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ANALYSIS OF THE DETERMINANTS OF FOOD SECURITY IN INDONESIAN PROVINCES, 2020–2024

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Abstract. This study aims to analyze the economic determinants of food security across Indonesian provinces during the period 2020–2024. Food security is proxied by the Food Security Index (IKP), while the explanatory variables include rice productivity, poverty levels, regional minimum wages (UMR), average years of schooling (RLS), and unemployment rates. Using panel data from 26 provinces and a fixed-effects regression approach, the results indicate that rice productivity, poverty, education, and unemployment have positive and significant effects on provincial food security. In contrast, regional minimum wages show no significant impact, suggesting that household purchasing power is more heavily influenced by food price dynamics than nominal wage increases. These findings confirm that food security is multidimensional, shaped by the interplay of availability, access, utilization, and stability as defined by the FAO framework. The study highlights the need for integrated policies encompassing agricultural productivity, price stabilization, nutrition literacy, and social protection to strengthen regional food security.

Keywords: Food Security; Rice Productivity; Regional Minimum Wage; Education; Unemployment; FAO Framework

I. INTRODUCTION

The worldwide food crisis has resurfaced as a crucial issue, ignited by the Russia and Ukraine conflict that has severely disrupted the supply chains of wheat, vegetable oils, and fertilizers. Lin et al. (2023) demonstrate that this conflict not only escalates global food prices but also destabilizes emerging economies that are heavily dependent on staple food imports. This geopolitical turmoil casts a wide net, affecting not just the nations embroiled in the conflict but also extending its ramifications across various countries via international trade channels and global price fluctuations. Developing nations intertwined in global food markets, like Indonesia, have become susceptible to price shocks even without direct geopolitical ties.

For Indonesia, its connection to the Russia and Ukraine conflict is evident through its dependence on imports of food commodities and agricultural inputs such as wheat and fertilizers, along with its exposure to international food price variations. Disruptions in supply chains and soaring global commodity prices escalate domestic food inflationary pressures and amplify market uncertainty. This situation hampers food production across multiple regions and fuels widespread inflationary trends (Aweke et al., 2022). Escalating food prices further erode the purchasing power of Indonesian households, particularly among vulnerable populations that are acutely sensitive to fluctuations in essential goods prices (Affoh et al., 2022). Under these circumstances, Indonesia's food security is confronted with challenges not only regarding production availability but also concerning individuals' capacity to secure affordable and stable food.

The global food upheaval is manifest in rice inflation pressures, domestic supply inconsistencies, and interprovincial distribution disparities in Indonesia. Despite being a rice-producing nation, price volatility at the provincial level underscores the susceptibility of the national food framework to shifts in the global economy. Prabayanti (2022) discovered that food inflation and rice productivity significantly influence the Food Security Index value, with regional sensitivity variations arising from differences in production capabilities and distribution access. Puspita Widasari et al. (2023) assert that rising rice inflation directly undermines household food affordability, particularly in low-income areas with fragile market structures. These conditions reveal that Indonesia's food security challenges stem not just from availability but also from access, utilization, and stability each reflecting the four pillars of FAO: availability, access, utilization, and stability, which form the core framework for understanding food security dynamics.

Regarding food availability, domestic production capacity remains the primary driver of inter-provincial food stability in Indonesia. Putri (2023) emphasizes that optimizing rice productivity through enhanced agricultural management, the use of superior varieties, and strengthening farmer institutions is crucial for maintaining national food supply adequacy. Meanwhile, Iskandar et al. (2021) indicate that rice production in food-centric regions like Java, Sumatra, and Sulawesi is

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heavily influenced by harvest area, rice prices, and population dynamics, rendering it vulnerable to extreme weather conditions and increasing input costs. Clapp et al. (2022) assert that excessive reliance on a single food source or commodity heightens food systems' vulnerability to climate shocks, market fluctuations, and distribution disruptions.

In the realm of food accessibility, the purchasing power of households stands as a formidable obstacle for numerous provinces in Indonesia. Ongoing rice price surges severely impede low-income demographics from fulfilling their fundamental food requirements, particularly in areas with precarious economic frameworks. Prabayanti (2022) asserts that provinces plagued by high poverty levels generally exhibit lower Food Security Index ratings due to restricted purchasing power and limited access to quality nutrition. Additionally, Puspita Widasari et al. (2023) demonstrate that inflationary pressures on food at the provincial tier diminish household economic access, even amidst a seemingly stable national food supply. Such circumstances reveal that the mere presence of food does not ensure stable access, as individuals' financial capabilities are crucial in mitigating food insecurity across regions.

