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Economy-Wide Impacts of International Trade and Climate Shocks: Insights for Malawi

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— Gregory N. Sixt,
FACT Alliance Director

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Economy-Wide Impacts of International Trade and Climate Shocks: Insights for Malawi

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Abstract

This study investigates the systemic impacts of international trade and climate shocks on food security and macroeconomic stability in Malawi. Utilizing a static Computable General Equilibrium (CGE) model calibrated to a 2022 Social Accounting Matrix, the research simulates two primary stressors: a 15% fluctuation in world export prices for food crops and a 15% reduction in total factor productivity (TFP) across crops and livestock. Results indicate that Malawi's economy is significantly more vulnerable to climatic disruptions than to trade price volatility. A 15% TFP reduction serves as a catastrophic shock, causing GDP to contract by 3.08% and domestic food prices to spike. most notably for rice (34.88%) and tobacco (26.30%). These climate-induced supply shortages trigger a regressive welfare impact, where skyrocketing prices erode the real consumption of both urban consumers and the rural poor. In contrast, international trade shocks primarily influence the real exchange rate and terms of trade, with marginal effects on aggregate GDP. While higher export prices can bolster rural land incomes, they do not offset the systemic losses caused by productivity failures. The study concludes that internal climatic shocks pose an existential threat to household food security, driving radical inflation and worsening trade deficits as imports surge to cover production gaps. Policy recommendations prioritize investments in climate-resilient irrigation, strengthening strategic grain reserves to buffer against price spikes and expanding social safety nets indexed to food inflation to protect the most vulnerable households.

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1. INTRODUCTION

The intersection of international trade volatility and climate change presents a formidable challenge to the economic stability and food security of developing nations like Malawi. Domestically, food security remains precarious; acute food insecurity has fluctuated sharply, rising from an estimated 1.69 million people in early 2020 to 6.2 million facing a crisis during the 2024/25 lean season (Banda et al. 2025). Beyond these acute spikes, chronic food insecurity persists (Malawi Government 2025), with approximately 5.4 million people experiencing moderate to severe long-term food instability. Nutritional indicators further highlight deep-seated structural challenges: stunting affects 37% of children under five, and the prevalence of undernourishment consistently hovers around 20% of the population (National Statistics Office 2025). While interventions like input subsidies have periodically bolstered maize production, their impact has been frequently undermined (Pangapanga-Phiri et al. 2022) by repeated droughts, catastrophic cyclones, including Idai, Ana, and Freddy, and rampant food inflation. Consequently, the national discourse has shifted from a narrow focus on food availability toward a more holistic emphasis on resilience and sustainable food systems transformation.

As a small, open economy heavily dependent on rain-fed agriculture, Malawi is particularly vulnerable to exogenous shocks, including fluctuating global commodity prices and the increasing frequency of extreme weather events (World Bank 2025). These disruptions do not merely affect crop yields. They propagate across the entire economy, altering relative prices, shifting household income distributions, and reshaping the country's macroeconomic trajectory. Understanding these complex interactions requires an analytical approach that looks beyond individual markets to capture the systemic interdependencies of the Malawian economy.

At the heart of this economic vulnerability is the structural composition of Malawi's production and consumption patterns. Agriculture remains the primary driver of the nation's Gross Domestic Product (GDP) and the chief source of livelihoods for the majority of the population. Consequently, any shock, whether it be a shift in international export demand or a climate-induced reduction in total-factor productivity, triggers a cascade of effects across industrial and service sectors. To evaluate these multifaceted impacts, it is essential to employ a framework that maps the feedback loops among production, trade, and household welfare, providing a comprehensive view of how external stressors translate into real-world outcomes for food security.

