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EL NIÑO AND THE ETHIOPIAN ECONOMY: UNDERSTANDING ECONOMIC IMPACTS AND THE CASE FOR EARLY ACTION

Evidence from a Two-Sector Dynamic Stochastic General Equilibrium Model

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KEY MESSAGES

- **A severe El Niño can create a major household crisis even when the Gross Domestic Product (GDP) impact appears modest.** A Super El Niño reduces agricultural output by 6.7% and lowers GDP by 1.6% at its peak, but increases food poverty by 8.1 percentage points, equivalent to millions of additional people falling below the food poverty line.
- **The effects spread beyond agriculture through food prices, incomes, and economic linkages.** While non-agricultural sectors cushion part of the initial agricultural shock, households dependent on farming experience much larger losses than aggregate GDP figures suggest.
- **Acting early saves resources.** Activating support before harvest failure and scaling interventions in phases can reduce the fiscal cost of response from 5.5% of GDP under a full immediate package to approximately 2.4% of GDP while achieving most of the poverty reduction benefits.
- **Different policies protect different outcomes.** Safety-net expansion is the most effective tool for protecting vulnerable households, reducing the poverty impact by 38% at a cost of 1.5% of GDP. Agricultural investment provides the strongest support for economic recovery, reducing GDP losses by 15% at a cost of 1.2% of GDP. Monetary easing can accelerate recovery without direct fiscal expenditure.
- **Preparedness financing is essential.** Severe climate shocks cannot be managed through emergency response alone. Pre-arranged financing mechanisms allow governments to act before households experience irreversible losses.

INTRODUCTION

Ethiopia is among the world's economies most vulnerable to climate risk. Agriculture accounts for 37% of GDP, employs over 70% of the workforce, and depends largely on rainfall. When rains fail, agriculture is affected first, but the shock quickly spreads through food prices, household incomes, employment, and public finances.

The El Niño Southern Oscillation (ENSO) is the main driver of year-to-year climate variability during Ethiopia's primary agricultural season, Kiremt (June–September). When the Oceanic Niño Index (ONI) exceeds $+0.5^{\circ}$C, El Niño conditions can suppress rainfall in parts of the country and increase drought risk (Korecha and Barnston, 2007; NOAA/CPC, 2024). The 2015–16 Super El Niño, which peaked at an ONI of $+2.8^{\circ}$C, left an estimated 18.1 million Ethiopians food-insecure and required more than US$1.4 billion in humanitarian assistance (OCHA, 2016). The 2023–24 El Niño episode again highlighted Ethiopia's persistent exposure to recurring

climate shocks and the fiscal pressures they generate (World Bank, 2024).

The challenge is not that El Niño events are unpredictable. Advances in climate science make it possible to forecast El Niño conditions months ahead, often six to nine months before peak impacts occur (Barnston et al., 2012). Yet policy responses remain largely reactive. Emergency appeals are typically launched only after harvest losses occur, food prices rise, and households have depleted their coping strategies. By then, humanitarian impacts and fiscal costs are far higher. Ethiopia still lacks a forward-looking assessment of how a future El Niño shock would affect the economy: the potential loss of growth, likely food-price responses, deterioration in household welfare, and the scale of fiscal response required.

This brief addresses that gap by developing a macroeconomic framework, calibrated to Ethiopian data, that estimates the economy-wide effects of El Niño shocks. The model separates agriculture from the rest of the economy and traces how an initial rainfall shock affects agricultural output, prices, household incomes, consumption, and government finances (see Box 1). It uses Ethiopian Statistics Service (ESS) surveys and national accounts; National Bank of Ethiopia monetary and price statistics; Ministry of Finance and IMF fiscal records; FAO and World Bank sectoral and poverty databases; and NOAA and National Meteorology Agency climate series to construct and calibrate climate-shock scenarios. Building on Christiano et al. (2005), Zerihun et al. (2022), and Marto et al. (2018), the analysis estimates how El Niño shocks of different intensities affect the economy over time and identifies which policy responses provide the strongest protection relative to cost. The objective is to help shift policy from reacting after climate disasters occur to anticipating and managing their economic consequences before they unfold.