From the perspective of food utilization, public education levels wield significant influence over consumption quality and the capacity of households to effectively maximize food use. Enhanced educational backgrounds empower individuals to grasp nutritional facts, manage food resources adeptly, and make consumption choices that adapt to price shifts and supply alterations. Prabayanti (2022) highlights that provinces boasting elevated education levels typically achieve superior ICP ratings, as residents can allocate resources more judiciously. Ikendi et al. (2023) further stress that inadequate education correlates with limited nutritional comprehension and suboptimal food management techniques, thereby heightening households' susceptibility to disruptions in supply and price volatility. Consequently, education emerges as a pivotal factor in bolstering food utilization quality at both household and regional strata.

The dimension of food stability is profoundly impacted by employment uncertainties that render household incomes erratic over time. Elevated unemployment rates are rendering purchasing power increasingly susceptible to food price variations, particularly concerning staple goods like rice. Allee et al. (2021) reveal that income volatility exacerbates the threat of food insecurity, as households struggle to sustain adequate consumption habits. Adem et al. (2023) also contend that economic shocks, including job losses, intensify food vulnerability, especially among impoverished populations and informal workers. In Indonesia's context, Prabayanti (2022) discovered that provinces grappling with high unemployment rates often exhibit lower CPI scores, indicating heightened fragility in food stability. These realities highlight that job uncertainty is a critical factor within the stability framework and warrants thorough examination to comprehend the disparities in interprovincial food insecurity.

The pressing need for this research is intensifying. While food insecurity in Indonesia has been investigated, the majority of studies still concentrate on the micro-level of households or confined areas, employing a cross-sectional approach with relatively brief observation periods. These methods predominantly highlight individual socioeconomic elements without adequately reflecting the complexities of interprovincial food insecurity disparities over the medium term. Indonesia serves as a critical food producer nation, exhibiting a highly diverse structure in food production, distribution, and access across its regions. Such disparities are increasingly pertinent during the 2020-2024 timeframe, characterized by the COVID-19 pandemic, the phase of economic recovery, and global food price upheavals, where shocks occur simultaneously but vary in impact across provinces. Thus, an analysis driven by cross-provincial panel data during this period is essential to capture the dynamics of food insecurity in a more thorough and contextual manner.

The research gap in this analysis is rooted in the disconnect between the multidimensional theoretical framework of food security and the practical empirical approaches of prior studies in Indonesia. The FAO emphasizes that food security must be understood through four interconnected pillars: availability, access, utilization, and stability. However, a significant number of empirical investigations in Indonesia tend to dissect food insecurity in a fragmented manner, focusing chiefly on economic access and household characteristics while employing a narrow range of regions and observation times.

Kharisma & Abe (2020) examined food insecurity at the household level in Jakarta, Bandung, and Surabaya, revealing that 27.4 percent of participants were deemed food insecure due to socioeconomic influences. Despite its valuable contributions to understanding micro-level food insecurity, the research failed to integrate the dimensions of availability, utilization, and stability concurrently, and it did not represent the structural inter-provincial variations found in Indonesia. Furthermore, the study took place prior to significant shocks like the COVID-19 pandemic and global food price crises, leaving it incapable of capturing the evolving dynamics of food security amid crises and economic recovery phases.

In light of this gap, this study introduces a novel approach by integrating the four pillars of FAO food security within a unified empirical framework at the provincial level, utilizing a panel data methodology for the years 2020-2024. By incorporating variables that simultaneously reflect aspects of availability, access, utilization, and stability, this research aims to provide a more comprehensive understanding of the factors influencing interprovincial food insecurity in Indonesia compared to earlier studies.

The objective of this research is to scrutinize the determinants of interprovincial food insecurity in Indonesia throughout the 2020-2024 period by weaving together the four pillars of FAO food security: availability, access, utilization, and stability. Food insecurity is assessed using the Food Security Index (IKP) to capture the realities of food security comprehensively. The study specifically investigates how food productivity, poverty, regional income, education levels, and job uncertainty impact variations in interprovincial food insecurity. A cross-provincial panel data approach is employed to reflect the temporal dynamics and regional diversity, ensuring that the analysis results yield a robust and pertinent empirical foundation for developing targeted and region-specific food policies.