This study employs an economy-wide Computable General Equilibrium (CGE) model (Löfgren, Robinson, and Harris 2002) to analyze the impacts of international trade and climate shocks on food security in Malawi. This multisector macroeconomic framework captures the complex feedback effects across production, consumption, and trade, allowing for an evaluation of distributional and welfare implications. While recursive dynamic models exist, a static CGE model was selected as it is most appropriate for analyzing one-off external shocks where intertemporal adjustments are not the primary focus. This model provides the necessary flexibility to examine short- and long-term effects by applying specific factor market closure rules and fundamental behavioral relationships governing state and household transactions.

2. METHODS: COMPUTABLE GENERALIZED EQUILIBRIUM MODELING

A CGE model to simulate the economy-wide implications of trade and climate shocks in Malawi was developed based on the 2022 Malawi Social Accounting Matrix (SAM) (International Food Policy Research Institute (IFPRI) 2022). The model provides a detailed snapshot of the country's multi-sectoral linkages,

particularly within its eighteen agricultural sub-sectors. By applying specific factor market closures and elasticity-based substitution functions, this framework enables a rigorous assessment of how fluctuations in world food prices and agricultural productivity shocks ripple through the economy. The following discussion outlines the model's calibration, the specific exogenous shocks applied, and the behavioral assumptions governing the simulation of Malawi's economic response.

The simulation is guided by key assumptions that production and trade flows are governed by Constant Elasticity of Substitution (CES) and Constant Elasticity of Product Transformation (CET) functions, respectively (Heinesen 2016).

Data for the model are calibrated using a 42-sector SAM with 2022 as the base year, featuring 18 agricultural sectors to reflect the sector's economic primacy, with various institutions, as shown in Figure 1. The model utilizes specific macroeconomic closures: a savings-driven investment account, a flexible exchange rate for the current account to maintain fixed foreign savings, and the producer price index as the numeraire. Regarding factor markets, land and skilled/semi-skilled labor are assumed to be fully employed, and mobile capital remains activity-specific, and unskilled labor is modeled as unemployed and mobile to accurately reflect the structural realities of the Malawian labor market.

Entry	Name
111	ERRSAMBAL
107	ERRSAMFLOW
398	MACROSAM
72	NEWSAM
67	SAM
68	SAMBALCHK
609	SAMBUD
677	SAMBUDGAP
674	SAMBUDP
110	SAMGAPCUTOFF
101	SAMSHR

Search ...

ACMAC [1] | ACMACP [2] | Value

	ACT2	COM2	FAC2	HOU2	GOV2	ROW2	S-I2	INSTAX2	IMPTAX2	COMTAX2	TOTAL2
ACT2		19541...		1970....							21511....
COM2	10423...	1846....		8494....	1171.8...	1076....	1506.75				24520....
FAC2	11088...										11088....
HOU2			10567...	4013....	779.233	378.847					15740....
GOV2						437.779		750.237	131.38	572.822	1892.2...
ROW2		2428....	520.627								2949.2...
S-I2				509.968	-58.869	1055....					1506.75
INSTAX2				750.237							750.237
IMPTAX2		131.38									131.38
COMTAX2		572.822									572.822
TOTAL2	21511...	24520...	11088...	15740...	1892.2...	2949....	1506.75	750.237	131.38	572.822	

Figure 1. An Extract of 2022 Malawi SAM in Generalized Algebraic Modeling System

3. RESULTS AND DISCUSSION

3.1 Macroeconomic Impacts of International and Climate Shocks

To analyze the impacts of international trade impacts, two scenarios were simulated: 1) an exogenous shock of a 15% increase and 2) a 15% reduction in world export prices for food crops. The scenarios are an appropriate representation of Malawi's status as a small open economy that takes global prices as given. An additional scenario was simulated to represent a local climatic shock. The Climate scenarios were modeled as a 15% reduction in total-factor productivity across all crops and cattle. These shocks allow for a rigorous examination of subsequent shifts in food prices, household welfare, and broader macroeconomic indicators.

