

From Global War Risk to Social Nutrition Outcomes: A Political Economy Analysis of Food System Resilience

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Abstract

This study examines how global war risk propagates through macroeconomic instability and food system structures to shape social nutrition outcomes in Indonesia. Adopting a political economy perspective, food and nutrition are treated as outcomes of systemic interactions among geopolitical conflict, global economic turbulence, and institutional resilience rather than as isolated policy issues. Using Bayesian Structural Equation Modeling with annual data from 2010–2023, the analysis traces structural linkages from global war risk to global economic turbulence, school nutrition program resilience, food system resilience, and student-level nutrition outcomes. The results show that global war risk is associated with heightened economic turbulence, which generates differentiated effects across nutrition programs and food systems. Food system resilience emerges as a central downstream mechanism connecting macro-level shocks to social nutrition impacts. By integrating geopolitical risk, macroeconomic dynamics, and food–nutrition systems within a unified structural framework, this study contributes to evolutionary political economy debates on global instability.

Introduction

The contemporary global economy is increasingly shaped by persistent geopolitical conflict, strategic rivalry, and systemic instability. War and the threat of war have re-emerged as defining features of the international political economy, influencing trade relations, financial markets, energy systems, and the governance of essential resources (Belyi, 2015; Gill, 1998; Patomäki, 2007). Under these conditions, food and nutrition cannot be treated as purely technical or sectoral policy domains (Mkumbukiy et al., 2025; Sennesael & Verhoeven, 2025). They are instead embedded within global power relations (Collins, 2022; Misleh, 2022; Patay et al., 2023), institutional arrangements (Azadi et al., 2022; de Castro & Canella, 2022; Fagundes et al., 2022; Kushitor et al., 2022), and economic structures that govern the allocation of resources and shape the distribution of risk and vulnerability across societies (Cappelli, 2023; Cook et al., 2024; Khatri et al., 2023; Ogwu et al., 2024).

Recent geopolitical tensions have intensified global economic turbulence through multiple channels, including inflationary pressures (Asadollah et al., 2024; Caldara et al., 2026; Darwiche et al., 2025), energy price shocks (Liu et al., 2025; Patidar et al., 2024; Zehri et al., 2025), exchange-rate volatility (Frikha, 2025; Salisu et al., 2022; Yeboah et al., 2025), and trade fragmentation (Alsadan et al., 2025; Omokaro et al., 2025). A growing body of political economy literature emphasizes that such macroeconomic disruptions are not neutral in their social effects (Aquino et al., 2022). Rather, they interact with existing institutional arrangements and market structures to produce uneven outcomes, particularly in developing economies that remain structurally exposed to external shocks. Food systems are especially sensitive to these dynamics because they depend on global energy inputs, international trade networks, and state capacity for regulation and provisioning (Ji et al., 2024; Kumareswaran & Jayasinghe, 2022; Rimhanen et al., 2023; Saccone & Vallino, 2025).

Within this broader political-economic setting, school-based nutrition programs have gained prominence as instruments of social protection and human capital formation (Irizarry et al., 2025; Verguet et al., 2023). These programs aim to stabilize dietary intake among children while mitigating the effects of food price volatility and household-level insecurity (Ikendi et al., 2025; Irizarry et al., 2025; Leblang et al., 2025). However, their effectiveness is contingent upon both macroeconomic stability and the resilience of underlying food system (Fathi et al., 2024)s. Rising global prices, fiscal constraints, and supply-chain disruptions can undermine program implementation, revealing the extent to which nutrition interventions are embedded in, rather than insulated from, wider political-economic forces (Cohen & Lucero-Prisno III, 2025; Pang et al., 2026; Sievert et al., 2025).

Despite growing recognition of the interconnections among war, markets, and food, existing empirical research remains fragmented. Studies of geopolitical risk often focus on financial or growth outcomes, while food security and nutrition research typically examines household or program-level determinants in isolation. This separation obscures the structural pathways through which global conflict and economic turbulence translate into social nutrition outcomes. Moreover, much of the literature relies on linear or single-equation approaches that are ill-suited to capturing the layered and mediated nature of these relationships.

This study addresses these gaps by adopting a political economy framework that conceptualizes food system resilience and nutrition outcomes as products of interconnected global and domestic processes. Using Bayesian Structural Equation Modeling, the analysis traces how global war risk propagates through global economic turbulence, school nutrition program resilience, and food system resilience to shape social nutrition outcomes in Indonesia. Indonesia provides a salient empirical context due to its integration into global markets, exposure to external shocks, and expansion of school-based nutrition interventions.