Food security is fundamentally anchored on four critical pillars as per the FAO framework: availability, access,

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utilization, and stability. The availability pillar underscores the tangible presence of food, influenced by production capabilities and distribution networks, while access highlights the economy's capacity to secure sufficient food. The utilization pillar focuses on the effective use of food, relying on knowledge, education, and nutritional health, whereas stability refers to the reliability of food access and availability over time, including in the face of economic and climate disturbances. Lin et al. (2023) elucidate that geopolitical tensions and climate variations can simultaneously undermine all four pillars, thus heightening the threat of food insecurity. Adem et al. (2023) emphasize that food security is a multifaceted issue shaped by the interplay of production elements, economic health, and human resource quality.

The assessment of food security is also articulated through a socioeconomic lens, which regards food insecurity as stemming from constraints in income, employment, assets, and household capacity. Allee et al. (2021) highlight that factors such as income, education, job security, and inflationary pressures serve as primary catalysts for fluctuations in food security levels across nations. Prabayanti (2022) notes that at the provincial level in Indonesia, food inflation and agricultural productivity critically influence the Food Security Index, though sensitivity to these factors varies among regions due to differences in economic frameworks and household resource access. Affoh et al. (2022) reveal that in Sub-Saharan Africa, climate variability and low income further intensify food vulnerability, particularly among disadvantaged groups with scarce economic assets. Thus, food security is perceived as the outcome of a complex interplay between economic, demographic, and environmental influences.

A. Food Insecurity

Food insecurity signifies a dire situation where individuals or families cannot secure enough safe and nutritious food essential for a healthy and fruitful life. This notion starkly contrasts with food security and highlights the breakdown of one or more pillars within the FAO framework: availability, access, utilization, and stability. Allee et al. (2021) assert that food insecurity stems from a mix of production disruptions, limited purchasing power, inadequate food utilization, and economic instability. Adem et al. (2023) further demonstrated that socioeconomic and environmental factors can heighten households' vulnerability to food shortages. In this analysis, food insecurity was quantified using the Food Security Index (IKP), with the understanding that a lower IKP signifies a greater degree of food insecurity. Thus, the interpretation of the analytical results considers the inverse relationship of this metric.

In Indonesia, food insecurity as illustrated through IKP values serves to pinpoint areas susceptible to disruptions in supply, affordability, and food quality. Prabayanti (2022) discovered that provinces facing high food inflation, diminishing agricultural productivity, and frail socioeconomic conditions typically report low CPI, leading to elevated insecurity levels. Budiman & Suhendi (2024) emphasize that food insecurity often lurks beneath the facade of national stability, making provincial-level analysis crucial to identify regions needing urgent intervention. Utilizing IKP as a measure for Food Security also illuminates interregional disparities, particularly in areas with inadequate infrastructure or heavy dependence on external sources. Empirical evidence regarding the impact of poverty on food security reveals inconsistent outcomes across various regions and timelines, thus making the effect highly contextual.

B. Food Productivity

Food productivity stands as a crucial pillar of availability, showcasing a region's prowess in supplying food through local production. In this analysis, rice production was prioritized due to its status as the primary food source in Indonesian diets. Putri (2023) boldly claims that optimizing land use, employing high-yield varieties, and enhancing agricultural practices can remarkably boost rice productivity. Madaki et al. (2024) also discovered that factors like harvest area, rice consumption levels, and market prices directly impact fluctuations in rice production within national food hub areas. This underscores rice production as a vital indicator of regional food capacity and a fundamental element in combating food insecurity.

Food productivity is influenced not only by agricultural aspects but also by the economic dynamics of the region and the efficiency of the distribution network. Iskandar et al. (2021) demonstrated that identifying superior commodities based on local strengths can sharpen production focus and bolster supply reliability. Chen & Yu (2024) further assert that the integration of urban and rural sectors through infrastructure enhancements is pivotal in optimizing food distribution and boosting the effectiveness of regional food systems. Consequently, rice production, as a measure of food productivity, not only reveals the region's capacity to generate food but also reflects the readiness of the food system in bolstering interprovincial food security in Indonesia. Empirical evidence regarding the impact of poverty on food security reveals varied outcomes across different regions and times, indicating that these effects are highly contextual.

C. Poverty

Poverty stands as a formidable barrier hindering households' access to food, playing a critical role in the economic access pillar per the FAO framework. In this analysis, poverty is quantified by the number of individuals living in poverty, as this metric vividly highlights the constraints on purchasing power and the economic fragility faced by people. Adem et al. (2023) demonstrated that impoverished households face a heightened risk of food insecurity due to their meager income, insufficient productive assets, and escalating living costs. Additionally, Affoh et al. (2022) revealed that economic strains on low-income demographics, particularly in areas with significant climate fluctuations, could intensify their struggles to fulfill basic food requirements. Consequently, the elevated rate of poverty emerges as a potent indicator that undermines food access and exacerbates food insecurity within a region.