METHOD AND DATA

To examine how an El Niño shock propagates through Ethiopia's economy, we develop a dynamic macroeconomic model that captures interactions between agriculture and the wider economy. The model separates agriculture where rainfall failures first affect production from non-agricultural sectors such as manufacturing and services, which are affected indirectly through higher food prices, lower rural incomes, and disruptions to agricultural input supply. It also captures feedback through household demand, fiscal responses, and monetary policy, allowing us to assess how climate shocks affect food prices, poverty, and food insecurity over time (see 1 for transmission channels from climate shock to the rest of the economy).

The model is calibrated using national accounts and interest-rate data from the National Bank of Ethiopia and the World Bank, consumer price data from the Central Statistical Agency, the Oceanic Niño Index from NOAA's Climate Prediction Center, and CHIRPS satellite rainfall estimates.[1] The analysis covers 2015–2024, including the severe 2015–16 El Niño and the milder 2023–24 episode.

Box 1 summarises the model structure

Box 1: About the Model (Technical Summary)

The estimates in this brief come from a **two-sector New Keynesian dynamic stochastic general equilibrium (DSGE) model** with an embedded climate–agriculture block, estimated on Ethiopian data for 2015Q2–2024Q4. Its main elements are:

Sectors. Agriculture (share $\omega = 0.37$ of GDP) and non-agriculture (services and manufacturing combined), linked by a constant-elasticity-of-substitution (CES) aggregator with elasticity $\sigma = 0.5$.

Households consume food and non-food goods with habit formation ($h = 0.65$), supply labour across sectors, and save in nominal bonds.

Firms are monopolistically competitive and face Calvo price and wage rigidity ($\theta = 0.75$, an average price duration of about four quarters).

Policy. Monetary policy follows a Taylor-type interest-rate rule; fiscal policy responds counter-cyclically to the output gap and to agricultural shortfalls, including a PSNP-style safety-net transfer that scales with poverty deviations.

[1] CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) provides quasi-global rainfall estimates at 5 km resolution from 1981 onward, combined with in-situ station data.

Climate transmission. The ONI follows an AR(1) process. Precipitation responds contemporaneously ($\gamma_{\text{PREC}} = 0.28$), and an accumulated drought index carries persistent moisture deficits ($\rho_{\text{DRT}} = 0.40$). Together, these shift agricultural total factor productivity. A small positive direct loading ($\gamma_{\text{ENSO}} = +0.124$) captures a temperature-to-yield effect that partly offsets but does not reverse the dominant rainfall-suppression channel. Non-agricultural productivity is exposed to 10% of the agricultural climate sensitivity, capturing agro-processing and supply-chain linkages.

Parameter	Value	Meaning
ω	0.37	Agricultural share of GDP
σ	0.50	Elasticity of substitution, agri. vs non-agri.
h	0.65	Consumption habit
θ	0.75	Calvo price/wage stickiness (≈4-qtr duration)
γ_{PREC}	0.28	Precipitation response to the ONI
ρ_{DRT}	0.40	Drought-index persistence
γ_{ENSO}	+0.124	Direct ONI loading on agri. TFP
Spillover	10%	Non-agri. exposure to agri. climate sensitivity

Estimation. The model is estimated by Bayesian methods (Metropolis Hastings) using seven quarterly series: output, consumption and investment growth; the nominal interest rate; agricultural productivity; the output gap; and welfare.

Figure 1. El Niño Transmission Mechanism: From Climate Shock to Policy Response.