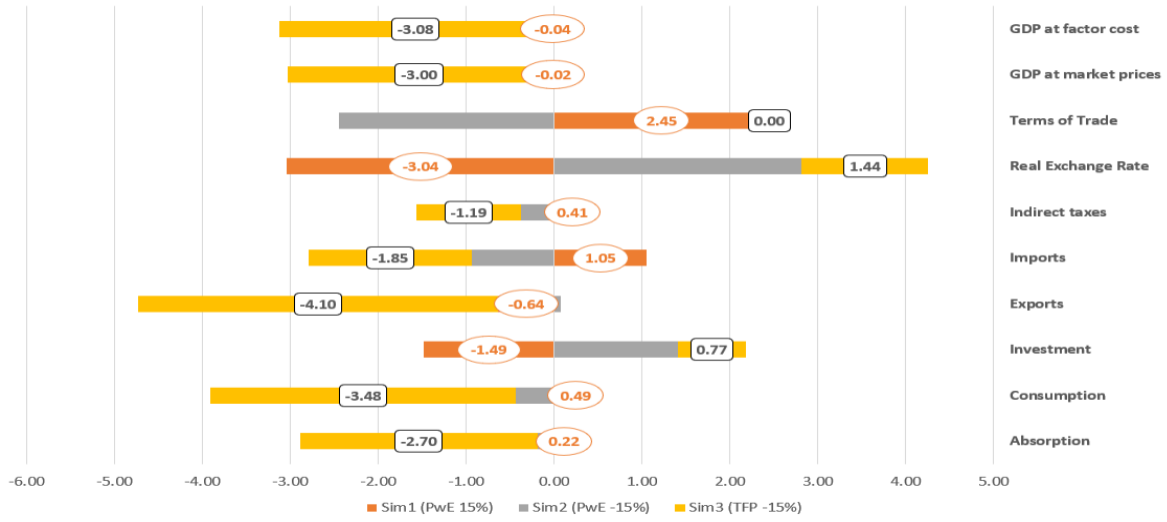

Figure 2. Macroeconomic impacts of international trade and climate shocks

Simulations on the contractionary impact of climate shocks and international trade volatility on Malawi's macroeconomic stability are presented in Figure 2, highlighting a particularly high sensitivity to productivity losses. The results indicate that a 15% reduction in total factor productivity (Sim 3) is the most detrimental shock, leading to substantial declines in both GDP at factor cost (-3.08%) and consumption (-3.48%), likely driven by the dominance of agriculture in the national economy. In contrast, trade shocks, represented by 15% fluctuations in world export prices (Sim 1 and Sim 2), show comparatively marginal impacts on aggregate GDP, though they trigger notable shifts in the trade balance and the real exchange rate. Specifically, an increase in export prices (Sim 1) induces a significant real exchange rate appreciation (-3.04%), which suppresses exports (-0.64%) and investment (-1.49%), whereas a decline in export prices (Sim 2) leads to a great improvement in the terms of trade (2.45%) and a rise in imports. Collectively, these findings suggest that while trade price fluctuations alter the composition of absorption and competitiveness, internal climatic disruptions pose a more existential threat to Malawi's overall economic output and domestic consumption levels.

3.2 Sectoral Impacts of International Trade and Climate Shocks

The study further assessed the effects of international trade and climate shocks on sectoral economic growth in Malawi, as shown in Figure 3. The simulations reveal a stark disparity in how different sectors of the Malawian economy respond to productivity- and price-related shocks, with the agricultural sector bearing the brunt of climatic disruptions. The 15% reduction in total factor productivity triggers a devastating collapse in sectoral output, most notably in all food crops (-15.00%), agriculture (-9.36%), and export crops (-7.48%), illustrating the extreme vulnerability of Malawi's primary production base to adverse climate events. While the industrial and manufacturing sectors show relative resilience to climate shocks, they exhibit mixed sensitivity to international trade volatility; for instance, an increase in world export prices marginally boosts export crops but negatively impacts metals and wood products. Conversely, a reduction in export prices provides a surprising benefit to certain manufacturing sub-sectors, such as metals (1.06%), machinery and equipment (1.06%), and wood products (1.21%), likely due to reduced input costs or shifting resource allocations. Ultimately, the data

underscores that while trade price fluctuations create sectoral winners and losers, climate-induced productivity shocks result in systemic losses that disproportionately cripple the nation's food and agricultural foundation.

