indonesia: A System GMM Approach

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ABSTRACT

Indonesia faces food insecurity which is reflected by the increasing prevalence of undernourishment in 2023 compared to 2018. This study examines the impact of food production, inflation, unemployment, and social food assistance on undernourishment with people's purchasing power as a mediating variable. The mediating variable is the novelty of this research which can offer a new perspective which still limited in previous studies. Dynamic panel analysis with the Generalized Method of Moment (GMM) and Sobel test is used to examine direct and mediation relationships for the data period 2018-2023. The results show the direct and indirect effects of inflation, unemployment, and social food assistance on the prevalence of undernourishment in Indonesia through the mediation of people's purchasing power. Meanwhile, food production has no effect either directly or indirectly. This study implies the government must maintain stable inflation, create jobs, target food assistance effectively, and reduce reliance on social food assistance.

Keywords: Prevalence of undernourishment, food insecurity, people's purchasing power, dynamic panel analysis, policy implication

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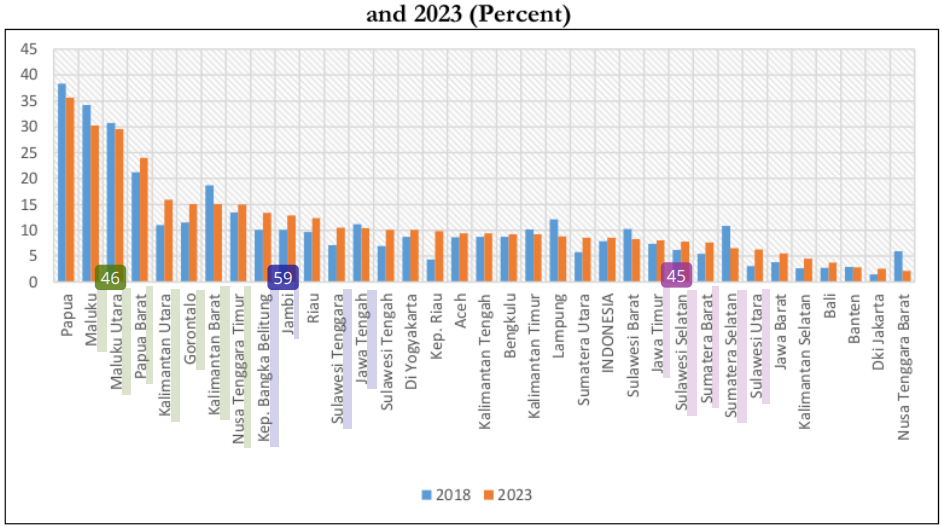
INTRODUCTION

Food security has become a main issue that receives serious attention from the Indonesian government. As a country with a population of more than 280 million people (BPS-Statistics Indonesia, 2024), Indonesia faces great challenges in ensuring the availability of sufficient, safe, and nutritious food for all people, as stated in the Food Security Law No.18 of 2012. Climate change has caused various negative impacts on the agricultural sector, such as changes in growing season patterns, increased frequency and intensity of natural disasters, and decreased land productivity. These conditions have resulted in a decrease in domestic food production, which has an impact on national food availability (FSIN and Global Network Against Food Crises, 2023). In addition, the COVID-19 pandemic that has hit the world since early 2020 has also put additional pressure on Indonesia's food security system. Supply chain disruptions, declining purchasing power, and mobility restrictions have affected food distribution, especially in hard-to-reach areas (World Food Programme, 2020). The crisis has exposed the vulnerability of national food security and prompted the government to strengthen a more resilient and sustainable food system (Sjahrir & Dawam, 2022).

As part of the efforts to understand and address food insecurity, the National Food Agency in 2023 officially said that one of the indicators to assess the condition of food insecurity is the prevalence of undernourishment (National Food Agency, 2023). The prevalence of undernourishment is defined as the condition of inadequate fulfillment of minimum energy from continuous food consumption in a country. This indicator describes the availability of food and the ability of households to access it at different socio-economic levels (FAO et al., 2021). It is included as an indicator in the second Sustainable Development Goal (SDG), namely no hunger.