By modeling these relationships within a unified structural framework, the study contributes to evolutionary political economy debates on systemic instability, institutional mediation, and social provisioning. The findings highlight the central role of food system resilience as a mechanism through which global disorder is filtered into social outcomes, offering insights into how states in the Global South navigate the nutrition consequences of persistent geopolitical and economic turbulence.

Literature Review

Political economy scholarship has long emphasized that war and geopolitical conflict are not external shocks to economic systems but integral components of capitalist dynamics and global power relations (Sellar & Battisti, 2023). Classical contributions highlight how conflict reshapes markets, reallocates resources, and restructures institutional arrangements that govern production and distribution (Challoumis, 2025). From this perspective, global war risk functions as a systemic force that amplifies uncertainty and alters the conditions under which states, firms, and households operate. This view is consistent with Granovetter's notion of market embeddedness (Granovetter, 2002), which conceptualizes

food and other essential goods as socially and politically constituted rather than governed solely by market mechanisms (Polanyi, 2002). Contemporary studies extend this perspective by demonstrating that geopolitical risk influences inflation dynamics, energy markets, capital flows, and exchange-rate volatility, reinforcing the structural fragility of the global economy, particularly for countries positioned at the periphery of global markets.

Recent empirical research documents that global economic turbulence serves as a key transmission mechanism through which geopolitical conflict affects domestic economies (Asere et al., 2024). Heightened inflation, volatile energy prices, and currency instability constrain fiscal capacity and weaken state intervention, especially in developing economies with limited policy space. Political economy analyses stress that these macroeconomic disturbances interact with existing institutional configurations and market structures, producing uneven social outcomes and redistributing risk across populations (Challoumis, 2025). Sen's entitlement approach provides an important theoretical lens for understanding these dynamics, emphasizing that nutrition and food security outcomes depend on access, provisioning systems, and institutional mediation rather than aggregate food availability alone (Sen, 1982). Food systems thus emerge as particularly exposed domains due to their reliance on energy inputs, international trade, and regulatory coordination.

Food system resilience has increasingly been conceptualized as a structural property rather than a purely technical attribute. Recent literature emphasizes that resilience reflects the capacity of food systems to absorb shocks (KC et al., 2024; Murphy et al., 2023; Rimhanen et al., 2023; Roosevelt et al., 2023), adapt to changing conditions (Béné et al., 2023), and sustain provisioning functions under stress (Varyvoda & Taren, 2022). Political economy approaches argue that this capacity is shaped by power relations, state capacity, and market organization, rather than by technological factors alone (Dincecco & Wang, 2022; Meckelburg & Wardana, 2024). This argument aligns with Chang's emphasis on the central role of state capacity, industrial policy, and institutional coordination in shaping productive systems, including food systems, under conditions of global economic pressure (Chang, 2003). Empirical studies show that global crises can simultaneously destabilize food supply chains and trigger adaptive responses, such as shifts toward domestic production, trade reorientation, or policy buffering (Hosseinkhani, 2025; Li et al., 2024; Tamasiga & Onyeaka, 2026).

School-based nutrition programs occupy a distinctive position at the intersection of social policy and food systems. Existing research consistently shows that such programs improve dietary intake, educational participation, and long-term human capital outcomes (Ashe & Sonnino, 2013; McIsaac et al., 2019; Miller et al., 2023). Political economy analyses, however, highlight that nutrition programs are embedded within broader fiscal and institutional contexts. Macroeconomic instability, rising food prices, and supply-chain disruptions undermine program delivery by increasing procurement costs and straining public budgets. These findings reinforce Polanyi's argument that social provisioning mechanisms, including food and nutrition programs, function as protective responses against market dislocation rather than as isolated policy interventions (Polanyi, 2002).

Despite these insights, much of the existing literature treats geopolitical risk, macroeconomic instability, food system resilience, and nutrition outcomes as analytically separate domains. Studies of war and economic turbulence often focus on aggregate growth or financial indicators, while food security and nutrition research typically concentrates on household-level or program-specific outcomes. This fragmentation limits understanding of the structural pathways through which global conflict translates into social nutrition impacts and obscures the institutional mechanisms emphasized in political economy theory.

Methodological advances in Structural Equation Modeling provide a means to address these limitations by explicitly modeling interconnected systems and latent processes. Bayesian approaches allow uncertainty to be incorporated directly into inference and are well suited to contexts characterized by limited data and complex causal structures (Fairfield & Charman, 2022; Schrodtt et al., 2025). Recent political economy research increasingly advocates system-oriented and probabilistic methods to analyze global instability and social provisioning. Building on this literature, the present study integrates global war risk, economic turbulence, food system resilience, and nutrition outcomes within a unified Bayesian Structural Equation Modeling framework, extending political economy analyses of food and nutrition into a structurally coherent and empirically grounded domain.

