

Food Security and Poverty Depth in Indonesia: Evidence from Provincial Fixed-Effects Panel Data (2019–2023)

Fathimah Kurniawati

Universitas Diponegoro, Indonesia

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Abstract

This study examines the relationship between food security and poverty depth in Indonesia using provincial panel data from 34 provinces during 2019–2023. Poverty depth is measured using the Poverty Gap Index, while food security is represented by the Food Security Index. Using a fixed effect panel model with cluster robust standard errors, this study finds that food security has a negative but statistically insignificant effect on poverty depth. In contrast, GRDP per capita, unemployment, and social assistance expenditure significantly affect poverty depth. These findings suggest that poverty depth in Indonesia is more strongly associated with labor market conditions, the inclusiveness of economic growth, and social protection responses than with short-term changes in aggregate food security. This study contributes to the literature by shifting the focus from poverty rate to poverty depth and by examining food security as a determinant of the poverty gap at the provincial level. The findings imply that food security policies should be integrated with employment creation, inclusive growth strategies, and regionally adjusted social assistance to reduce poverty depth more effectively.

Keywords

food security; poverty depth; poverty gap index (P1); panel data; fixed effects; inclusive growth; Indonesia

Corresponding Author:

Fathimah Kurniawati

Universitas Diponegoro, Indonesia; fathimahk@live.undip.ac.id

1. INTRODUCTION

Food security is a central issue in development economics because it is directly related to people's ability to meet basic needs, maintain quality of life, and escape socio-economic vulnerabilities (FAO, 2008; Andrianarison, 2022). It is closely linked to poverty, as low-income households often struggle to access adequate, safe, and nutritious food due to limited availability and weak purchasing power (Andrianarison, 2022; Barraclough, 1997). This connection is reflected in the Sustainable Development Goals (SDGs), especially SDG 1 on ending poverty and strengthening resilience, and SDG 2 on eliminating hunger and ensuring food security for all by 2030 (United Nations Development Programme, n.d). Therefore, anti-poverty policies need to consider food security as an essential component of poor household welfare and socio-economic resilience (Andrianarison, 2022; Guyalo, 2025).



As an archipelagic country, Indonesia faces substantial food security challenges related to food distribution constraints, regional disparities in food prices, geographical conditions, and unequal access across regions (Tangkudung & Nasrudin, 2025; Bulkis et al., 2026). Food assistance with a uniform nominal value may generate different purchasing power across regions because food prices and distribution costs vary. As a result, the real benefits received by poor households in high-cost regions tend to be smaller than those received by households in lower-cost regions (Tangkudung & Nasrudin, 2025). Tangkudung & Nasrudin (2025) show that the purchasing power of Indonesia's non-cash food assistance varies across regions and that the effectiveness of food assistance depends on regional differences in food prices and consumption patterns.



Figure 1. Food Security and Vulnerability Atlas

Resource: National Food Agency, 2025.

Figure 1 shows the FSVA 2025 map published by the National Food Agency illustrates substantial regional disparities in food security across Indonesia. The map uses dark green to indicate very food-secure areas, green for food-secure areas, and light green for moderately food-secure areas. In contrast, pink indicates moderately vulnerable areas, red indicates vulnerable areas, and dark red indicates highly vulnerable areas. Most districts in Java and western Indonesia are shown in green and dark green, suggesting relatively stronger food security conditions. Meanwhile, many districts in Papua, Maluku, and East Nusa Tenggara are shown in pink, red, and dark red, indicating higher food vulnerability. This spatial pattern provides an empirical context for this study. The concentration of food vulnerability in eastern Indonesia and relatively stronger food security in Java and western Indonesia suggests that food security is unevenly distributed across regions. These disparities justify the use of provincial panel data, as regional differences in geography, infrastructure, distribution systems, and purchasing power may shape the relationship between food security and poverty depth.

Food security consists of four main dimensions as availability, access, utilization, and stability (FAO, 2008; Andrianarison, 2022; Guyalo, 2025). Theoretically, this study is grounded in Sen's Entitlement Theory, which emphasizes that food insecurity may occur not only because food is unavailable, but also because households lack the entitlement to access food through income, assets, exchange, or social support (Sen, 1983). This perspective is relevant to poverty depth because poor households may remain far below the poverty line even when aggregate food availability improves (Sen, 1983; Hadiprayitno, 2010). In the Indonesian context, this issue becomes more complex because several regions face ecological vulnerability, natural disasters, limited infrastructure, and institutional constraints that affect food production and distribution (Bulkis et al., 2026). In this sense, food security affects poverty not only through production, but also through affordability, purchasing power, distribution, and access (FAO, 2008; Andrianarison, 2022). As a result, improvements in food production alone may be insufficient to reduce poverty if vulnerable households continue to face constraints in accessing food resources (Barracough, 1997; Guyalo, 2025).