RESULTS AND DISCUSSION

We simulate four ENSO scenarios based on NOAA's standard Oceanic Niño Index classification (NOAA/CPC, 2024): Weak (ONI $= 0.8$, within the 0.5–0.9 band), Moderate (ONI $= 1.2$, within the 1.0–1.4 band), Strong (ONI $= 1.8$, within the 1.5–1.9 band), and Super (ONI $= 2.5$) a level reached only by the 1997–98 and 2015–16 El Niño events.

Peak Impacts of El Niño

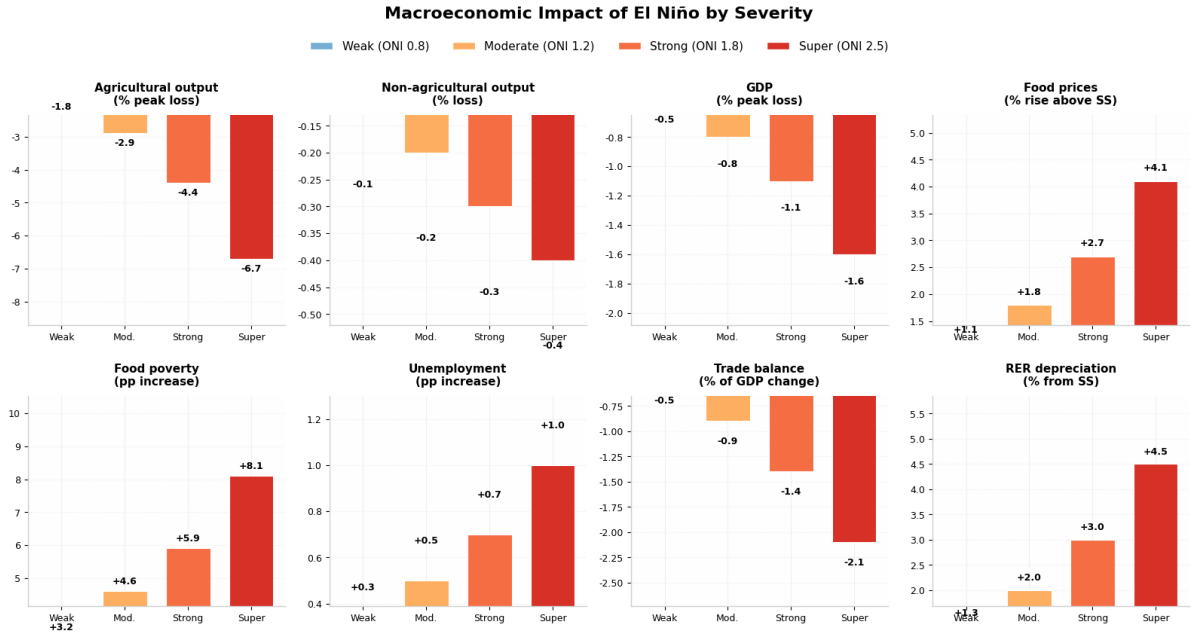
Figure 2 summarises the peak impacts across scenarios. The simulations show that a Super El Niño reduces agricultural output by nearly 7%, while aggregate GDP falls by about 1.6%. Non-agricultural output, including industry and services, declines by less than 0.5% because these sectors account for roughly two-thirds of GDP and partly cushion the aggregate effect. This gap highlights a limitation of national averages: severe rural production losses can appear as a modest slowdown in GDP even when the consequences for farming households are substantial. Relying on GDP alone therefore risks understating the crisis and delaying an adequate policy response.

The results also show a sharp divergence between macroeconomic losses and household welfare effects. In every scenario, food poverty rises much more than GDP falls. A Weak El Niño lowers GDP by about 0.5% but raises food poverty by more than three percentage points. A Super El Niño lowers GDP by 1.6% and increases food poverty by roughly eight percentage points, equivalent to about ten million additional people falling below the food poverty line. Across the scenarios, each one-percentage-point decline in GDP is associated with a five- to six-percentage-point increase in food poverty.