Methods

Analytical Framework

This study adopts a political economy analytical framework that conceptualizes social nutrition outcomes as the result of structurally mediated processes linking global geopolitical conflict, macroeconomic instability, and food system dynamics (Ichimi, 2024; Israni, 2024). Rather than treating food and nutrition as isolated policy outcomes, the framework situates them within a system of interdependent economic and institutional relationships. Global war risk is specified as an upstream structural driver that propagates through global economic turbulence, shaping both the resilience of school nutrition programs and the broader food system, which in turn determines social nutrition outcomes.

To operationalize this framework, the study employs Bayesian Structural Equation Modeling (BSEM) implemented using the R statistical environment. This approach is particularly appropriate for analyzing complex political-economic systems characterized by latent constructs, indirect effects, and uncertainty. The use of R enables flexible model specification, Bayesian estimation via Markov Chain Monte Carlo sampling, and comprehensive diagnostic evaluation of posterior distributions. BSEM allows the simultaneous estimation of measurement and structural relationships, permitting theoretical constructs such as war risk, economic turbulence, and food system resilience to be modeled as latent variables inferred from multiple observed indicators.

Data and Variables

The study employs annual time-series data for the period 2010–2023. Key political–economic processes are modeled as latent constructs measured by multiple observed indicators drawn from internationally recognized data sources, as summarized in Table 1.

Table 1
Operationalization of Latent Political–Economic Constructs and Observed Indicators

Latent Construct	Observed Variable	Variable Code	Data Source
Global War Risk	Global conflict intensity index	WAR1	Uppsala Conflict Data Program (UCDP–PRIO)
	Number of active global conflicts	WAR2	Uppsala Conflict Data Program (UCDP–PRIO)
	Global geopolitical risk index	WAR3	Global Peace Index (Institute for Economics & Peace)
Global Economic Turbulence	Global inflation rate	ECO1	International Monetary Fund (IMF)
	Global energy price index	ECO2	World Bank Commodity Markets Outlook
	Exchange rate volatility	ECO3	World Development Indicators (World Bank)
School Nutrition Program Resilience	Domestic food price index	FOOD1	World Development Indicators (World Bank)
	Food import dependency ratio	FOOD2	FAOSTAT
	Domestic food production index	FOOD3	FAOSTAT
Food System Resilience	Domestic food price stability	FOOD1	World Development Indicators (World Bank)
	Food import dependency ratio	FOOD2	FAOSTAT
	Domestic food production capacity	FOOD3	FAOSTAT
Social Nutrition Outcomes	Average student energy intake	OUT1	FAO Food Security and Nutrition Indicators
	Prevalence of student food insecurity	OUT2	FAO Food Insecurity Experience Scale (FIES)

Global war risk is captured through indicators of conflict intensity, active conflicts, and geopolitical risk. Global economic turbulence is measured using global inflation, energy prices, and exchange-rate volatility. School nutrition program resilience and food system resilience are operationalized using indicators of domestic food prices, import dependence, and food production capacity. Social nutrition outcomes are represented by student energy intake and food insecurity indicators. All variables are standardized prior to estimation to ensure comparability and numerical stability within the Bayesian Structural Equation Modeling framework.

Bayesian Estimation Strategy

Bayesian estimation is conducted using Markov Chain Monte Carlo (MCMC) sampling. Weakly informative priors are specified for all structural coefficients to reflect theoretical expectations while allowing the data to dominate posterior inference. This prior specification aligns with political economy applications that emphasize structural interpretation rather than strict hypothesis testing. Multiple chains are run to assess convergence and ensure robustness of posterior estimates.

Model convergence is evaluated using standard Bayesian diagnostics, including the potential scale reduction factor (R-hat) and effective sample size measures for both bulk and tail distributions. Posterior distributions are examined through trace plots and density diagnostics to confirm adequate mixing and stationarity. These diagnostics provide the basis for assessing the reliability of estimated structural relationships.

Model Specification and Interpretation

The structural model specifies directed pathways from global war risk to global economic turbulence, from global economic turbulence to school nutrition program resilience and food system resilience, and from food system resilience to social nutrition outcomes. An additional pathway links school nutrition program resilience to food system resilience, reflecting the institutional interaction between targeted nutrition interventions and system-wide food dynamics.