The relationship between food security and poverty is important because food constitutes a major share of expenditure among poor households (Soon et al., 2024; Andrianarison, 2022). When income declines, food access may be disrupted, leading households to reduce the quality of food consumed or reallocate spending from education and health to meet food needs (Soon et al., 2024; Andrianarison, 2022). This condition may deepen poverty because household expenditure moves farther below the poverty line (Andrianarison, 2022). Therefore, poverty measurement should not rely only on the poverty rate, but also on poverty depth (World Bank, n.d). The Poverty Gap Index provides a more substantive measure because it captures how far poor households remain below the poverty line, rather than simply counting the number of poor people (World Bank, n.d).

Previous studies have extensively examined the relationship between food assistance, social protection, and food security (Borjas, 2004; Merkeb et al., 2024; Tangkudung & Nasrudin, 2025). Tangkudung & Nasrudin (2025) show that the purchasing power of food assistance is associated with food insecurity and that program effectiveness differs across regions due to variations in prices and consumption patterns. In another context, Merkeb et al. (2024) find that Ethiopia's Productive Safety Net Program can help save lives and improve food security, but it has not fully succeeded in building resilience or lifting households out of the poverty trap. These findings suggest that the relationship between food security and poverty is complex and requires analysis that goes beyond food status alone (Andrianarison, 2022; Merkeb et al., 2024). It should also consider poverty depth, regional inequality, access, purchasing power, and other dimensions of food security (Barracough, 1997; Tangkudung & Nasrudin, 2025).

Despite the growing literature on food security, social protection, and poverty, several gaps remain. First, most previous studies examine food security as an outcome of household characteristics, social assistance programs, or regional economic conditions rather than as an explanatory factor for poverty depth (Borjas, 2004; Guyalo, 2025; Merkeb et al., 2024). Second, many poverty studies focus primarily on poverty rates, while less attention has been given to the Poverty Gap Index, which captures how far poor households remain below the poverty line and therefore reflects the intensity of poverty (World Bank, 2026; Nairobi et al., 2025). Third, empirical evidence linking the Food Security Index to poverty depth at the provincial level in Indonesia remains limited. Existing Indonesian studies largely focus on the determinants of food security itself (Gantina et al., 2020; Daulay & Arka, 2025) or on poverty determinants without explicitly incorporating food security indicators (Nairobi et al., 2025).

This study contributes to the literature by positioning food security as a determinant of poverty depth and by using provincial panel data to capture regional disparities in food access, purchasing power, and socio-economic vulnerability. Empirically, this study provides evidence on whether improvements in food security are associated with a lower poverty gap across Indonesian provinces. From a policy perspective, the study highlights the need to integrate food security policies with employment creation, inclusive economic growth, and regionally adjusted social protection programs to address both food insecurity and persistent poverty simultaneously (UNDP, n.d.; Tangkudung & Nasrudin, 2025).

2. METHODS

This study employs a quantitative approach using panel data regression. The unit of analysis consists of 34 provinces in Indonesia over the period 2019 to 2023. The use of 34 provinces aims to maintain panel consistency, considering that the establishment of new provinces in Papua occurred during the observation period. The period 2019–2023 was selected because it captures important socio-economic dynamics before, during, and after the COVID-19 pandemic.

This study uses secondary data obtained from Statistics Indonesia, the National Food Agency, and the Directorate General of Fiscal Balance (DJPK) of the Ministry of Finance. Data from Statistics Indonesia are used to obtain the Poverty Gap Index (P1), mean years of schooling, GRDP per capita, rice production, food expenditure, the percentage of households with proper sanitation, and population. Data from the National Food Agency are used to obtain the Food Security Index. Meanwhile, data from DJPK are used to obtain regional government social assistance expenditure.

The empirical model used in this study is specified as follows:

$$P_{it} = \beta_0 + \beta_1 FSI_{it} + \beta_2 YOS_{it} + \beta_3 GRDPCap_{it} + \beta_4 RiceCap_{it} + \beta_5 Sanitation_{it} + \beta_6 UR_{it} + \beta_7 SocAssist_{it} + \beta_8 FoodExp_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

Where P_{it} denotes the Poverty Gap Index in province i and year t , FSI_{it} represents the Food Security Index, YOS_{it} refers to mean years of schooling, $GRDPCap_{it}$ denotes the logarithm of GRDP per capita, $RiceCap_{it}$ refers to the logarithm of rice production per capita, $FoodExp_{it}$ denotes the logarithm of food expenditure, $Sanitation_{it}$ represents the percentage of households with proper sanitation, UR_{it} denotes the unemployment rate, and $SocAssist_{it}$ represents social assistance expenditure per capita. The term λ_t captures year fixed effects, μ_i captures province-specific fixed effects, and ε_{it} is the error term.