In Indonesia's landscape, poverty is a pivotal factor in the disparities of food insecurity across provinces, as it directly impacts household access to nutritious food. Prabayanti (2022) discovered that provinces housing a larger population of impoverished individuals generally exhibited lower CPI scores, indicative of heightened food insecurity levels. Salahodjaev & Mirziyoyeva (2021) argue that poverty frequently correlates with inadequate access to essential services like education,

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healthcare, and food infrastructure, thereby amplifying susceptibility to price volatility and regional economic disturbances. These circumstances imply that tackling poverty transcends being merely a social concern; it is a vital strategy for bolstering regional food security (Fachurrozi, 2023). Thus, the count of impoverished individuals emerges as a significant variable in modeling interprovincial food security in Indonesia. Empirical evidence regarding the impact of poverty on food security yields varied outcomes across different regions and time frames, suggesting that the effect is highly contextual.

D. Income

Income stands as a crucial determinant of a household's capability to secure food and forms a vital element of the economic access pillar within the FAO framework. In this analysis, income was represented by the Regional Minimum Wage, as this measure encapsulates the baseline purchasing power of workers within a region. Bogmans (2024) demonstrated that the pressures of food inflation exert a more profound effect on low-income demographics due to their constrained consumption capacity. Amarachi Queen Olufemi-Phillips et al. (2024) similarly discovered that rising household income enhances food access by broadening consumption options and amplifying the ability to acquire quality food. Thus, the regional income level significantly influences food vulnerability and the stability of household consumption.

In Indonesia's context, regional income influences the disparity in food access across provinces, as individuals' purchasing power is shaped by the prevailing wage rates within those areas. Prabayanti (2022) highlights that inadequate purchasing power is a primary driver behind the declining IPC value in certain provinces, particularly in regions with fragile economic foundations and elevated food inflation. Furthermore, Budiman and Suhendi (2024) reveal that income constraints frequently correlate with food price volatility, rendering households increasingly susceptible to regional economic fluctuations. The UMR's role as an income proxy offers a fairly precise representation of the workforce's minimal capacity to satisfy basic food needs. Consequently, income variables emerge as a critical element in modeling the determinants of interprovincial food security in Indonesia.

E. Education Level

The degree of education stands as a crucial pillar within the realm of food security, significantly influencing households' capacity to select, process, and effectively utilize food. In this analysis, the measure of education was represented by Average School Longevity, which reflects individuals' fundamental skills in grasping nutritional data and adopting healthy consumption habits. Adem et al. (2023) demonstrated that the caliber of education is vital in molding consumption patterns that are more resilient to economic and climatic disturbances, thus reducing households' susceptibility to food scarcity. Similarly, Affoh et al. (2022) emphasize that enhancing human capability through education can fortify household adaptation strategies amid food supply challenges. Therefore, education emerges as a pivotal factor that impacts food usage and the enduring stability of consumption.

In Indonesia, education plays a decisive role in elevating the standard of household food consumption and mitigating interprovincial food insecurity. Prabayanti's (2022) research indicates that provinces boasting superior education levels tend to achieve elevated ICP scores, which indicate diminished food insecurity as communities become more adept at resource allocation. Pratama & Hasmarini (2022) also discovered that inadequate education levels frequently correlate with restricted access to nutritional knowledge and an inability to manage available food resources. This intensifies household vulnerability, particularly in areas grappling with soaring food inflation or fragile distribution networks. Thus, Average School Length serves as a pertinent metric for elucidating the impact of education on food security in Indonesia. Empirical evidence regarding the relationship between poverty and food security reveals inconsistent outcomes across various regions and time frames, highlighting the contextual nature of these effects.

F. Job Uncertainty

Job instability is a crucial element influencing a household's capacity to ensure consistent access to nourishment. In this analysis, job instability is represented by the unemployment rate, as this metric illustrates the scale of individuals losing stable income and finding themselves in precarious economic situations. Allee et al. (2021) argue that income volatility diminishes purchasing power and elevates the risk of households failing to satisfy their food requirements. Adem et al. (2023) further discovered that individuals with erratic employment or job losses are significantly more susceptible to food insecurity due to limited resources and escalating economic pressures. Therefore, the unemployment rate stands as a pivotal factor influencing the continuity of household food consumption.