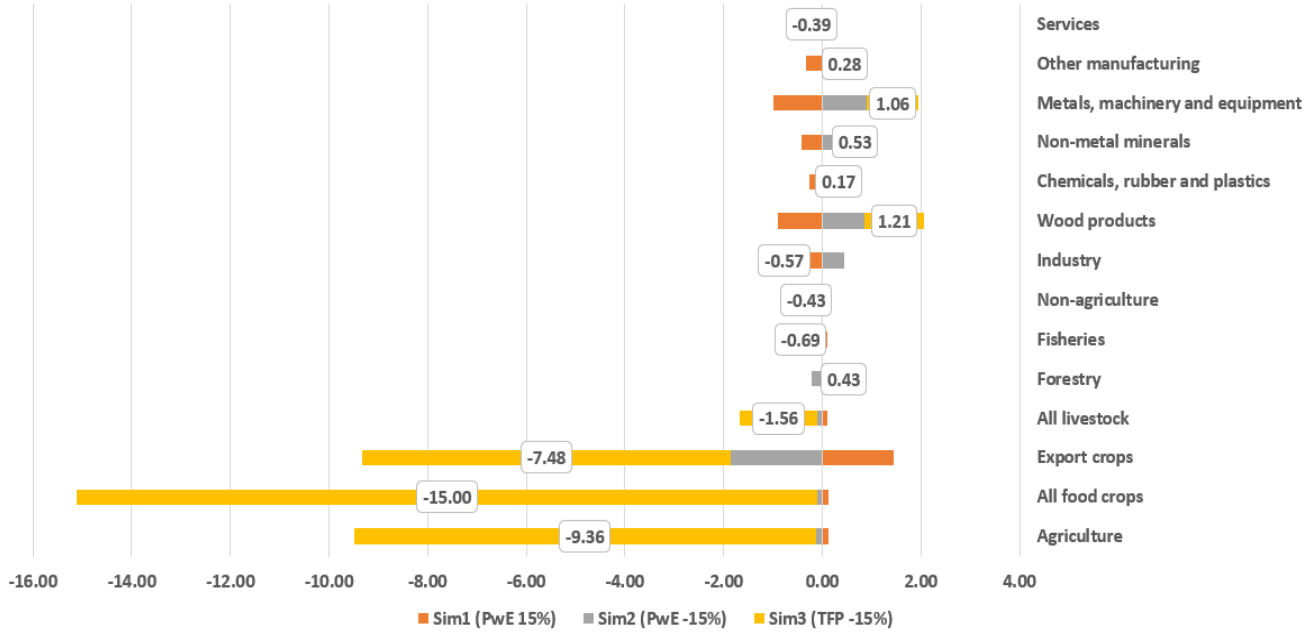

Figure 3. Impact of international trade and climate shocks on sector gross domestic products

3.3 Impacts of International Trade and Climate Shocks on Terms of Trade

Climate and trade shocks fundamentally reshape Malawi's trade balance, revealing a precarious reliance on agricultural exports (Aragea, Pauw, and Pernechele 2018) to finance domestic consumption (Figure 4). For instance, the climatic shock triggers a collapse in real export values across the board, with pulses (-41.47%), oilseed crops (-35.79%), and all food crops (-33.69%) suffering the most drastic declines due to diminished domestic supply. This contraction in exports is coupled with a necessary surge in real import values, particularly for tobacco and export crops (both at 17.50%), as the economy attempts to bridge the gap left by production failures, severely worsening the trade deficit. Regarding trade-specific shocks, an increase in world export prices generally boosts export values for key commodities such as coffee and oilseeds, while a decrease in prices facilitates a rise in livestock and poultry exports. Notably, the data suggest that while favorable price shifts can provide temporary relief to the export sector, the sheer magnitude of climate-induced productivity losses far outweighs the potential gains from trade, forcing a heavy reliance on imports and highlighting the fragile state of Malawi’s terms of trade under environmental stress.