The dependent variable in this study is the Poverty Gap Index (P1), which captures how far the average expenditure of poor households falls below the poverty line. Thus, P1 does not merely indicate the number of poor people but also reflects the intensity or depth of poverty. The main independent variable is the Food Security Index (FSI), which represents regional food security conditions, including the dimensions of food availability, affordability, and utilization.

This study also includes control variables to reduce potential omitted variable bias. These control variables consist of mean years of schooling, GRDP per capita, rice production per capita, the percentage of households with proper sanitation, the unemployment rate, and social assistance expenditure per capita. Mean years of schooling represents the quality of human capital. GRDP per capita reflects the level of regional economic development. Rice production per capita is used as a proxy for local food availability. Food expenditure is included to capture household food consumption patterns. The percentage of households with proper sanitation is used as an indicator of environmental quality and basic health conditions. Social assistance expenditure per capita is used to capture the role of regional government social protection.

Table 1. Operational Definition of Variables

Variable Type	Variable Name	Description
Dependent	P1	Poverty Gap Index
Main Independent	FSI	Food Security Index
Control	YOS	Mean Years of Schooling
Control	GRDPCap	Log of GRDP per capita
Control	RiceCap	Log of rice production per capita
Control	FoodExp	Log of food expenditure
Control	Sanitation	Percentage of households with proper sanitation
Control	UR	Unemployment rate
Control	SocAssist	Log of Social Assistance per capita

This study estimates panel data models by comparing the common effect model, fixed effect model, and random effect model. The Chow test is used to compare the common effect model and fixed effect model, while the Hausman test is used to determine whether the fixed effect model or random effect model is more appropriate. The Lagrange Multiplier test is also conducted to compare the common

effect model and random effect model. These tests are commonly used in panel data analysis to identify the most appropriate estimation model (Baltagi, 2021; Wooldridge, 2010).

In addition to model selection tests, this study also conducts diagnostic tests related to the Gauss-Markov assumptions. Multicollinearity is examined using the Variance Inflation Factor (VIF). Heteroskedasticity is tested using the Modified Wald test for groupwise heteroskedasticity in the fixed effect model. Autocorrelation is examined using the Wooldridge test for serial correlation in panel data (Baltagi, 2021; Wooldridge, 2010). The diagnostic results indicate the presence of heteroskedasticity and first-order autocorrelation. Therefore, the final estimation uses cluster robust standard errors at the provincial level. Clustering at the provincial level is appropriate because it allows the error terms to be correlated within the same province over time and produces more reliable statistical inference in the presence of heteroskedasticity and within-panel serial correlation (Baltagi, 2021; Wooldridge, 2010).

3. FINDINGS AND DISCUSSION

The estimation results of the fixed effect model with cluster robust standard errors indicate that the model is jointly significant. This means that the independent variables collectively explain variations in the Poverty Gap Index across provinces over time. The within R-squared value shows that approximately 22.45% of the within-province variation in poverty depth can be explained by the model. Although the within R-squared value is relatively modest, this is still acceptable in a fixed effects panel model because the estimation relies on within-province variation over time after absorbing time-invariant provincial characteristics (Baltagi, 2021; Wooldridge, 2010). Meanwhile, the rho value of 0.9849 indicates that most of the variation in poverty depth originates from time-invariant provincial characteristics. Therefore, the fixed effect model is appropriate for controlling unobserved provincial heterogeneity, such as geographical conditions, regional economic structure, and institutional capacity.

Table 2. Panel Regression Results for Poverty Depth in Indonesia

Variable	Coefficient	Robust std. error
Constanta	0.3517	5.1756
FSI	-0.0041	0.0045
YOS	-0.1391	0.5114
GRDPCap	0.8112**	0.3740
RiceCap	-0.0211	0.0223
Food exp	-0.0042	0.0265
Sanitation	-0.0020	0.0197
UR	0.0836***	0.0303
Soc. Assistance	0.5292***	0.1274
Number of observations		170
F-stat		7.60***
Within R-squared		0.2245
Rho		0.9849

¹The fixed effect model was selected as the appropriate model based on the Chow, Hausman, and Lagrange Multiplier tests.