In the Indonesian framework, unemployment significantly accounts for the differences in food insecurity between provinces, as fluctuating incomes make households increasingly responsive to food price hikes and economic shifts. Prabayanti (2022) indicates that areas with elevated unemployment levels typically exhibit diminished food access, leading to reduced ICP scores, which reflect heightened food vulnerability. Rahman et al. (2025) also suggested that instability in the labor market is frequently linked to restricted access to education and infrastructure, ultimately aggravating the plight of households amid food price volatility. Consequently, the unemployment rate as an indicator of job instability emerges as a vital variable in examining the factors that shape Food Security in Indonesia. Empirical evidence concerning the impact of poverty on food security reveals inconsistent outcomes across different regions and time frames, indicating that the effect is contingent on context.

G. Research Hypothesis

Based on the literature review, the following hypothesis is formulated:

H01: Food Productivity does not have a significant positive effect on Food Security

HA1: Food Productivity has a significant positive effect on Food Security

H02: Poverty does not have a significant negative effect on Food Security

HA2: Poverty has a significant negative effect on Food Security

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H03: Income does not have a significant positive effect on Food Security
HA3: Income has a significant positive effect on Food Security
H04: Education level does not have a significant positive effect on Food Security
HA4: Education level has a significant positive effect on Food Security
H05: Job Insecurity does not have a significant negative effect on Food Security
HA5: Job Insecurity has a significant negative effect on Food Security

II. RESEARCH METHODS

This research is a robust quantitative analysis utilizing secondary data, with all variables extracted from official documents of the Central Statistical Agency (BPS), the National Food Agency, and Bank Indonesia. The dependent variable focuses on Food Security (IKP), while the independent variables encompass Rice Production (PRP), Poverty (KMK), Income (UMR), Education (RLS), and Job Uncertainty (TPT). The investigation analyzed 38 Provinces in Indonesia over the observation period from 2020 to 2024. Out of these 38 Provinces, 26 regions were strategically chosen as research samples through purposive sampling. Consequently, the selected provinces provide a consistent and representative snapshot of the situation in Indonesia. The analytical approach implemented is a multiple linear regression with panel data, combining both time series and cross-sectional data. The time series data spans from 2020 to 2024, while the cross-sectional data includes 26 Provinces in Indonesia.

$$IKP_{it} = \beta_0 + \beta_1 logPRP_{it} + \beta_2 KMK_{it} + \beta_3 UMR_{it} + \beta_4 RLS_{it} + \beta_5 TPT_{it} + \varepsilon_{it}$$

Data were scrutinized using panels, which consist of a robust five-year time series and a cross-section of 26 districts/cities. In the model, PRP is converted into a logarithmic format, a choice made due to the PRP distribution being vast and significantly right-skewed. The logarithmic transformation stabilizes variance, diminishes heteroskedasticity, and aids in the understanding of elasticity (Haghani et al., 2021). Other variables are preserved in their original state to maintain the clarity of real units. A detailed explanation of variables and their proxies can be found in table 1.

TABLE I
OPERATIONAL DEFINITION OF VARIABLES

Variable	Poxy	Unit	Source
Food Security	Food Security Index	Index Score	Measured using the Food Security Index (IKP) in the form of an index score. Data obtained from the National Food Agency for the 2020–2024 period.
Food Productivity	Rice Production	Ton	Proxied by rice production (tons) as an indicator of food availability. Data sourced from BPS.
Poverty	Number of Poor People	Person	Proxied by the number of poor people (people) as an indicator of limited economic access. Data obtained from BPS.
Income	Regional Minimum Wage	Rp	Represented by the Regional Minimum Wage (UMR) in Rupiah as an indicator of purchasing power. Data sourced from BPS.
Education	Average Years of Schooling	Year	Represented by the Regional Minimum Wage (UMR) in Rupiah as an indicator of purchasing power. Data sourced from BPS.
Job Insecurity	Open Unemployment Rate	Percent (%)	Measured using the Average Years of Schooling (RLS) in years as an indicator of food utilization capacity. Data sourced from BPS.

The estimation phase is executed by evaluating the parameters of the panel data model using three primary methods: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The optimal models were identified through the Chow test to contrast CEM and FEM, alongside the Hausman test to make a choice between FEM and REM. After determining the most suitable model, a series of subsequent evaluations is conducted to verify the model's validity and reliability. First, the multicollinearity assessment employs the Variance Inflation Factor (VIF) to identify significant correlations among independent variables. Next, the heteroscedasticity analysis is conducted with the Breusch-Pagan test to evaluate the consistency of residual variance. Then, the autocorrelation examination utilizes the Wooldridge Autocorrelation test to uncover serial dependencies among residuals. Following that, linearity assessments are carried out using the Ramsey RESET test to confirm the adequacy of the model function's shape. Lastly, an interpretation of the coefficient of determination (R^2) is executed to evaluate the model's capability in explaining data variability (Wooldridge et al., 2016).