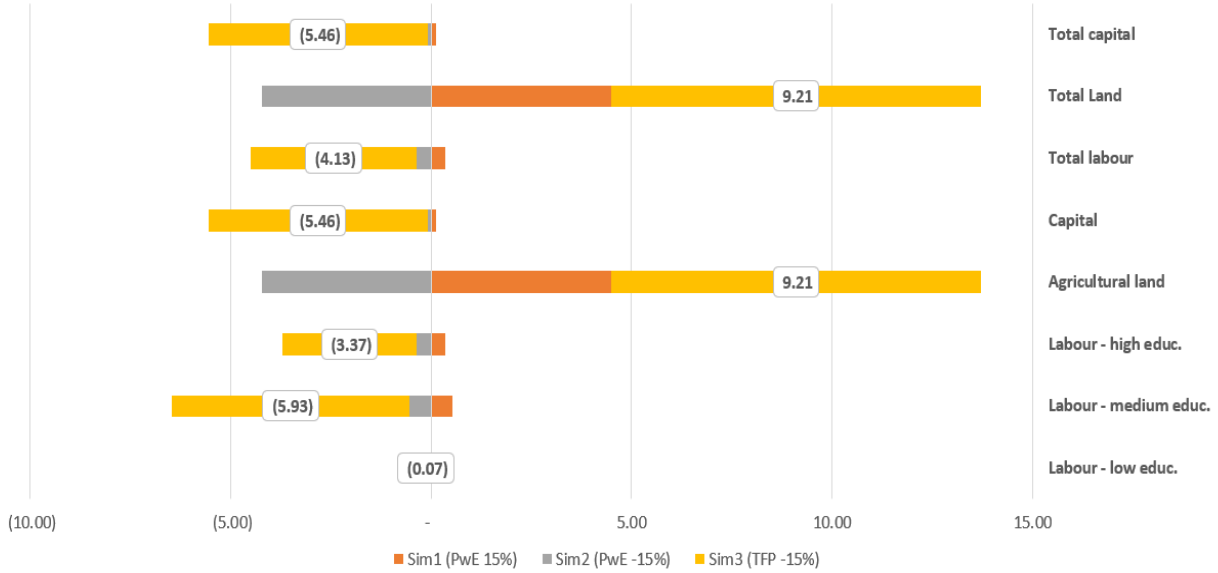

Figure 4. Impact of international trade and climate shocks on terms of trade of international trade

3.4 Impacts of International Trade and Climate Shocks on Food Prices

Regarding food prices, Figure 5 highlights their volatility in Malawi, showing that climate-induced productivity losses exert far greater upward pressure on domestic costs than international trade fluctuations. The climatic shock triggers a significant inflationary spike across almost all domestic food categories, with rice (34.88%), tobacco (26.30%), and export crops (23.24%) experiencing the most acute price increases as local supply dwindles. This domestic price surge is a direct consequence of the 15% reduction in total-factor productivity, which creates a scarcity that transcends the influence of global markets. While trade shocks, such as a 15% increase in world export prices, do contribute to moderate increases in domestic and import prices (averaging around 2.6% to 2.8%), their impact is relatively contained compared to the internal supply shock. Conversely, a reduction in world export prices leads to a contraction in export prices for Malawian goods, particularly affecting maize (-3.75%) and vegetables (-9.71%) on the global stage. Ultimately, the data underscores a critical threat to food security: while international trade volatility influences the margins, climatic disruptions drive radical domestic price inflation that directly compromises the affordability of staple foods for the Malawian population.