The prevalence of undernourishment is categorized into 5 statuses, they are very low (<2.5%), low (2.5% to 4%), medium (5% to 19%), high (20% to 34%), and very high (>35%) (Ministry of Agriculture, 2022). Based on Figure 1., the prevalence of undernourishment in most provinces in Indonesia is in the medium category. At the same time, the four regions with high status are West Papua, North Maluku, Maluku, and Papua. It is of further concern that more than half of the regions (23 out of 34 provinces) in Indonesia experienced an increase in the prevalence of undernourishment in 2023 compared to 2018. Moreover, 22 provinces in Indonesia still have a prevalence of undernourishment rates above the Indonesian average. This condition makes the author feel it is essential to examine what factors influence the prevalence of undernourishment in Indonesia.

Figure 1. Prevalence of undernourishment in Indonesia by Province in 2018 and 2023 (Percent)



Source: BPS-Statistics Indonesia, 2024

The ability to meet food consumption needs in a region is strongly tied to the income levels of its residents, according to Keynes's consumption theory that consumption is influenced by the level of income and consumption expenditure is part of income that is ready to be spent or what is called disposable income (Dornbusch et al., 2008). Disposable income directly determines the level of people's purchasing power (Du, 2022). People's purchasing power is directly related to food accessibility, and its fluctuations can weaken or strengthen the influence of other socioeconomic factors on food consumption levels (C. Smith & Haddad, 1999). Several studies have found that increasing purchasing power can reduce the prevalence of undernourishment (Solana, 2022; Dai & Sulila, 2020; Mazouzi & Amina, 2024). Increased purchasing power will encourage changes in people's consumption patterns for the better so that undernourishment can be resolved (Putra & Wardana, 2018). Furthermore, El-laithy et al. (2023) argue that food insecurity generally results from households' low access to food due to low purchasing power.

An economic factor that is also an important pillar in the food security system is food availability. Food must be available for everyone because how can people's food consumption be met if food is unavailable or scarce? High-quality food production can help ensure a balanced nutritional intake, thereby reducing the prevalence of undernourishment (Marson et al., 2023). When food production increases during the harvest season, food prices will generally be lower because there is more food available, which makes people's purchasing

power higher so that food consumption is fulfilled (National Food Agency, 2023). Several studies have suggested that increasing food production can reduce the prevalence of undernourishment, such as studies by Solana (2022), Kezia et al. (2022), Njangang et al. (2022), Grewal et al. (2024) and Domguia et al. (2023). Adequate food production can help reduce the prevalence of undernourishment by ensuring adequate food availability for the population. High-quality food production can also help ensure a balanced nutritional intake. However, research by Daccache et al. (2024) suggests that increasing agricultural production alone is not enough to significantly impact food security if improvements do not follow in distribution and policies that support food access. Squires & Gaur (2020) also argued that despite increased food production, food access and distribution issues remain a major challenge.

The next economic factor is price stability. The level of public consumption is inseparable from the influence of the price of goods. A rise in the prices of certain goods, as indicated by the inflation rate, will affect public consumption. High inflation, generally caused by rising food prices unaccompanied by rising incomes, can reduce people's purchasing power, especially those on low incomes, resulting in difficulties in meeting food needs. They will tend to turn to cheaper and less nutritious food, resulting in undernourishment (El-Laithy et al., 2023; Obiora et al., 2023). High inflation rates directly impact food affordability, both as a result of rising food prices and as a result of budget constraints due to rising costs of utilities, housing, and services (Stone et al., 2024). Furthermore, Johnstone & Lonnie (2023) argued that price increases, especially food prices, which are not accompanied by wage increases, make it difficult for those on low incomes to buy or access healthy food. Research by Solana (2022); Domguia et al. (2023); Arrohmah et al. (2023); and Azid et al. (2012) found that inflation can increase the prevalence of undernourishment.