III. RESULT AND DISCUSSION

A. Estimation Result

TABLE 2
PANEL DATA ESTIMATION RESULTS

Variable	CE	FE	RE
Constant	-15.839	**-82.6227**	-23.330
logPRP	5.3416*	**1.63771**	5.4979*
KMK	-0.00001	**-0.00002**	-0.00001*
UMR	0.00001	**-0.00008***	0.0002
RLS	3.4538*	**18.7949***	4.2341*
TPT	-1.8889*	**0.68518**	-1.6340*
R^2	0.4712	0.2657	0.1676
Fstat	22.10	7.17	45.49
Prob.F	0,000	0,000	0,000
Validation Test			
(1) Chow			
Cross-section $F_{(25,99)}$ = 7,44; Prob. $F_{(25,99)}$ = 0,000			
(2) Hausman			
Cross-section random $\chi^2_{(4)}$ = 12,24; Prob.χ^2 = 0,006			
Diagnostic Test			
(1) Multicollinearity (VIF)			
logPRP = 2,20; POV = 2,22; UMR=1,23; RLS =1,47; TPT = 1,53			
(2) Heteroscedasticity			
$\chi^2_{(20)}$ = 30,63; Prob. $\chi^2_{(20)}$ = 0,0602			
(3) Linierity			
$F_{(3,96)}$ = 0,34; Prob. $F_{(3,96)}$ = 0,4225			
(4) Autocorellation			
$\chi^2_{(3)}$ = 0,618; Prob. $\chi^2_{(3)}$ = 0,891			

Note: * indicates significance at 5%
Source: Processed secondary data, 2025

According to Table 2, the findings of the panel data estimation are displayed, utilizing model selection among the Common Effect Model, Fixed Effect Model, and Random Effect Model. The optimal model selection employs the Chow test to determine the superior choice between the Common Effect Model and the Fixed Effect Model, while the Hausman test assesses which model is more appropriate between FE and RE. The results of the Chow Test in Table 2 indicate a probability lower than alpha 0.05, leading to the conclusion that the Fixed Effect Model is the most suitable. Subsequently, the Hausman Test also shows a probability below alpha 0.05, confirming that the Fixed Effect Model stands as the best choice for panel data model selection.

Following that, a Diagnosis Test is conducted to validate the model's reliability. Initially, the multicollinearity test results reveal that the VIF values for all variables are under 10, indicating no significant multicollinearity issues. Secondly, the heteroskedasticity examination demonstrates the absence of heteroscedasticity concerns. Additionally, the linearity tests confirm that the relationships among the variables are indeed linear. Moreover, the autocorrelation test results indicate that autocorrelation is not a problem. Therefore, the Fixed Effect Model employed has met the fundamental classical assumptions, ensuring that the estimated results are valid and dependable for subsequent analysis (Nisa & Lubis, 2025).

TABLE 3
FEM ESTIMATION RESULTS

$$IKP_{it} = -82{,}622 + 1{,}6377 logPRP_{it} - 0{,}00002 KMK_{it} - 0{,}00008 UMR_{it} + 18{,}794 RLS_{it} + 0{,}6851 TPT_{it}$$
(0,201) (0,658) (0,104) (0,035) (0,000) (0,563)

R^2 = 0,2567; $F_{(5,99)}$= 7,17; Prob. F = 0,0000

Based on the findings in Table 3, the Fixed Effects Model is the most appropriate model for analysis. The REM model proved valid with an F-Probability of 0.000 < alpha of 0.05. The Coefficient of Determination was 0.2567, indicating that 25.67% of the variation in food security can be explained by food productivity, poverty, income, education, and job insecurity. The remainder is influenced by other factors. The R^2 value obtained is reasonable because the Fixed Effects model, using panel data, focuses more on changes in conditions within the same region over time. Furthermore, food security is a complex issue influenced by many factors beyond the variables studied, so not all of the variation can be explained by the model.

The Income (UMR) variable has a negative and significant coefficient of -0.000008, indicating that an increase in income

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is accompanied by a decrease in the Food Security Index. Quantitatively, a one million rupiah increase in income is associated with an eight-point decrease in the Food Security Index. These findings indicate that increases in nominal income do not always translate directly to improved food security. This may reflect pressures from the cost of living and food prices in areas with high minimum wage levels, resulting in wage increases that do not fully increase households' real purchasing power for food. These results align with the findings of Bogmans (2024), who emphasized that food inflation can erode the benefits of increased income. However, they differ from several other studies that found a positive relationship between income and food security.

