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Social Inequality and Food Security in Indonesia: The Role of Education

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ABSTRACT

This study evaluates the impact of social inequality, measured by gini index and poverty rate, on food security across Indonesian provinces during the 2019–2023 period, incorporating the mean years of schooling as a moderating variable. Utilizing panel data from 34 provinces and a fixed effects model, the findings reveal that poverty has a significant negative effect on food security, while the gini index representing income inequality shows no effect. However, when moderated by education, the gini index becomes significant, highlighting the role of education in amplifying the effects of social inequality. Provinces with higher education levels display greater sensitivity to poverty and inequality because of increased expectations for food quality and living standards. Education functions as a direct determinant and as a social mechanism that enhances nutritional literacy, awareness of equitable food distribution, and community adaptive capacity during food crises. These results underscore the need for effective food security policies that integrate human capital development strategies, particularly in education. Practical implications include the promotion of agricultural education, food literacy training, and community empowerment programs in vulnerable regions. This study recommends a multidimensional approach to food security policies that extends beyond production and distribution to emphasize social equity, poverty reduction, and educational strengthening.

Keywords: food security, gini index, mean years of schooling, poverty rate, social inequality

INTRODUCTION

Food security is a fundamental pillar of a country's economic development and social welfare. According to the Food and Agriculture Organization, food security is achieved when all individuals, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and preferences to lead active and healthy lives. The concept encompasses four main dimensions: availability, accessibility, utilization, and stability. The four dimensions are interrelated and serve as an evaluative framework to assess the extent to which a food system can sustainably support its people.

Food security is increasingly recognized as a multidimensional issue involving social, economic, political, and environmental factors (Manikas *et al.* 2023). In developing countries such as Indonesia, structural inequalities, particularly between urban and rural areas and across regions with different development levels, often hinder equitable access to food (Nurhasan *et al.* 2024). As an archipelagic country with diverse regional characteristics, Indonesia faces substantial interregional disparities in income, infrastructure, and basic services that affect access to food resources and contribute to uneven food security outcomes (Meliala & Djamaluddin 2024). Although Indonesia currently consists of 38 provinces, this study focused on 34 provinces with consistent data availability from 2019 to 2023. Accordingly, a panel data approach was employed to capture the dynamics of social inequality and food security over time.

This study employs three key indicators to represent interprovincial socioeconomic inequality: the Gini Index, Poverty Rate, and Mean Years of Schooling. These indicators reflect the structural dimensions influencing food security, including income distribution, purchasing power, and human capital quality (UNDP 2022). Provinces with higher socioeconomic inequality tend to face greater constraints in accessing food and often rely more heavily on external food supplies, increasing their vulnerability to distribution disruptions and price volatility (Azwardi *et al.* 2019). This highlights that food security is shaped not only by food availability but also by the social and economic capacity of regions to ensure stable, equitable, and sustainable food systems.

In addition, pressures on food security have intensified over the past five years owing to various global and domestic dynamics, including the COVID-19 pandemic, supply chain disruptions, rising commodity prices, and the impacts of climate change. Ongoing inequalities in access to infrastructure, public services, and education also weaken the regional capacity to maintain stable and resilient food systems. Therefore, studies on food security need to adopt a holistic approach by considering the underlying social and

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structural determinants rather than focusing solely on production and distribution aspects.

Although a substantial body of literature on food security exists, most studies continue to emphasize the production and availability dimensions, while the underlying socioeconomic determinants remain insufficiently explored (Rusmawati *et al.* 2023). In particular, systematic analyses that integrate income distribution, poverty rates, and mean years of schooling within an interprovincial panel data framework are relatively limited. Addressing this gap, the present study examines the effects of social inequality on food security across Indonesian provinces during 2019–2023, while also evaluating the moderating role of mean years of schooling in shaping this relationship. The findings are expected to provide a robust empirical basis for formulating more inclusive, equitable, and sustainable food security policies, particularly at the regional level.