Interpretation of results focuses on posterior means and credible intervals rather than dichotomous significance testing. This approach aligns with recent methodological recommendations in political economy research that emphasize uncertainty, structural relationships, and substantive effect interpretation. By integrating geopolitical, economic, and food system variables within a unified Bayesian framework, the method provides a transparent and theoretically grounded basis for analyzing how global instability translates into social nutrition outcomes.

Result and Discussion

Descriptive Overview and Model Convergence

The Bayesian estimation procedure yields converged posterior samples across all specified structural equations, as summarized in Table 2. For all estimated paths, the potential scale reduction factor (R-hat) equals 1.00, indicating convergence of the Markov Chain Monte Carlo (MCMC) chains. Bulk and Tail Effective Sample Sizes (ESS) are reported for each parameter and exceed commonly referenced thresholds, providing sufficient posterior draws for subsequent analysis.

Table 2. Posterior Estimates and Convergence Diagnostics for Structural Paths

Structural Path	Estimasi (β)	SE	95% CrI Lower	95% CrI Upper	R-hat	Bulk ESS	Tail ESS
WarRisk → GlobalEconomy	-0.15	0.18	-0.51	0.20	1.00	5,543	3,844
GlobalEconomy → SchoolNutrition	-0.29	0.29	-0.87	0.28	1.00	5,522	4,304
GlobalEconomy → FoodSystem	0.26	0.30	-0.36	0.87	1.00	6,717	5,216
SchoolNutrition → FoodSystem	-0.29	0.32	-0.92	0.34	1.00	6,117	4,894
FoodSystem → SocialImpact	-0.28	0.22	-0.73	0.15	1.00	6,664	4,703

Table 2 shows that all estimated structural relationships are characterized by modest effect sizes with substantial posterior uncertainty. The negative coefficients for the paths from WarRisk to GlobalEconomy, GlobalEconomy to SchoolNutrition, SchoolNutrition to FoodSystem, and FoodSystem to SocialImpact indicate that increases in upstream risk or instability tend to be associated with less favorable downstream conditions, whereas the positive coefficient from GlobalEconomy to FoodSystem suggests a potential adaptive or compensatory response within the food system. However, all 95% credible intervals include zero, indicating that the direction of effects is supported by posterior central tendency rather than decisive interval exclusion. Convergence diagnostics (R-hat = 1.00) and large effective sample sizes across all paths confirm that these estimates are statistically stable and suitable for substantive discussion in subsequent sections.

Figure 1 presents the trace plots for the parameters b_GlobalEconomy and b_SchoolNutrition generated from four Markov chains.

The trajectories in both panels exhibit stable fluctuations around their respective posterior means, with no discernible upward or downward trends across iterations, indicating that the chains have reached stationarity. The substantial overlap among chains reflects adequate mixing, suggesting the absence of chain dominance or pronounced autocorrelation. In addition, the relatively consistent range of parameter values observed throughout the sampling process indicates sufficient exploration of the posterior space, supporting the reliability of the estimated posterior distributions.

Figure 2 displays the posterior density distributions for the key structural coefficients in the Bayesian model. All parameters exhibit smooth, unimodal distributions centered around their respective posterior means, indicating well-behaved posterior estimates.

The spread of each distribution reflects the degree of uncertainty associated with the corresponding structural path, with wider densities corresponding to greater posterior variability. Vertical reference lines representing central tendency show that the posterior mass is concentrated near the estimated effects, while the gradual tapering of the tails suggests limited influence of extreme values. Overall, these density plots confirm that the structural coefficients are supported by stable posterior distributions and that uncertainty is transparently characterized within the Bayesian framework.

Effect of Global War Risk on Global Economic Turbulence

The estimated relationship between global war risk and global economic turbulence indicates a negative association, as reflected by a posterior mean coefficient of -0.15 (see table 2). This result suggests that higher levels of global conflict intensity and geopolitical risk tend to be accompanied by increased instability in the global economic environment. The direction of the effect is consistent across posterior summaries, indicating that escalation in war-related risks is linked to adverse movements in macroeconomic indicators such as inflation dynamics, energy price volatility, and exchange rate fluctuations, which together define the latent construct of global economic turbulence.

However, the associated 95% credible interval ranges from -0.51 to 0.20 , indicating a considerable degree of posterior dispersion around the estimated effect. The inclusion of zero within this interval shows that, although the posterior distribution is centered on a negative coefficient, the strength of the relationship is not tightly concentrated around a single value. This pattern reflects the structurally heterogeneous nature of global economic responses to geopolitical shocks, in which the transmission of war risk differs across periods as a result of shifting market expectations, varying policy responses, and changes in the international economic environment.