Another economic factor that contributes to the prevalence of undernourishment is unemployment. High unemployment reflects the fact that many people do not earn an income due to unemployment and thus face difficulties in meeting food consumption due to limited purchasing power (Faubert & Moppett, 2015). Unemployment poses a major risk to household food security, primarily impacting food consumption due to negative income shocks and income instability (Sam et al., 2019). Research by Yahya et al. (2023); Abebaw et al. (2020); Owens et al. (2020); Enakhe & Tamuno, (2021); and Etana & Tolossa (2017) suggest that unemployment can increase the prevalence of undernourishment. Unemployed

people generally have limited financial resources, so they prefer to consume less or less nutritious food because the price is more affordable, which will impact undernourishment.

Furthermore, social factors that play a role come from government policies, namely social food assistance. This program seeks to reduce the financial burden on poor and vulnerable families in meeting their food needs. Social protection policies, such as social food assistance, play a crucial role in enhancing purchasing power and improving access to healthy diets for the most at-risk populations. (FAO et al., 2020). Sustaining the social food assistance program helps ensure the food security of beneficiary households (Sartiyah & Suriani, 2019). Research results by Mary et al. (2018); Solana (2022); Tranchant et al. (2019); and Treloar et al. (2024) suggest that social assistance programs such as food assistance can reduce the prevalence of undernourishment. Food assistance is a form of government transfer that can increase income for beneficiaries or provide an increase in real income so that people can meet their food needs (Suparmono, 2018; Nurhana & Fahrika, 2022). Research by Suriani & Sartiyah (2020) proves that social food assistance from the government can improve food security.

Several studies on the determinants of the prevalence of undernourishment in Indonesia have been conducted (Solana, 2022; Kezia et al., 2022; Mardison, 2020; Arrohmah et al., 2023; Mone & Utami, 2021). The difference between this research and its novelty is the use of mediating variables, namely people's purchasing power so that this research can provide a new perspective on the factors directly and indirectly related to the prevalence of undernourishment in Indonesia.

Based on the background previously described, the aims of this study are: to analyze the effect of food production, inflation, unemployment, social food assistance, and people's purchasing power on the prevalence of undernourishment in Indonesia; to analyze the role of people's purchasing power in mediating the effect of food production, inflation, unemployment, and food social assistance on the prevalence of undernourishment in Indonesia.

The remainder of this article is structured as follows: Section 2 details the data, variables, and methodology of this study. Section 3 presents the findings and discusses them, including the mediation test results (Sobel test). Section 4 concludes with insights and policy implications based on the results.

METHOD

Data Source

This study utilizes panel data from 34 provinces in Indonesia over the 2018-2023 period (6 years), resulting in a total of 204 observations. The data employed are secondary data entirely sourced from BPS-Statistics Indonesia.. Variable types, definitions, units, and data sources in this study can be seen in Table 1.

Table 1. Explanation of Variables

Variable	Explanation	Source(s)
Prevalence of undernourishment (POU)	The proportion of the population in an area that consumes food below the standard threshold of adequate energy needed (%)	BPS-Statistics Indonesia
Food Production (FP)	Total rice production (million tons)	BPS-Statistics Indonesia
Inflation (CPI)	Inflation based on consumer price index (index)	BPS-Statistics Indonesia
Unemployment (UNE)	Open unemployment rate (%)	BPS-Statistics Indonesia
Social Food Assistance (FA)	Realization of social food assistance expenditure (trillion rupiah)	BPS-Statistics Indonesia
People's purchasing power (PP)	Adjusted per capita expenditure (million rupiah)	BPS-Statistics Indonesia

Source: author's compilation

Model Specification and Estimation Approach

Economic variables in reality have a dynamic relationship, which is characterized by the lag of the dependent variable between the independent variables. There are two models in this study, the first model is to see the effect of independent variables on the mediating variable, PP. The second model is to see the effect of the independent variables on the dependent variable by including the mediating variable. Because there are differences in units between variables, some variables are converted into natural logarithms to facilitate interpretation except for POU and UNE variables which already have percent units. The model in this study is written as follows:

Model 1:

$$PP = f(FP, CPI, UNE, FA) \quad (3)$$

$$lnPP_{it} = \alpha_1 + \delta_{11} lnPP_{i,t-1} + \beta_{11} lnFP_{it} + \beta_{12} lnCPI + \beta_{13} UNE_{it} + \beta_{14} lnFA_{it} + u_{it} \quad (4)$$