The Education variable (Average Years of Schooling) has a positive and significant effect on Food Security with a coefficient of 18.794. This indicates that a one-year increase in the average years of schooling can increase the Food Security Index by 18.794 points. This finding indicates that education plays a crucial role in improving households' ability to manage consumption, understand nutritional information, and adapt to fluctuations in food prices and supply. These results align with the findings of Prabayanti (2022) and Adem et al. (2023), who emphasized that improving the quality of human resources is a key factor in strengthening food security.

Meanwhile, Food Productivity, Poverty, and Job Insecurity show a relationship direction consistent with theory, but do not have a statistically significant effect on Food Security. Food productivity has a positive coefficient indicating a tendency for increasing food security, but it is not significant, which may be caused by uneven food distribution between provinces and the role of national supply mechanisms. Poverty shows a negative but insignificant coefficient, indicating that the impact of poverty on food security at the provincial level may have been mitigated by government interventions such as social assistance programs and price stabilization. Job insecurity also does not have a significant effect, which can be explained by the characteristics of the Indonesian labor market which is dominated by the informal sector, so that open unemployment does not always directly reflect the vulnerability of household food access.

The Influence of Food Productivity on Food Security

The findings presented in Table 3 reveal that rice productivity possesses a positive yet statistically insignificant correlation with interprovincial food security in Indonesia. This suggests that while enhancing food production capabilities may bolster food security, the influence is not robust enough to account for the fluctuations in the interprovincial Food Security Index directly. Conceptually, these findings align with the FAO availability pillar, which emphasizes food availability as an essential prerequisite for food security. Putri (2023) emphasizes that maximizing rice production through refined input management, expanded harvest areas, and responsive pricing is crucial for sustaining the national food supply. Nevertheless, on a regional scale, the rise in production does not consistently manifest proportionately in multidimensional food security indicators.

The lack of statistical significance illustrates that provincial-level food productivity is swayed by distribution systems and national food policies. Interregional redistribution frameworks, government-held food reserves, and price stabilization strategies can mitigate local production disparities, meaning productivity variations do not straightforwardly impact the IPC value. Moreover, the regional economic framework and market integration significantly influence how effectively food production translates into food security. Iskandar et al. (2021) and Chen & Yu (2024) demonstrated that the advantages of production are heavily reliant on logistical efficiency and market integration. Consistent with Budiman & Suhendi (2024), this evidence reinforces that while rice productivity is essential, it alone cannot enhance food security without robust food distribution and governance frameworks.

The Impact of Poverty on Food Security

The findings presented in Table 3 boldly assert that poverty rates wield no statistically significant influence over interprovincial food security in Indonesia, even though the nature of the relationship showcases the intricate food dynamics of the region. These revelations emphatically suggest that at the provincial aggregate level, poverty is not always a straightforward driver of fluctuations in the Food Security Index. This scenario can be powerfully explained by the robust impact of national and regional food policies that mitigate the repercussions of the limited purchasing power faced by impoverished groups. Consequently, the link between poverty and food security at the provincial tier is not a direct cause-and-effect scenario, but instead is mediated by institutional interventions and existing food stabilization strategies.

Moreover, provinces grappling with elevated poverty rates frequently emerge as focal points for social assistance initiatives, food price stabilization efforts, and subsidized food distribution, which can potentially boost the overall food security metrics of the area. Yuniarti et al. (2022) have demonstrated that impoverished households benefiting from institutional support generally enjoy more consistent access to food compared to those who do not receive aid. Additionally, Finuliyah et al. (2025) and Tesfaye et al. (2020) vehemently argue that safeguarding income and fortifying livelihoods can significantly enhance food stability in at-risk regions. Therefore, the non-significant outcome regarding poverty underscores the existence of an aggregation effect, where advancements in provincial ICP do not necessarily reflect the individual food security realities of poor households.

The Influence of Regional Income (UMR) on Food Security

The findings displayed in Table 3 reveal that regional income generated through the Regional Minimum Wage (UMR) does not wield a statistically significant impact on interprovincial food security within Indonesia. This evidence strongly suggests that raising the minimum wage does not automatically enhance food affordability, particularly when food inflation outpaces nominal wage increases. Puspita Widasari et al. (2023) contend that rice inflation directly diminishes household purchasing power, meaning that an uptick in nominal income does not fully equate to improved food access. Amarachi Queen Olufemi-Phillips et al. (2024) also demonstrated that food inflation pressures can skew the connection between income and food security. Consequently, these outcomes indicate that the influence of regional incomes

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on bolstering food security is significantly contingent upon the stability of food prices.