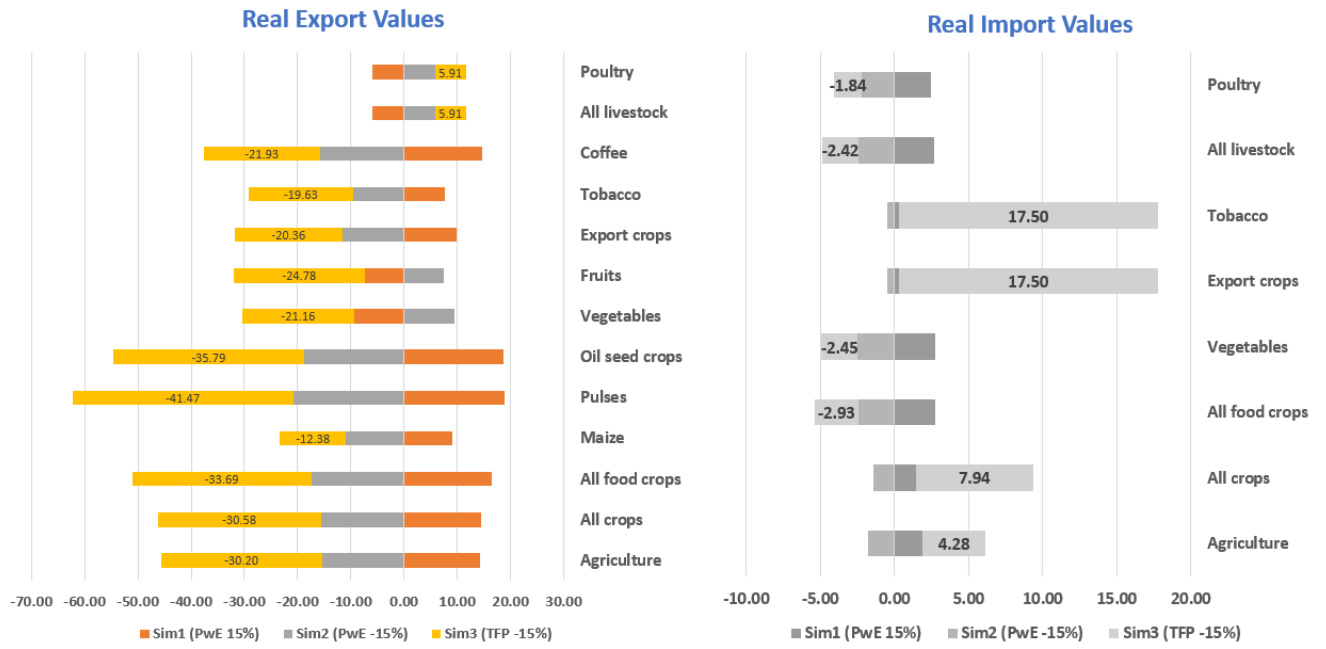

Figure 5. Impact of international trade and climate shocks on terms of trade of international trade

3.5 Impacts of International Trade and Climate Shocks on Factor Income

The study further examined the impact of international trade and climate shocks on factor incomes in Malawi (Figure 6), highlighting how these shocks disrupt wealth redistribution across households based on their primary production assets. The climatic shock exerts a dualistic pressure on the economy: while it severely diminishes the returns to total capital (-5.46%) and labor, particularly for those with medium education (-5.93%), it paradoxically drives a massive spike in the value of agricultural land (9.21%). This surge in land income likely reflects a scarcity-induced rise in domestic food prices that outpaces the decline in physical productivity, disproportionately benefiting land-owning households at the expense of wage earners. In contrast, the trade shocks show that fluctuations in world export prices have a more pronounced effect on land rents than on labor or capital; specifically, an increase in export prices bolsters land income, whereas a price reduction significantly erodes it. Across all simulations, low-educated labor appears most insulated from these specific shocks (-0.07%), suggesting that economic volatility primarily filters through more formal capital markets and higher-skilled segments of the workforce, while the most vulnerable households are affected more by the resulting shifts in land-based wealth and food affordability.