Based on the theoretical framework and empirical gaps identified above, this study formulates several testable hypotheses to guide the analysis. Income inequality, as measured by the gini index, is hypothesized to influence food security across Indonesian provinces, reflecting the role of unequal income distribution in shaping access to food resources. The poverty rate is expected to negatively affect food security, as higher levels of poverty constrain purchasing power and limit access to sufficient and nutritious food. Meanwhile, the mean years of schooling is hypothesized to positively affect food security, indicating that higher educational attainment enhances social capacity, food literacy, and the ability to access and utilize food sustainably. In addition, education is expected to moderate the relationship between social inequality and food security, such that the effects of income inequality and poverty vary according to the provincial levels of educational attainment.

METHODS

Studi Area and Data Structure

This study was conducted at the provincial level in Indonesia, covering 34 provinces as the unit of analysis over the 2019–2023 period. Although Indonesia has 38 provinces since 2022, the newly formed provinces are excluded due to the unavailability of complete and consistent data to maintain the continuity and integrity of the panel dataset. The selected provinces represent Indonesia's geographical and socioeconomic diversity, making them suitable for examining interregional variations in social inequality and food security issues. The study employs panel data consisting of 34 cross-sectional units observed over five years, with all variables collected for the first semester of each year to ensure temporal consistency, as second-semester data for 2023 on key indicators, including the gini index and poverty rate, are not yet available.

Data Collection and Methods

The dependent variable is the Food Security Index, while the independent variables include the gini index, poverty rate, and mean years of schooling. All data are secondary and were obtained through documentation from official provincial macroeconomic and social indicator publications provided by the Badan Pusat Statistik (BPS), particularly those related to food security and social conditions (Badan Pusat Statistik 2023). Data processing was conducted using Microsoft Excel, and panel data regression analysis was performed using EViews 12. The analysis began with the Pooled Least Squares (PLS) method (Gujarati & Porter 2009), followed by Chow and Hausman tests to determine the appropriate model specification between the Fixed Effect Model (FEM) and the Random Effect Model (REM) (Wooldridge, 2013). Based on these tests, the FEM was selected because it more effectively captures unobserved heterogeneity across provinces (Baltagi 2021).

To extend the analysis, a moderation test was conducted to evaluate the role of the mean years of schooling in moderating the effect of social inequality on food security. Two interaction variables were created: between the gini index and mean years of schooling, and between the poverty rate and mean years of schooling. Both interaction variables were then entered into the fixed effects (FEM) model. A similar analytical approach, which uses interaction variables between education and economic indicators to assess their combined effect on food security, has been applied in previous panel data studies.

Model Specification

Based on the analytical framework, this study specifies two panel data regression models to examine the relationship between social inequality and food security across provinces and over time. The first model serves as a baseline to estimate the direct effects of income inequality, poverty, and education on food security. The second model extends the baseline by incorporating interaction terms to assess the moderating role of education in shaping the effect of social inequality on food security.

The baseline model is specified as:

$$FSIit = \alpha i + \beta 1GIit + \beta 2PRit + \beta 3MYSit + \varepsilon it$$

Where FSI_{it} denotes the Food Security Index of province, *i* in year *t*, GI*it* represents the Gini Index as a measure of income inequality, PR*it* refers to the Poverty Rate, and MYS*it* denotes Mean Years of Schooling. The term α_i captures province-specific fixed effects that control for time-invariant unobserved heterogeneity, while ε_{it} is the error term.

To examine the moderating role of education, interaction terms between the mean years of schooling and indicators of social inequality are included in the following specification:

$$FSIit = \alpha i + \beta 1GIit + \beta 2PRit + \beta 3MYSit + \beta 4(Giit \times MYSit) + \beta 5(PRit \times MYSit) + \varepsilon it$$

The inclusion of these interaction terms allows the effects of income inequality and poverty on food security to vary with the level of educational attainment across all provinces. All models were estimated using the fixed effects model, as selected based on the Chow and Hausman test results.