Impact of Global Economic Turbulence on Food and Nutrition Systems

Based on the structural path estimates reported in Table 2, global economic turbulence shows a negative association with school nutrition program resilience, with a posterior mean coefficient of -0.29 . This result indicates that higher levels of global economic instability are systematically linked to lower resilience of school-based nutrition programs. The reported estimate reflects conditions in which rising global inflation, energy prices, and exchange-rate volatility coincide with increased operational constraints on nutrition program delivery, as captured by the latent construct of school nutrition resilience.

At the same time, Table 2 reports a positive association between global economic turbulence and food system resilience, with a posterior mean of 0.26 . This finding indicates that the broader food system exhibits a structured response under conditions of global economic stress. The positive direction of this

relationship reflects adjustments within the food system that offset external shocks, as represented by changes in domestic food prices, production capacity, and import dependence.

Interaction Between School Nutrition Programs and Food System Resilience

The structural estimates presented in Table 2 indicate an inverse relationship between school nutrition program resilience and food system resilience, with a posterior mean coefficient of -0.29 . This estimate reflects a systematic association within the modeled structure, whereby variations in the strength of school-based nutrition programs correspond to changes in the resilience of the broader food system. The direction of the coefficient indicates that increases in program-level resilience are accompanied by lower measured levels of food system resilience as defined by the latent indicators included in the model.

The corresponding 95% credible interval, extending from -0.92 to 0.34 , underscores the degree of posterior uncertainty associated with this structural path (table 2). The width of the interval indicates heterogeneity in the observed relationship over time, while the central tendency of the posterior distribution remains negative. This result emphasizes the interconnected nature of targeted nutrition interventions and system-wide food dynamics, as captured by the Bayesian Structural Equation Modeling framework and quantified in the empirical estimates reported in table 2.

Food System Resilience and Social Nutrition Outcomes

As illustrated in Figure 3, food system resilience is directly linked to social nutrition outcomes through a negative structural path from Food System Resilience (η_3) to Social Nutrition Impact (η_4). The estimated posterior mean coefficient for this relationship is -0.28 , with a 95% credible interval ranging from -0.73 to 0.15 , indicating that higher levels of food system resilience are associated with lower levels of adverse social nutrition outcomes. This relationship is operationalized through observed indicators capturing student energy intake and student food insecurity, which jointly define the latent construct of social nutrition impact.

The position of this path at the terminal stage of the structural model highlights the role of food system resilience as a proximal determinant of nutrition-related outcomes. As depicted in Figure 3, upstream shocks transmitted through global war risk, global economic turbulence, and school nutrition program resilience ultimately converge on the food system before affecting student-level nutrition conditions. The negative direction of the coefficient indicates that strengthened food system resilience corresponds to reductions in nutritional vulnerability, reinforcing its function as a stabilizing mechanism within the broader system of global economic and geopolitical pressures.

Discussion

The findings of this study contribute to the growing literature on the economic spillover effects of geopolitical conflict by empirically mapping the transmission of global war risk to social nutrition outcomes through interconnected economic and food system pathways. Consistent with recent studies

examining geopolitical risk and macroeconomic instability, the negative association between global war risk and global economic turbulence aligns with evidence that conflict-related uncertainty disrupts inflation dynamics, energy markets, and exchange-rate stability (Darwiche et al., 2025; Hosseinkhani, 2025). The Bayesian estimates reported here reinforce the view that war-related risks function as upstream stressors within the global economic system.

The relationship between global economic turbulence and school nutrition program resilience reveals patterns that both corroborate and extend earlier research. Previous studies document that economic shocks constrain public-sector nutrition (Murendo et al., 2020; Takeshima, 2024) and social protection programs through fiscal tightening (Ohrnberger, 2022) and procurement volatility (Xiuzhen et al., 2022). The negative coefficient observed in this study is consistent with these findings, indicating that school-based nutrition programs are particularly sensitive to macroeconomic instability. Unlike short-term program evaluations, the present study situates this relationship within a structural system, highlighting its persistence across multiple years.

In contrast, the positive association between global economic turbulence and food system resilience differentiates this study from a substantial portion of the existing literature, which often emphasizes vulnerability rather than adaptation. Recent food systems research increasingly recognizes adaptive responses such as domestic production shifts, trade reorientation, and policy buffering during global crises (Gereffi et al., 2021; Hosseinkhani, 2025). The positive structural coefficient observed here aligns with this newer strand of literature, suggesting that food systems exhibit endogenous adjustment mechanisms under sustained global economic pressure.