Figure 6. Impact of international trade and climate shocks on factor income

3.6 Impacts of International Trade and Climate Shocks on Household Income and Consumption

The study observes a regressive nature of climate and trade shocks on Malawian welfare, revealing that urban and wealthier households often face deeper nominal income losses, while rural and poorer households suffer most acutely in real consumption terms. Based on Figure 7, data show that under the climatic shock, urban households and those in higher wealth quintiles experience the largest declines in nominal income, yet the consumption data reveal a more nuanced vulnerability: urban quintile 4 (-4.00%) and urban quintile 5 show significant consumption drops, likely driven by the spike in food prices analyzed in previous sections. In contrast, rural quintile 1 (the poorest) shows the greatest resilience in nominal income but still experiences a contraction in consumption, suggesting that, while their income sources might be less integrated with formal markets, the rising cost of staples erodes their purchasing power. Trade shocks further highlight this divide; an increase in export prices generally bolsters incomes for rural households, who are more likely to be producers, leading to modest consumption gains, particularly for rural quintile 1. Conversely, a reduction in export prices negatively impacts consumption across almost all categories. Overall, the data suggest that while climate shocks are universally damaging, the specific transmission mechanisms, income versus price, vary significantly across the rural-urban and socioeconomic divide, with climate-induced productivity losses posing the most severe threat to national household welfare.

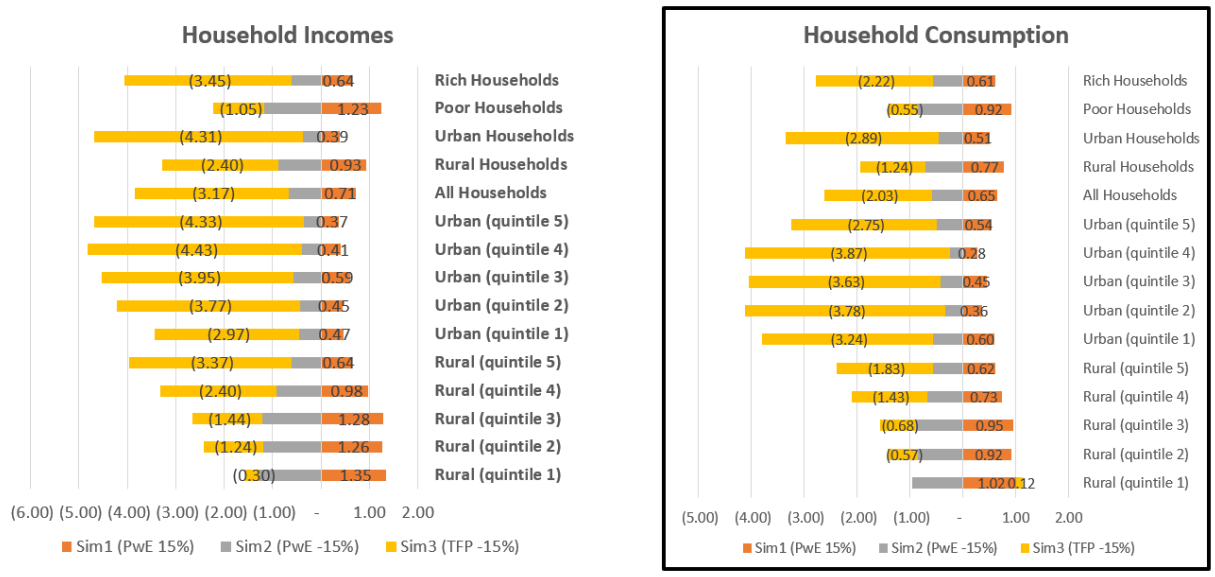

Figure 7. Impact of international trade and climate shocks on household income and consumption