²The diagnostic tests indicate the presence of heteroskedasticity and autocorrelation, so the estimation uses cluster robust standard errors at the provincial level. ³***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

The main variable of this study, the Food Security Index, has a negative coefficient of -0.0041. This result is consistent with the theoretical expectation that higher food security tends to reduce poverty depth. However, the coefficient is statistically insignificant, suggesting that improvements in provincial food security have not been strong enough to reduce the expenditure gap of poor households from the poverty line, where improvements in aggregate food security conditions do not necessarily translate into immediate welfare gains for poor households.

One possible explanation lies in the multidimensional nature of food security, which encompasses food availability, access, utilization, and stability (FAO, 2008). According to Sen's Entitlement Theory, food insecurity may persist even when food is available because households lack the economic entitlement to access food through income, assets, or market exchange (Sen, 1983). Therefore, improvements in regional food systems may not reduce poverty depth unless they strengthen the purchasing power and economic access of poor households. This interpretation is supported by Andrianarison (2022), who argues that access, stability, and quality are essential dimensions linking food security to poverty reduction.

This finding is also consistent with Hadiprayitno (2010), who argues that food policy in Indonesia has often been linked to national stability and macro-level food availability, while household and individual access to food has received less policy attention. This implies that a province may show relatively good aggregate food security, but poor households within that province may still face limited access to food. Therefore, the effect of food security on poverty depth will become stronger only when improvements in food systems are able to increase the consumption capacity and purchasing power of poor households.

The first control variable, GRDP per capita, has a positive coefficient of 0.8112 and is statistically significant at the 5% level. This result indicates that an increase in GRDP per capita is associated with an increase in poverty depth. Theoretically, this finding differs from the initial hypothesis that economic growth should reduce poverty. A possible explanation is that provincial economic growth has not been sufficiently inclusive. An increase in GRDP per capita may have been driven by sectors that do not directly absorb poor workers, such as capital-intensive industries, extractive sectors, or modern service sectors. As a result, regional economic growth does not directly increase the expenditure of poor households. This finding is in line with Barraclough (1997), who argues that sufficient food availability and high average income do not necessarily eliminate hunger or poverty when income distribution and household access remain unequal. Therefore, the positive coefficient of GRDP per capita should be interpreted as an indication that growth alone is insufficient to reduce poverty depth if its benefits are unevenly distributed.

The unemployment rate has a positive and significant effect on poverty depth. This means that a 1% increase in unemployment is associated with an increase in poverty depth by 0.0836 points. This finding is consistent with development economics theory because unemployment reduces household income, weakens purchasing power, and widens the expenditure gap between poor households and the poverty line. In the context of food security, unemployment also reduces households' economic access to food, especially among poor households whose expenditure is largely allocated to staple food consumption (Andrianarison, 2022).

Mean years of schooling has a negative but statistically insignificant coefficient, indicating that education tends to reduce poverty depth, although the effect is not statistically strong during the period of observation. This may occur because education usually affects poverty through long-term channels, such as better employment opportunities, higher productivity, and income mobility. Therefore, changes in mean years of schooling during the study period may not be sufficient to explain variations in poverty depth. This interpretation is consistent with Andrianarison (2022), who finds that education is an important driver of both poverty reduction and food security improvement.

Rice production per capita also has a negative but statistically insignificant coefficient. This indicates that an increase in food production does not necessarily reduce poverty depth. This result is consistent with the entitlement approach, which argues that food insecurity is not only caused by insufficient food availability, but also by weak household access to food through income, prices, and distribution mechanisms (Sen, 1983). In other words, local food production may increase aggregate food availability, but poor households may still remain far below the poverty line if they cannot afford food or if distribution systems do not effectively connect production areas with vulnerable consumers. Guyalo (2025) explains that household food security is shaped by demographic, socioeconomic, institutional, and environmental factors, including access to credit, market distance, assets, livelihood opportunities, and exposure to natural shocks.

Food expenditure also has a negative but statistically insignificant coefficient. This result should be interpreted carefully because food expenditure may represent two different mechanisms. First, higher food expenditure can indicate better consumption capacity and improved access to food. Second, for poor households, a high share of food expenditure may reflect vulnerability because most income is spent on basic food needs, leaving fewer resources for education, health, and productive investment. Soon et al., (2024) show that the poorest households are vulnerable to income and food price shocks, and their food expenditure patterns do not always indicate improved welfare. Thus, food expenditure alone may not fully capture food security unless it is combined with information on food prices, expenditure shares, dietary quality, and household purchasing power. Meanwhile, sanitation has a negative but statistically insignificant coefficient, suggesting that its effect on poverty depth may

operate indirectly through health, nutrition, and productivity, and may require a longer period to be observed in provincial panel data.