RESULTS AND DISCUSSION

This section presents the estimation results of the panel data regression model used to analyze the effect of social inequality on food security in 34 provinces in Indonesia during the 2019-2023 period. Model selection was performed gradually through statistical testing, starting with the Chow test to determine the most appropriate model between the Common Effect Model (CEM) and the Fixed Effect Model (FEM). As shown in Table 1, the Chow test results produced a probability value of 0.0000. Since the value is smaller than the 5 percent significance level (α = 0.05), the null hypothesis (H_0) is rejected, indicating that the Fixed Effect Model (FEM) is more appropriate for further analysis than the Common Effect Model (CEM).

To further validate the model selection, a Hausman test was conducted to determine whether the fixed effects model (FEM) was more appropriate than the random effects model (REM). As shown in Table 2, the Hausman test yields a probability value of 0.0000, which is below the 5 percent significance level (α = 0.05). Therefore, the null hypothesis (H_0) is rejected, and the FEM is selected as the most appropriate approach. This model consistently accommodates interprovincial heterogeneity over the observation period, thus providing estimates that are more consistent with the characteristics of the panel data used in this study.

After determining the most appropriate model, the next step was to conduct a classical assumption test to ensure the validity of the estimation results and the fulfillment of the Best Linear Unbiased Estimator (BLUE) criteria. The first test conducted was the multicollinearity test, which aimed to detect a high correlation between independent variables. As shown in Table 3, the centered Variance Inflation Factor (VIF) values for the gini index, poverty rate, and mean years of schooling are 1.087494, 1.405343, and 1.305873, respectively. Because all these values are well below the common threshold of 10, there is no indication of serious multicollinearity in the model. This indicates that the independent variables are not excessively correlated with each other, so the model can produce stable and reliable coefficient estimates.

To assess the possibility of heteroscedasticity, a visual inspection of the residual distribution was conducted using a scatterplot. As shown in Figure 1, the residuals appear to be randomly and symmetrically scattered around the zero line, with no funnel-like pattern or conspicuous extreme spreads. This visual pattern suggests that the variance of the residuals is constant, indicating homoscedasticity. Given the limited number of time periods in the panel data (t = 5), formal heteroscedasticity tests such as the Breusch-Pagan or Modified Wald tests are considered less reliable. Therefore, visual analysis is considered more appropriate in this context than other methods. This finding strengthens the validity of the FEM and confirms that the model meets the classical assumptions and is suitable for further analysis.

After the classical assumption tests are satisfied, panel data regression is estimated using the Pooled Least Squares (PLS) approach as the baseline model. The estimation results in Table 4 show that not all

Table 1 Chow test result of the panel data regression model

Test name	effects test	Statistic	Prob.	α = 5%
Chow Test	Cross-section F	23.7518	0.0000	0.05
	Cross-section Chi-square	328.1934	0.0000	0.05

Table 2 Hausman test result of the panel data regression model

Test name	Test summary	Chi-square Statistic	Prob.	α = 5%
Hausman test	Cross-section Random	36.3245	0.0000	0.05

Table 3 Multicollinearity test of the panel data regression model

Variable	Centered VIF
Gini index (GI)	1.0875
Poverty rate (PR)	1.4053
Mean years of schooling (MYS)	1.3059

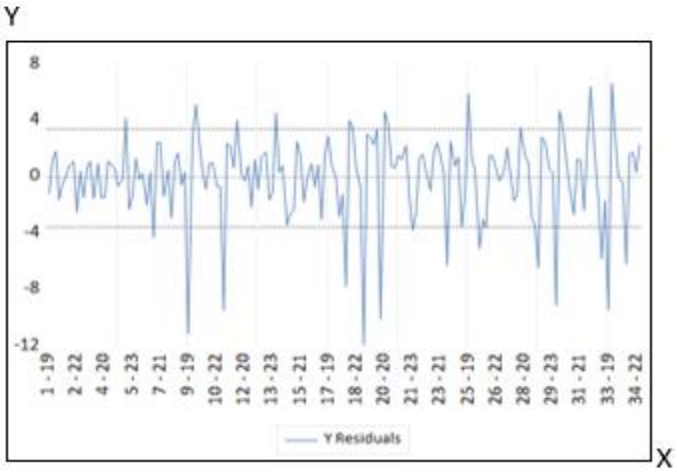

Figure 1 Heteroskedasticity test based on residual scatter plot.