Model 2:

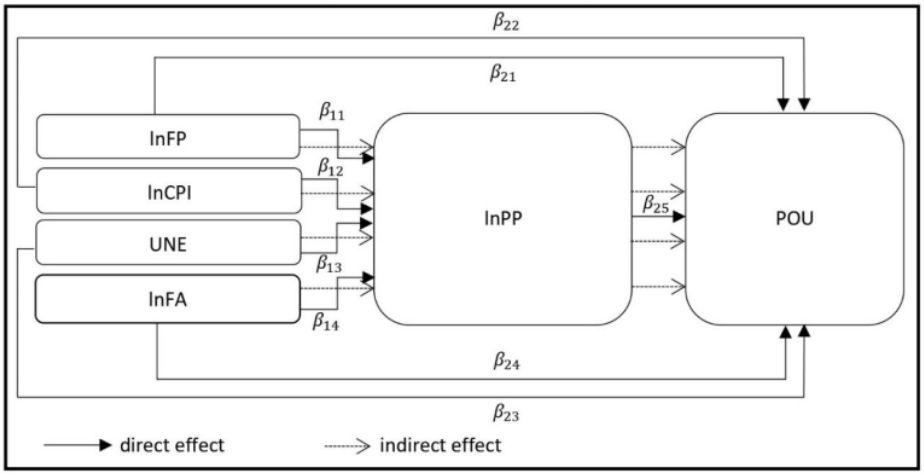
$$POU = f(FP, CPI, UNE, FA, PP) \quad (5)$$

$$POU_{it} = \alpha_2 + \delta_{21} POU_{i,t-1} + \beta_{21} lnFP + \beta_{22} lnCPI_{it} + \beta_{23} UNE_{it} + \beta_{24} lnFA_{it} + \beta_{25} lnPP_{it} + u_{it} \quad (6)$$

The analysis method used in this research is dynamic panel analysis with the Generalized Method of Moment (GMM). The GMM dynamic panel method was chosen because it is designed for panel data situations with small T and large N that match the data conditions of this study (Roodman, 2009). The type of estimator used is the Generalized Method of Moments System (SYS-GMM) or the so-called Blundell-bond estimator which is claimed to be more efficient than the Arrellano Bond estimator (Baltagi, 2005). This is due to the use of additional level information, namely the moment of condition and matrix of instrument variable level in addition to the first difference by combining the moment of condition and matrix of instrument variable (first difference and level). Several model specification tests were carried out to ensure that the model used was valid, consistent, and unbiased, namely the Sargan test, Arrellano Bond test, and estimator unbiasedness test (Ullah et al., 2023)

Furthermore, the Sobel test is used to see the mediation effect of the mediator variable. If there is a mediation effect, then there is a direct and indirect influence between the independent variable and the dependent (Duryadi, 2021). An illustration of the framework conducted in this study can be seen in Figure 2.

Figure 2. Framework Analysis



RESULT AND DISCUSSION

Descriptive Statistic and Correlation Analysis

The analysis started with an examination of the descriptive statistics for all variables and the correlation matrix among the independent variables, as presented in Table 2. Descriptive statistics provide insights into the variability and distribution of the variables. The results show that the mean and median values of all variables fall within their minimum and maximum ranges, indicating an appropriate and symmetrical distribution.. This implies that the variables have a high level of consistency.

Table 2. Summary Statistics for The Variables

Variables	Mean	Median	Std. dev.	Min	Max	Obs
POU	11.5443	9.3600	8.5599	1.4300	38.3500	204
FP	0.9318	0.2977	1.5455	0.0002	6.0068	204
CPI	108.1869	106.2900	5.6880	99.8700	120.0500	204
UNE	5.1035	4.7000	1.7506	1.4000	10.9500	204
FA	1.0259	0.3970	1.9291	0.0156	10.3002	204
PP	10.9223	10.7730	2.2073	6.9540	19.3730	204

Source: author's computation

Next, the correlation coefficient was calculated to assess the potential for multicollinearity in the estimated model. A correlation coefficient of 0.85 or higher suggests a risk of multicollinearity in the model (Napitupulu et al., 2021). Based on the correlation matrix in Table 3, it can be concluded that there is no multicollinearity among the independent variables.