The inverse relationship between school nutrition program resilience and food system resilience highlights a structural tension that is less frequently documented in prior studies. While existing research often treats nutrition programs as integral components of food system strengthening, recent evaluations indicate that targeted interventions can generate resource competition when systemic capacity expansion does not occur concurrently (Leeuwis et al., 2021; Neufeld et al., 2024). The negative association identified in this study supports this perspective, underscoring the importance of policy coordination between programmatic nutrition initiatives and broader food system investments.

The role of food system resilience as a direct determinant of social nutrition outcomes is strongly supported by the empirical results. This finding is consistent with recent cross-country analyses showing that resilient food systems reduce exposure to food insecurity and improve dietary outcomes during periods of economic or climatic stress (Ben Hassen et al., 2025; Noort et al., 2022; Savary et al., 2020). By linking food system resilience to student energy intake and food insecurity, the present study extends this literature to the context of child and adolescent nutrition, an area that remains underrepresented in macro-structural analyses.

The integrated structural pathways identified in this study offer a more comprehensive account of how global shocks affect nutrition outcomes compared to linear or single-equation approaches commonly used in prior research. While earlier studies often examine isolated relationships, such as conflict–food

insecurity or inflation–nutrition links, the Bayesian SEM framework applied here demonstrates how these effects propagate sequentially through economic and institutional systems. This system-level perspective aligns with recent calls for integrated modeling approaches in food security research (Namany et al., 2020; Shoaib et al., 2021).

Beyond its empirical contributions, this study has direct implications for the political economy of food as articulated in classical and contemporary scholarship. The findings resonate with Polanyi's conception of food as a fictitious commodity, embedded within social and political institutions rather than governed solely by market forces. The structural transmission from global war risk to nutrition outcomes illustrates how disruptions in the global economic order reassert the embedded nature of food systems under conditions of crisis. At the same time, the results align with Sen's entitlement approach by demonstrating that nutrition outcomes are shaped less by aggregate food availability than by systemic conditions affecting access, provisioning, and institutional mediation. The role of food system resilience identified in this study also echoes Chang's emphasis on state capacity and structural transformation, highlighting how adaptive responses within food systems are contingent on institutional arrangements rather than market adjustment alone. Taken together, these findings reinforce a political economy perspective that conceptualizes food and nutrition as outcomes of historically and institutionally mediated processes shaped by power relations, conflict, and economic governance.

Conclusion

This study provides empirical evidence on the transmission of global war risk to social nutrition outcomes through interconnected economic and food system pathways using a Bayesian Structural Equation Modeling framework. The results demonstrate that global war risk is linked to global economic turbulence, which in turn shapes the resilience of school nutrition programs and the broader food system. Food system resilience emerges as a central downstream mechanism connecting macro-level shocks to student-level nutrition outcomes. By integrating geopolitical risk, macroeconomic instability, and food–nutrition systems within a unified structural model, the study advances current understanding of how global disturbances propagate across sectors and ultimately affect social nutrition conditions.

Several limitations warrant consideration. The analysis relies on a relatively short time series, which constrains temporal variability and limits the precision of posterior estimates. The structural relationships are estimated using aggregate indicators, preventing the identification of heterogeneity across regions, income groups, or population subgroups. Future research should extend this framework by employing longer time horizons, higher-frequency observations, or subnational panel data to capture spatial and distributional variation in food system resilience and nutrition outcomes. Further studies should also integrate additional mediating mechanisms, including fiscal policy responses, food subsidy schemes, and social protection coverage, to better reflect institutional channels of adjustment. The application of fully integrated Bayesian Structural Equation Models or dynamic extensions would further enable the explicit modeling of feedback effects and temporal dependencies within the war–economy–food–nutrition nexus.

Declarations

Funding statement

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Conflict Interest

The author declares that there is no conflict of interest regarding the publication of this study.

Author Contribution

Ahmad Tantowi conceived, designed the study, instrumen data and methodWawan Sadtyo Nugroho conducted the experiments and collected the dataMuhammad Ali Gunawan conducted the experiments and collected the data.Nehru Millat Ahmad performed data analysis and interpretation.Camila Fatah Suroyya method and validation of results. Misbahun Nidhom supervised the research process and critically revised the manuscript.Rosikhan Anwar supervised the research process and critically revised the manuscript.