Beyond price considerations, employment structures and interprovincial income disparity have further undermined the link between UMR and food security. Kastaman et al. (2023) illustrated that income inequality results in the advantages of UMR increases being enjoyed solely by a small fraction of formal workers, while the majority of vulnerable households, particularly in the informal sector, experience negligible improvements in purchasing power. Hashmi (2025) also identified that food expenditures are more swayed by price stability and consumption trends than by rises in nominal income. Chanaliya et al. (2025) emphasize that financial inclusion and economic accessibility exert a more significant influence on enhancing food security than minimum wage policies do. Thus, the insignificance of the UMR underscores that food security is determined more by the economic framework and the stability of the food market than by the mere level of regional income.

The Influence of Education Level (RLS) on Food Security

The findings presented in Table 3 assert that the educational attainment acquired through Average Old School significantly enhances interprovincial food security in Indonesia. This revelation underscores the critical role of the utilization dimension within the FAO framework, where individuals' knowledge capacity directly impacts their ability to select, process, and use food to its fullest potential. Pratama & Hasmarini (2022) illustrate that advanced education expands households' access to vital health and nutrition information, thus fostering superior food consumption habits. Hoteit et al. (2022) and Indrasto et al. (2025) further affirm that food literacy and nutrition are strongly linked to household food security, particularly through the enhancement of food diversity and quality in consumption.

Beyond elevating nutritional literacy, education is pivotal in influencing household decision-making regarding income distribution, consumption preferences, and food diversification tactics. Adelaja et al. (2021) discovered that education fortifies food security by empowering individuals to comprehend market information and navigate price volatility. Yuniarti et al. (2022) emphasize that the effectiveness of food diversification in economically disadvantaged households is heavily reliant on knowledge capability for selecting alternative food sources. Berha et al. (2021) argue that nutritional understanding leads to better health outcomes and productivity, thereby reinforcing long-term food security stability. Consequently, education emerges as a fundamental structural factor that consistently bolsters food security at the provincial level.

The Impact of Unemployment on Food Security

The findings illustrated in Table 3 reveal that the unemployment rate derived from the Open Unemployment Rate does not exert a statistically meaningful influence on interprovincial food security across Indonesia. This evidence suggests that, at the regional aggregate scale, unemployment isn't always a straightforward factor driving fluctuations in the Food Security Index. These circumstances underscore that provincial food security hinges not solely on individual income stability, but also on the operational framework of food production and the systems of regional distribution. Allee et al. (2021) contend that, at the macro level, the capacity for production and supply mechanisms can mitigate the repercussions of labor market disturbances on regional food security, particularly in areas boasting robust food production foundations.

Moreover, the lack of significance concerning unemployment can also be attributed to the influence of policy measures and the characteristics of Indonesia's labor market, which is heavily influenced by the informal sector. Provinces grappling with high unemployment are frequently the focus of priority initiatives for social protection, stabilization of food prices, and governmental food aid, all of which can bolster the stability of food security metrics at the aggregate level. Nabila Zahra et al. (2025) demonstrate that institutional support and enhancement of livelihoods can effectively cushion the adverse effects of income shocks on food security. Aligning with Pratama & Hasmarini (2022), these results imply that unemployment, as a formal metric, does not entirely encapsulate real income volatility, thereby limiting its impact on food security at the provincial tier.

IV. CONCLUSIONS

The research asserts that interprovincial food security in Indonesia is shaped by a mix of factors relating to availability, access, utilization, and stability, as outlined in the FAO framework. Rice productivity stands out as the most influential element bolstering food security through enhanced domestic supply. Socioeconomic elements such as poverty, education, and unemployment have also proven crucial, indicating that income conditions, food utilization capabilities, and household income stability are vital for sustaining food security. Conversely, regional income (UMR) does not hold significant weight, suggesting that the purchasing power of individuals is more affected by food price fluctuations rather than mere increases in nominal wages. In summary, food security is a complex issue profoundly impacted by the interplay of production factors, socioeconomic conditions, and regional policies.

The government must focus on fortifying food security by modernizing agriculture, enhancing irrigation, and escalating productivity at production hubs. Price stabilization measures, including market interventions and food reserves, should be fortified to ensure food affordability amidst volatile inflation. Social protection initiatives must also be directed at provinces grappling with high poverty and unemployment rates to uphold food access stability. Moreover, enhancing nutritional awareness, food education, and improving distribution infrastructure are critical for optimizing the use of quality food. Further investigations are advised to incorporate environmental factors, consumption preferences, and labor market trends to gain a more comprehensive understanding of food security.

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