Table 3. Correlation Matrix of Independent Variables

Variables	lnFP	lnCPI	UNE	lnFA	lnPP
lnFP	1.0000				
lnCPI	-0.0192	1.0000			
UNE	-0.1577	-0.0460	1.0000		
lnFA	0.6849	0.2989	0.1971	1.0000	
lnPP	-0.1705	0.1262	0.3158	0.0441	1.0000

Source: author's computation

Econometric Results

The estimation results in Table 4. show the validity test of the instruments used in the estimation of the GMM system for both models. The validity test uses the Sargan test to check for overidentifying constraints. The null hypothesis tested is that the overidentifying restriction condition in the model estimation is valid. The probability value of the Sargan test

in model 1 is 0.0580, and in model 2 is 0.4398. Since the probability value for both models is greater than 0.05, it is concluded that the instrumental variables in both models are acceptable.

Furthermore, checking the serial correlation for both models with the Arellano Bond Test on AR(1) and AR(2) with the expected condition for the estimator to be consistent is the AR(2) condition. The results obtained from both models are as expected. They reject H_0 in AR(1) and fail to reject H_0 in AR(2), concluding that the estimators of both models are consistent.

To evaluate the unbiasedness of the SYS-GMM estimates, Pooled OLS and Fixed Effect estimates should be reported. Then a comparison of GMM independent variable lag estimators with FEM (Fixed Effect Model) which is biased downward and PLS (Pooled Least Squares) which is biased upward. The results in Table 4. show that the lag coefficients of the independent variables of FD-GMM and SYS-GMM are between the FEM and PLS models, which means that the estimators of the two models are unbiased. The results of testing instrument validity, consistency, and unbiasedness indicate that the SYS-GMM model meets the requirements and can be further analyzed.

In the GMM model, regression coefficients are obtained for both the short and long run. The estimation results with SYS-GMM for the first model show that inflation, unemployment, and social food assistance have a significant effect on people's purchasing power in the short and long run. Meanwhile, food production is not statistically significant in both the short and long run.

Inflation has a positive and significant effect on people's purchasing power in the short and long term. This shows that when there is an increase in prices or inflation the people's purchasing power will increase. The positive relationship indicates that inflation stability can maintain people's purchasing power as stated by Suriani & Asra (2014) that in the economic mechanism of society, a price increase is necessary as it motivates individuals to engage in production activities, thereby stimulating the economy and boosting national production. When prices rise, buyers pay more for goods and services. However, simultaneously, sellers earn more from their sales. Since most people generate income by selling their services, such as labor, income inflation occurs alongside price inflation (Mankiw, 2003). Based on data Bank Indonesia (2024), during the study period (2018-2023) Indonesia's inflation was low with an average annual inflation value below 6 percent.

Table 4. Estimation Result

Variables	Model 1 lnPP		Model 2 POU	
	Short Run	Long Run	Short Run	Long Run
lnPPt-1	0.7238***			
	(0.0423)			
POUt-1			0.2236***	
			(0.0368)	
lnFP	0.00003	0.0001	0.7630	0.9828
	(0.0036)	(0.0132)	(0.4749)	(0.5773)
lnCPI	0.4218***	1.5273***	33.0176***	42.5279***
	(0.0217)	(0.2081)	(1.8842)	(2.1664)
UNE	-0.0069***	-0.0249***	0.3347***	0.4312**
	(0.0012)	(0.0066)	(0.1029)	(0.1461)
lnFA	-0.0417***	-0.1555***	-0.8123***	-1.0463***
	(0.0022)	(0.0261)	(0.2170)	(0.2881)
lnPP			-27.1243***	-34.9371***
			(3.4696)	(3.7563)
Number of obs	170		170	
Prob. AR(1)	0.0286**		0.0138**	
Prob. AR(2)	0.8405		0.3216	
Prob. Sargan test	0.0580		0.4398	
lnPPt-1 (FEM)	0.4510***			
lnPPt-1 (PLS)	1.0026***			
POUt-1 (FEM)			0.1089	
POUt-1 (PLS)			0.7772***	

Source: author's computation

Note: This table presents regression results using eq (4) and (5). Standard error in parentheses. Superscripts *** and ** denote statistically significant at 0.01 and 0.05.