Table 4 Estimation results of panel data regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.6954	23.4555	-0.9676	0.3350
Gini index (GI)	-2.3515	34.9256	-0.0673	0.9464
Poverty rate (PR)	-1.5363	0.7692	-1.9973	0.0478
Mean years of schooling (MYS)	12.7047	1.9684	6.4542	0.0000

independent variables significantly affect the food security index. The gini index has a negative coefficient (−2.351470) but is statistically insignificant (p = 0.9464), indicating that income inequality does not significantly affect food security during the observation period. In contrast, poverty rate has a negative and statistically significant effect (coefficient = −1.536262; p = 0.0478), implying that higher poverty levels are associated with lower food security. Meanwhile, the mean years of schooling showed a positive and highly significant effect (coefficient = 12.70465; p = 0.0000), confirming the important role of education in improving food security outcomes.

Although the regression estimation results show that the gini index does not have a statistically significant effect on food security, this condition opens up opportunities for further analysis by considering the possibility of moderating effects from other variables. One relevant variable is education, which in this study is represented by the mean years of schooling. The selection of this variable was based on the consideration that education plays an important role in increasing the individual and collective capacity to access, manage, and respond more adaptively to food availability and distribution. Therefore, a moderation analysis was conducted by including the interaction between the gini index and mean years of schooling (GI × MYS) to test whether the level of education can strengthen or weaken the effect of income inequality on food security.

As shown in Table 5, the moderation analysis results show that the interaction between the gini index and mean years of schooling (GI × MYS) has a positive coefficient of 65.4452 and is statistically significant (p = 0.0100). Interestingly, the gini index, which was previously insignificant in the initial model (p = 0.9464), became significant after being moderated by the education variable (p = 0.0080). This finding indicates that the mean years of schooling not only acts as a direct predictor of food security, but also as a moderating variable that strengthens the effect of income inequality on food security.

The moderation analysis of the poverty rate variable shows an even more significant effect than the previous interactions. As shown in Table 6, the interaction between Mean Years of Schooling and Poverty Rate (MYS × PR) shows a very high significance level (p = 0.0001) with a coefficient of 1.068228, indicating that education consistently strengthens the negative impact of poverty on food security. Interestingly, once education was included as a moderating variable, the main coefficient of variable X_2 also became more statistically significant, increasing from p = 0.0478 to p = 0.0000. This finding provides strong statistical evidence that education not only moderates but also strengthens the fundamental relationship between poverty and food security.

Panel data regression analysis showed that the relationship between social inequality and food security is complex and not always linear. In the main model, the gini index, used as an indicator of income inequality, did not show a statistically significant effect on the food security index. This result may indicate that during the 2019-2023 period, income inequality in Indonesia did not reach a critical level sufficient to directly affect food security at the aggregate level. In

Table 5 Moderation analysis results of gini index and mean years of schooling

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	182.7277	87.7197	2.0831	0.0392
Gini index (GI)	-631.1465	234.2924	-2.6938	0.0080
Mean years of schooling (MYS)	-10.3525	9.3851	-1.1031	0.2720
Interaction between gini index and mean years of schooling (GIxMYS)	65.4452	25.0295	2.6147	0.0100

Table 6 Moderation analysis results of poverty rate and mean years of schooling

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	66.8529	29.8725	2.2379	0.0269
Poverty rate (PR)	-9.9691	2.2166	-4.4975	0.0000
Mean years of schooling (MYS)	1.5769	3.3478	0.4710	0.6384
Interaction between poverty rate and mean years of schooling (PRxMYS)	1.0682	0.2674	3.9949	0.0001

addition, the structural aspects of inequality reflected through the gini index may require reinforcement or interaction with other social dimensions, such as education, to fully demonstrate their impact.