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Figures

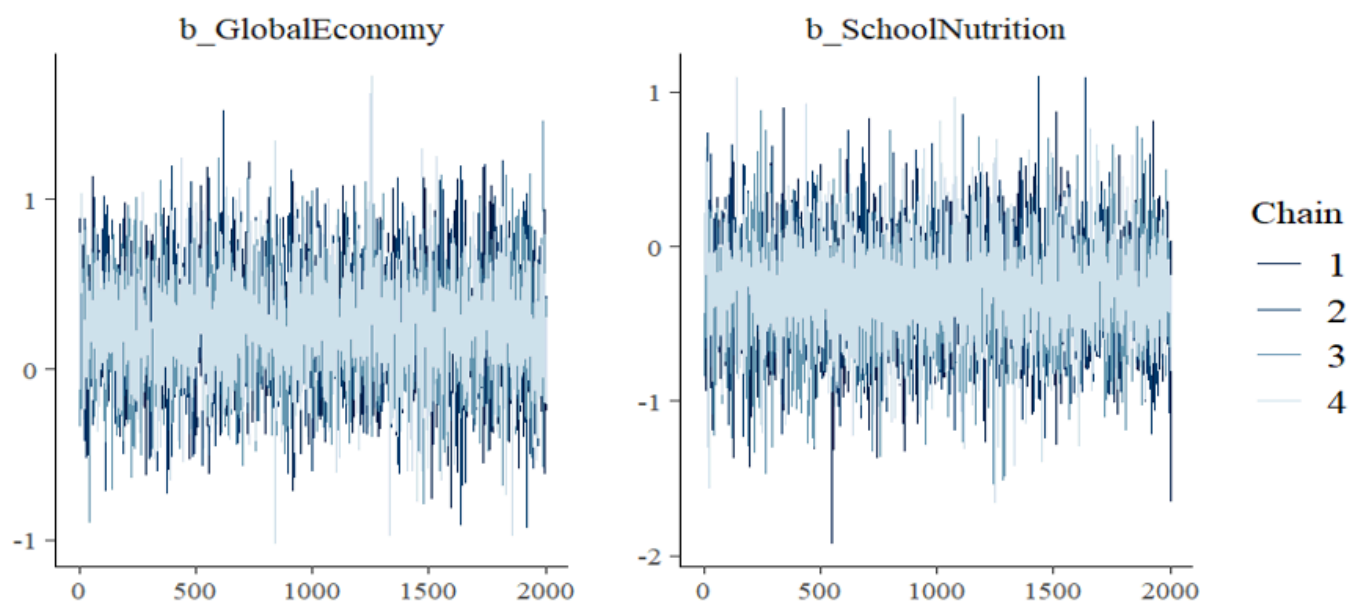


Figure 1

Trace Plots of Posterior Samples for Structural Parameters

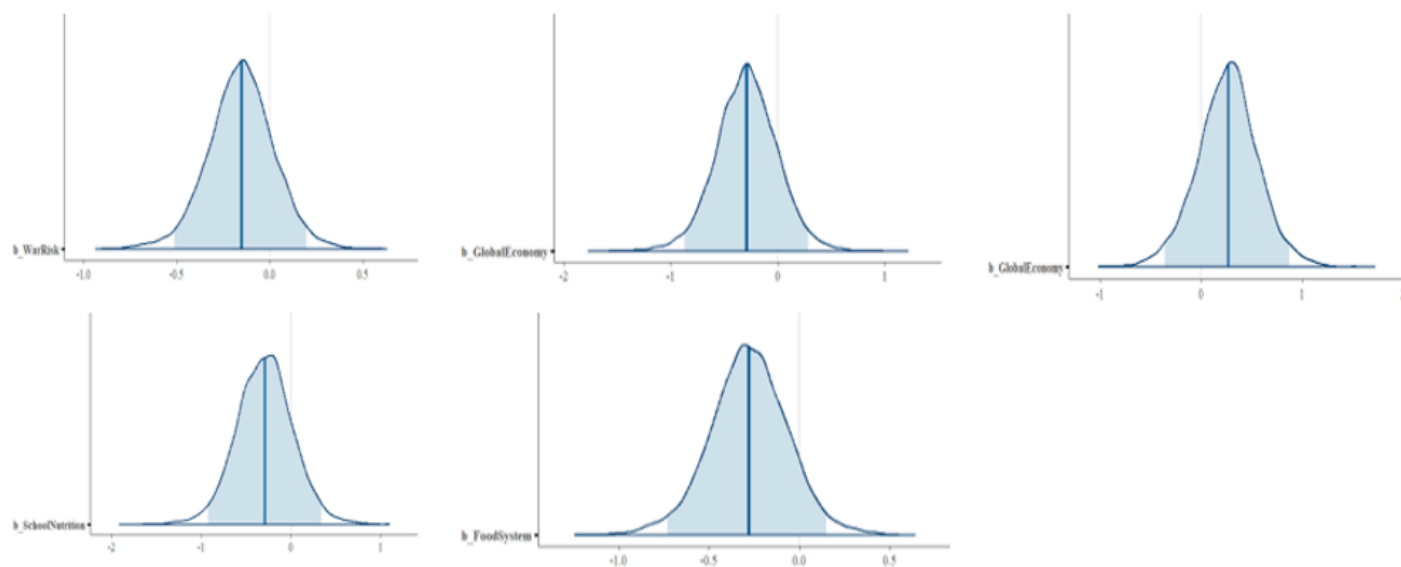


Figure 2