Furthermore, unemployment has a negative and significant effect on people's purchasing power in the short and long term. This indicates that when unemployment increases the people's purchasing power will decrease. This result is in line with Zarkasi (2017); Halim et al. (2022); Hurd & Rohwedder (2017); Gebretsadik (2016); and Al-Yasiri & Al-Yasiri (2022). When someone loses their job, their income decreases or even disappears completely, so they have less money to spend.

Social food assistance has a negative and significant effect on people's purchasing power. Surprisingly, this result contradicts the theory that government transfers such as food and social assistance can increase people's purchasing power. The results of this study are in line with Ridha (2024) that food assistance does have a significant effect on increasing food expenditure, but not total expenditure, which reflects an overall increase in purchasing power. Furthermore, food assistance is addictive, making people dependent without wanting to develop their potential to seek more income because they feel that their basic needs have

been met. This was stated by Rukmana et al. (2022); Sirega et al. (2023) dan Agustina & Megawati (2022) in their case studies.

The estimation results using SYS-GMM for the second model show that the inflation, unemployment rate, social food assistance, and people's purchasing power significantly affect the prevalence of undernourishment in the short and long term. Meanwhile, food production is not statistically significant in both the short and long term. This can occur due to unequal distribution and access gaps in some areas that can lead to food insufficiency despite sufficient food production nationally, as suggested by Daccache et al. (2024).

Inflation positively and significantly influences the prevalence of undernourishment in Indonesia in the short and long term. This is in line with what was stated in the research of Solana (2022), Domguia et al. (2023), Arrohmah et al. (2023), and Azid et al. (2012). An increase in the price of food in particular can cause food to become more expensive and less affordable for most people, especially those on low incomes. As a result, they may reduce the amount or quality of food consumed to save costs.

Unemployment has a positive and significant influence on the prevalence of undernourishment in Indonesia in the short and long term. This is in line with the findings by Yahya et al. (2023), Abebaw et al (2020), and Owens et al. (2020).

A high unemployment rate diminishes individuals' ability and opportunity to access sufficient and nutritious food, thereby increasing the prevalence of undernourishment. Furthermore, social food assistance has a negative and significant influence on the prevalence of undernourishment in Indonesia in the short and long term. This finding is in line with the findings of Mary et al. (2018); Solana (2022); and Tranchant et al. (2019). By its purpose, the food assistance program provides more balanced nutrition to beneficiary families.

People's purchasing power has a negative and significant effect on the prevalence of undernourishment in Indonesia in the short and long term. This is consistent with Keynes's consumption theory which states that consumption is part of disposable income, when disposable income increases, consumption levels will also increase (Dornbusch et al., 2008). With sufficient purchasing power, individuals and families can choose a more varied and nutritious diet, thereby improving their nutritional status and overall health.

The Sobel test was used to determine the effect of mediating variables on the relationship between the independent variable and the dependent variable in this study. The Sobel test conducted is for the coefficient and standard error in the short term and long term. The results of the Sobel test are in Table 5. show that the mediating variable, namely people's

purchasing power, significantly mediates the effect of inflation, unemployment, and social food assistance on the prevalence of undernourishment. Because there are direct and indirect effects of the three variables, people's purchasing power is called a partial mediation variable (Duryadi, 2021).