Social assistance has a positive and significant effect on poverty depth. This positive coefficient does not mean that social assistance causes deeper poverty. Rather, it may reflect a policy response, in which provinces with deeper poverty tend to allocate or receive larger social assistance spending. Social assistance should therefore be understood as a protective instrument, not as a stand-alone structural solution for reducing poverty depth. The effectiveness of social protection programs depends on program design, targeting accuracy, real benefit value, and regional context. Merkeb et al. (2024) show that social protection programs such as Ethiopia's Productive Safety Net Program can improve food security and protect households, but they do not always succeed in building resilience or lifting households out of poverty traps.

In the Indonesian context, the positive coefficient of social assistance can also be related to the purchasing power of food assistance. The Sembako Program, which provides uniform nominal assistance, may generate different real benefits across regions because food prices and consumption patterns vary. As a result, households in regions with higher food prices receive smaller real benefits. Tangkudung and Nasrudin (2025) show that the purchasing power of Indonesia's non-cash food assistance varies across regions and that a geographically adjusted benefit scheme may be more effective in reducing food insecurity disparities. This is consistent with the present study, where higher social assistance per capita may not be sufficient to reduce poverty depth if the real value of assistance does not match the actual food needs of poor households in high-cost regions.

Overall, the findings suggest that poverty depth in Indonesia is more strongly associated with labor market conditions, the inclusiveness of economic growth, and the design of social protection rather than with short-term changes in the aggregate Food Security Index. Although the Food Security Index has a negative coefficient consistent with theoretical expectations, its effect is not statistically significant. This finding does not imply that food security is irrelevant, but rather that improvements in food security may not reduce poverty depth unless they are translated into stronger economic access, affordability, and purchasing power for poor households. This interpretation is consistent with Sen's entitlement perspective, which emphasizes that food insecurity and poverty are not only caused by insufficient availability, but also by limited access through income, assets, exchange, and social support (Sen, 1983). It is also in line with Barraclough (1997), who argues that high average income and sufficient food availability do not necessarily eliminate hunger or poverty when distribution and household access remain unequal.

The main contribution of this study is that it shifts the analysis from poverty incidence to poverty depth and position food security as a determinant of the poverty gap at the provincial level. Previous

studies have mainly examined food security as an outcome of household characteristics, social protection, or regional conditions (Borjas, 2004; Guyalo, 2025; Merkeb et al., 2024), while this study examines whether provincial food security explains how far poor households remain below the poverty line. From a policy perspective, the findings support the SDG agenda, particularly SDG 1 on ending poverty and SDG 2 on ending hunger, because poverty reduction and food security improvement require integrated rather than sectoral interventions (United Nations Development Programme, n.d). Therefore, the government needs to design region-based food and social protection policies, such as adjusting assistance values in high-food-cost regions, strengthening food distribution systems, and integrating social assistance with local employment creation programs.

4. CONCLUSION

This study examines the relationship between food security and poverty depth in Indonesia using provincial panel data from 34 provinces during 2019–2023. This study concludes that food security has a negative but statistically insignificant effect on poverty depth in Indonesia. This indicates that improvements in aggregate provincial food security do not automatically reduce poverty depth unless they are accompanied by stronger household purchasing power, better food access, price stability, and effective distribution systems.

The results also show that GRDP per capita, unemployment rate, and social assistance expenditure significantly affect poverty depth. The positive effect of GRDP per capita suggests that regional economic growth has not been sufficiently inclusive for poor households. The positive effect of unemployment confirms that weak labor market conditions deepen poverty by reducing household income and purchasing power. Meanwhile, the positive coefficient of social assistance should be interpreted as a policy response, where provinces with deeper poverty tend to allocate larger social assistance spending.

This study contributes to the literature by shifting the focus from poverty rate to poverty depth by examining food security as a determinant of the poverty gap at the provincial level. The findings highlight that the relationship between food security and poverty is not automatic but depends on whether improvements in food systems that impact the real economic access for poor households. Therefore, policy efforts to reduce poverty depth should adopt an integrated and regionally targeted approach by strengthening food affordability, improving distribution systems, and expanding market access in vulnerable areas. In addition, social protection programs should be adjusted to regional living costs and combined with employment creation and inclusive growth strategies to ensure that improvements in food security generate tangible welfare gains for poor households. This study is subject to several limitations, including the use of aggregate provincial-level food security measures, a

relatively short observation period, and the exclusion of inequality and food price indicators. Therefore, future studies should incorporate longer panels, lagged variables such as education and social assistance, adding food price indicators, household-level food security measures, and additional socioeconomic indicators to better capture the relationship between food security and poverty depth.

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