In contrast, the poverty rate has a significant negative effect on food security, confirming that poverty directly constrains households' purchasing power and their ability to access sufficient nutritious food. In this context, socioeconomic inequality based on real income conditions, as reflected in absolute poverty, exerts a more pronounced influence on food security outcomes than income distribution inequality, as measured by the gini index, particularly in everyday social life. Meanwhile, the mean years of schooling, as a proxy for educational attainment, showed a positive and significant effect, indicating that education plays an important role in enhancing individuals' capacity to access, utilize, and evaluate food quality. This finding is consistent with recent evidence emphasizing that investment in human capital, especially education, can mitigate the adverse effects of income inequality on welfare and economic growth (Hanushek & Woessmann 2020).

The interaction analysis further reinforces education as a structural moderator that amplifies the effect of social inequality on food security. When interacted with the mean years of schooling, the previously insignificant gini index becomes statistically significant, indicating that income inequality has a stronger impact on food security in regions with higher educational attainment. This suggests that better-educated populations are more sensitive to social injustice and unequal food distribution, consistent with the finding Islam and Sim (2021). In contrast, in areas with lower education levels, the effects of income inequality tend to be less apparent, as households rely more on subsistence-based strategies. Supporting this interpretation, evidence shows that nutritional interventions combined with education significantly improve food utilization, dietary diversity, and household resilience (Beressa *et al.* 2024; Effendy *et al.* 2020). These findings highlight the importance of integrating education into food security and nutrition programs, particularly for socioeconomically vulnerable populations in Brazil. Supported by evidence from Nepal that emphasizes the role of maternal education in improving complementary feeding practices (Na *et al.* 2018)

The interaction between education and poverty level shows a highly significant effect, confirming that education amplifies the negative impact of poverty on food security. Higher educational attainment raises expectations regarding living standards, including food adequacy, thereby increasing awareness of vulnerability and unequal access to food among low-income households. This finding is supported by Bogale *et al.* (2025) and Asfaw *et al.* (2024), who showed that even basic education reduces the likelihood of food insecurity by strengthening awareness and food-related decision-making capacity. In the Indonesian context, interprovincial disparities in access to and quality of education contribute to variations in food security, with provinces exhibiting higher educational attainment generally achieving better outcomes owing to stronger food literacy and access to nutrition information (Islam & Sim 2021; Njura *et al.* 2024).

Thus, education functions not only as a direct predictor of food security but also as a structural mechanism that shapes how social inequality translates into food security outcomes. The findings indicate that income inequality, as measured by the gini index, does not have a significant direct effect unless moderated by educational attainment, whereas poverty consistently exerts a strong negative impact. This suggests that the influence of social inequality on food security is conditional on social capacity, underscoring the need to view food security as a multidimensional and socially embedded issue and to integrate education as a central component of food security development.

CONCLUSION

The social inequality affects food security in different ways across Indonesian provinces. The poverty rate has a significant and negative impact on the Food Security Index, confirming that limited purchasing power remains a key barrier to accessing sufficient, safe, and nutritious food. In contrast, income inequality, as measured by the gini index, does not exert a significant direct effect on food security unless moderated by the mean years of schooling. This indicates that the impact of income inequality becomes more pronounced in regions with higher social capacity, particularly through education, which functions as both a direct determinant and a structural moderator of food security outcomes.

The moderating role of education highlights the importance of investing in human capital to build a resilient and equitable food system. Higher educational attainment is associated with improved nutritional literacy, more efficient food utilization, and greater dietary diversity, as evidenced by studies in Indonesia and Togo. Accordingly, food security strategies should extend beyond production and distribution by integrating agricultural education, food literacy, vocational training, and community-based nutrition programs. This approach is further supported by evidence from Nepal, which emphasizes the role of maternal education in improving complementary feeding practices. Therefore, strengthening the synergy between education, poverty alleviation, and agricultural development is essential to enhance food availability, affordability, sustainability, and social justice, in line with Indonesia's food security direction outlined in the RPJMN 2020–2024.

Despite these contributions, this study has some limitations. Data coverage is limited to the first semester of each year from 2019 to 2023, and the quantitative panel data approach cannot fully capture the local socio-cultural dynamics affecting food security. Future research should adopt mixed-methods or qualitative approaches and expand the analytical scope to include production sustainability, climate vulnerability, and household nutritional quality to generate more comprehensive and context-sensitive policy recommendations.

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