The Sobel test analysis is in Table 5. shows that there is a significant direct and indirect effect (through people's purchasing power) of the variables inflation, unemployment rate, and food assistance on the prevalence of undernourishment. Inflation has a complex impact on food consumption inadequacy. Directly, inflation can increase the prevalence of undernourishment because rising prices reduce people's access to basic needs, especially for low-income people. Rising prices of food in particular make it difficult for low-income earners to buy food in sufficient quantity or quality. Indirectly, inflation can have a different impact if people's purchasing power increases through increased income. In this case, an increase in income can increase people's ability to buy food despite rising prices, which can reduce the prevalence of undernourishment. Thus, the impact of inflation on food consumption is not only determined by price increases but also by changes in purchasing power as a mediating factor. Economic policies aimed at protecting purchasing power such as wage adjustments could be a way to mitigate the negative impact of inflation on the prevalence of undernourishment.

Table 5. Sobel Test's Result

Variables	Short Term Coefficient			Long Term Coefficient		
	Test statistic	Direct	Indirect	Test statistic	Direct	Indirect
lnFP	-0.0075 (0.0987)	0.7630	-0.0007	-0.0075 (0.4605)	0.9828	-0.0035
lnCPI	-7.2550*** (1.5771)	33.0176***	-11.4419***	-5.7613*** (9.2614)	42.5279***	-41.4258***
UNE	4.6489*** (0.0400)	0.3347***	0.1862***	3.5052*** (0.2477)	0.4312**	0.8683***
lnFA	4.8946*** (0.8360)	-0.8123***	1.1302***	5.2030*** (1.0130)	-1.0463***	5.2705***

Source: author's computation
Note: Standard error in parentheses. Superscripts *** and ** denote statistically significant at 0.01 and 0.05.

Furthermore, the coefficient of the indirect effect of unemployment on the prevalence of undernourishment is positive, indicating the same direction as the direct effect. This indicates that an increase in unemployment can worsen the prevalence of undernourishment through a decrease in purchasing power. Therefore, the government is

expected to increase the provision of employment and investment in education to improve skills, especially for the working-age population.

The direct and indirect effects of food assistance on the prevalence of undernourishment also have different effects. Directly, food assistance can reduce the prevalence of undernourishment by providing direct access to food for groups in need. Food assistance ensures that the basic needs of vulnerable people are met, especially in times of crisis or extreme poverty. Indirectly, however, food assistance also has the potential to increase the prevalence of undernourishment through reduced purchasing power. This happens when there is a dependency on food assistance. When people become overly dependent on food assistance, their purchasing power does not develop or even decline as the assistance discourages people from taking the initiative to find sustainable income alternatives or develop their economic capacity. Hence, the importance of sustainable food assistance policies and government support in increasing people's purchasing power independently. Well-designed food asssitance must be accompanied by efforts to improve the economic capacity and self-reliance of recipients so that they are not solely dependent on assistance to meet their food needs.

CONCLUSION

This study aims to analyze the determinants of the prevalence of undernourishment in Indonesia. The method used is dynamic panel regression for the 2018-2023 data period with SYS GMM and path analysis. Several requirements, such as model specification tests, namely the Sargan test, Arrellano Bond test, and estimator test were carried out. A mediation test with the Sobel test was also conducted to see the effect of mediating variables. The results show that food production has no significant effect either directly or indirectly on the prevalence of undernourishment, while inflation, unemployment, and social food assistance have direct and indirect effects on the prevalence of undernourishment in Indonesia.

The policy implications for the Indonesian government based on the findings of this study are: First, encourage food diversification policies to reduce dependence on one type of food such as rice. Second, maintain price stability, especially for basic food prices. Appropriate monetary and fiscal policies need to be implemented to control inflation so that it is not too high, but also not too low because the effects of inflation affect different economic actors. Third, minimize the effects of dependency on food assistance so that people are not constantly dependent on assistance to meet their basic needs. This can be done by integrating social assistance programs and entrepreneurship training so that they can

find other sources of income. Fourth, improving the data collection system to be more accurate and transparent as well as stricter monitoring of the implementation of food assistance distribution. Community participation in the process of determining beneficiaries is also very important so that food assistance can be distributed effectively and on target. Fifth, facilitating fair wage negotiations between workers and employers where the minimum wage is adjusted periodically in line with the inflation rate and inflation expectations. Sixth, encourage the expansion of employment, especially through policies that support the growth of labor-intensive sectors and skills training programs.

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