Posterior Distributions of Structural Path Coefficients in the Bayesian SEM

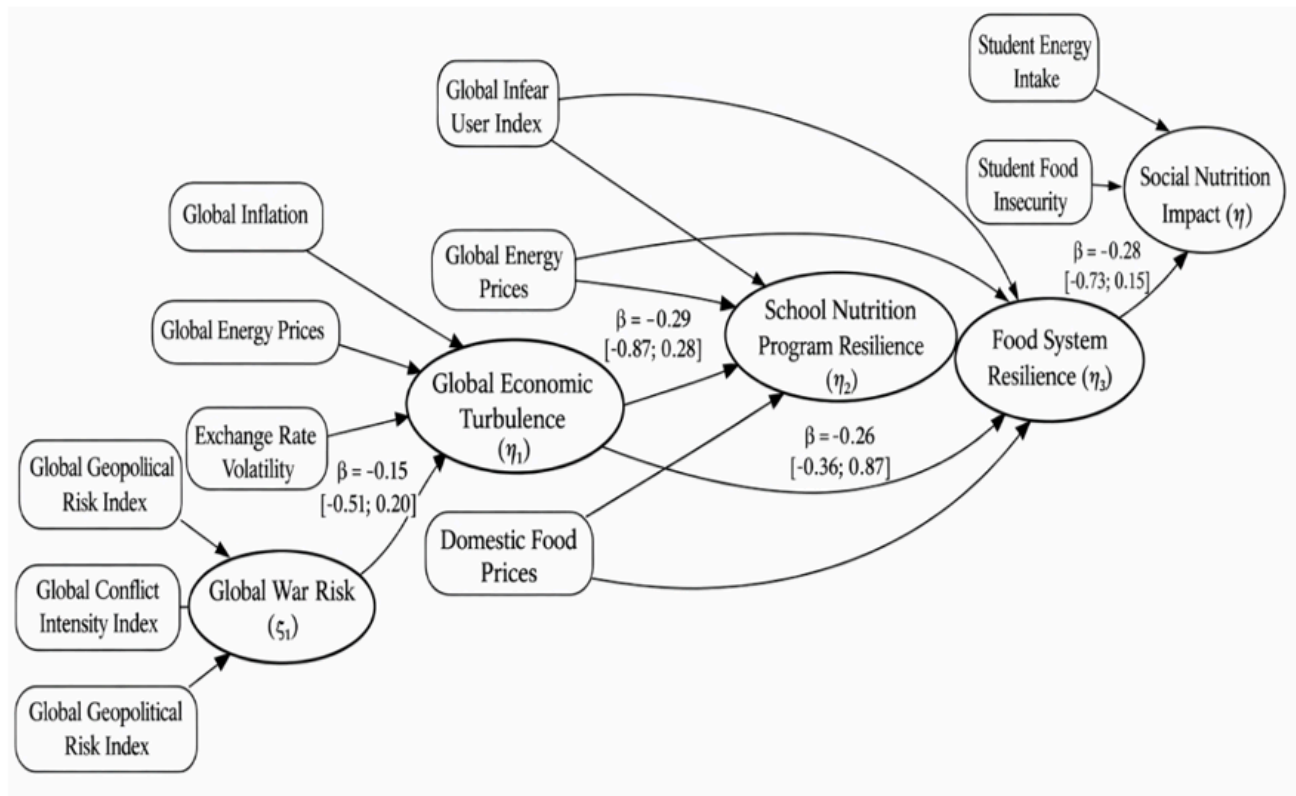


Figure 3

Structural Relationships and Posterior Estimates in the Bayesian Political Economy Model of Food System Resilience