4. CONCLUSION AND POLICY OPTIONS

The study concludes that Malawi's economic stability and food security are profoundly more sensitive to climate-induced productivity losses than to international trade price volatility. While fluctuations in global export prices trigger significant real exchange rate adjustments and redistribute income, primarily benefiting rural producers when prices rise, the 15% reduction in total factor productivity across the agricultural sector leads to a systemic contraction of GDP, severe domestic food price inflation (particularly for staples like rice, maize, pulses, and all food crops), and a sharp decline in urban household income and consumption, thereby negatively affecting household food security. The regressive nature of these shocks is evident in the resulting scarcity-driven price hikes, which erode the welfare of both urban consumers and the rural poor, underscoring that without robust adaptation strategies, climatic disruptions will continue to outweigh any potential gains from favorable trade terms.

The study, therefore, presents the following five key policy options.

- **Invest in Climate-Resilient Infrastructure**: Prioritize expanding solar-powered irrigation systems and high-yield, drought-resistant seed varieties to decouple agricultural productivity from increasingly erratic rainfall patterns.
- **Strengthen Strategic Grain Reserves**: Enhance the capacity and management of national food reserves to buffer against the drastic domestic price spikes (exceeding 20-30%) observed during productivity shocks, ensuring staple affordability for vulnerable quintiles.
- **Diversify Export Portfolios**: Reduce over-reliance on a narrow range of agricultural export crops by diversifying and incentivizing value-addition.
- **Enhance Social Safety Nets for the Urban Poor**: Implement targeted cash transfer programs specifically indexed to food inflation to protect urban households and the landless poor, who bear the brunt of rising domestic food prices despite not benefiting from increased land rents.

- **Promote Trade Facilitation and Price Stabilization**: Develop mechanisms to mitigate the impacts of real exchange rate appreciation during high-price cycles, ensuring that windfall gains from international trade are reinvested into agricultural technology rather than being lost to currency volatility.

Acknowledgments

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5. REFERENCES

Aragea, E., Pauw, K., and Pernechele, V., 2018: Achieving food security and industrial development in Malawi: Are export restrictions the solution? *World Development* 108 (2018) 1–15.

Banda, L. O. L., Banda, C. V., Banda, J. T., & Chidimbah Munthali, G. N., 2025: Food insecurity in Malawi: Regional disparities, sociocultural determinants, and the role of mobile advisory services. *Food and Humanity*, 5, 100695. https://doi.org/10.1016/j.foohum.2025.100695.

Heinesen, E., 2016: CES Transaction Functions in Macroeconomic Rationing Models. *Recherches Économiques de Louvain/ Louvain Economic Review* 60(3), pp. 301-331. https://doi.org/10.1017/S0770451800008022

International Food Policy Research Institute (IFPRI), 2022: Social Accounting Matrix for Malawi. https://doi.org/10.7910/DVN/RX3FYD

Löfgren, H., Robinson, S., and Harris, R. L., 2002: A Standard Computable General Equilibrium (CGE) Model in GAMS. *Microcomputers in Policy Research*. http://doi.org/338.1’01'51—dc21

Malawi Government, 2025: Acute Food Insecurity Situation for May - September 2025 and Projection for October 2025 - March 2026. *IPC - Integrated Food Security Phase Classification*. https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1159768/

Pangapanga-Phiri, I., Mungatana, E. D., Pangapanga, L., & Nkoka, F. S., 2022: Understanding the impact of sustainable land-scape management practices on farm productivity under intensifying tropical cyclones: Evidence from Southern Malawi. *Tropical Cyclone Research and Review*, 11(4), 265-276. https://doi.org/10.1016/j.tcrr.2023.02.002

World Bank, 2025: Malawi Economic Monitor: Getting Reforms Right. https://www.worldbank.org/en/country/malawi/publication/malawi-economic-monitor-getting-reforms-right