This disconnect reflects how El Niño affects households. Lower agricultural production reduces food availability and pushes up food prices, weakening the purchasing power of poorer households that spend a large share of income on food. Drought can also force rural households to sell productive assets, especially livestock, to meet immediate needs. These losses may not be fully captured in GDP, but they reduce household wealth and can slow recovery long after rainfall returns to normal.

Impacts rise steadily with El Niño intensity. Moving from Weak to Moderate, Strong, and Super scenarios produces progressively larger economic and welfare losses. This has direct implications for disaster reparedness. Because El Niño conditions can often be forecast six to nine months before their peak, and expected intensity can be monitored using the Oceanic Niño Index, governments and development partners have time to estimate likely losses and target interventions before households face severe hardship.

Figure 2. Macroeconomic impact of El Niño



How Long Do the Effects Persist?

Figure 3 tracks key economic and social indicators over the ten years after a Super El Niño begins, shown as deviations from the path the economy would have followed without the shock. The simulations show a clear sequence of effects, with agricultural production, prices, aggregate output, and household welfare adjusting at different times.

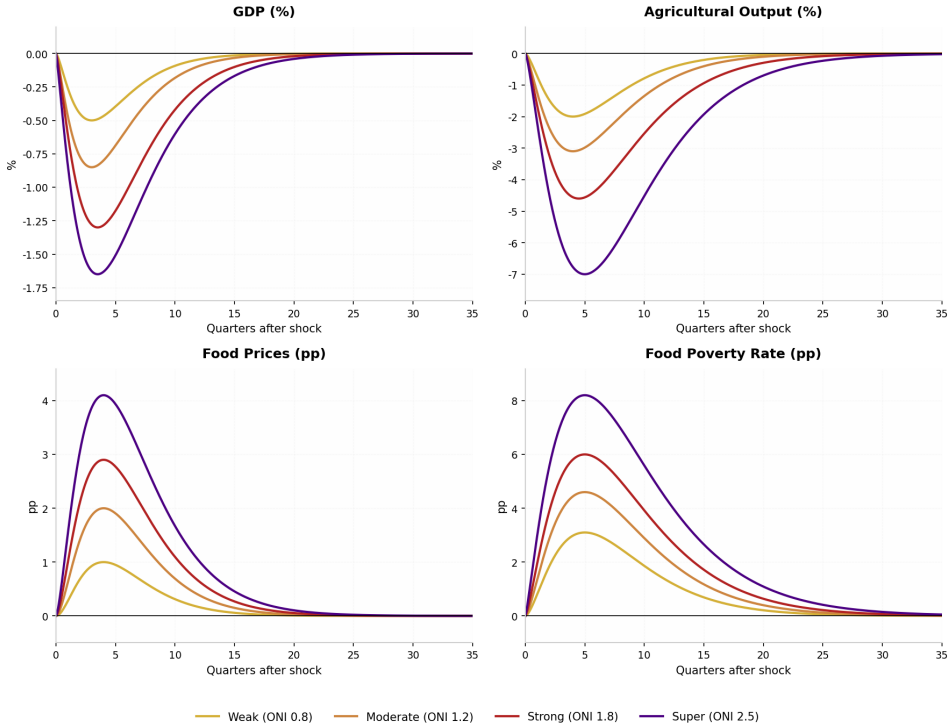
Food prices respond first, peaking around the fourth quarter at about 14% above baseline as weaker harvests restrict supply. Headline inflation peaks one quarter earlier, rising by 4.7 percentage points. Agricultural output reaches its lowest point in the fifth quarter, falling by 6.7%, while GDP bottoms out one quarter later at 1.6% below baseline. Household welfare follows a similar pattern to GDP, declining by about 7%. Poverty responds more slowly, peaking in the eighth quarter at 6.6 percentage points above baseline roughly four quarters after food prices and two quarters after GDP.

Recovery also varies across indicators. Food prices, inflation, and agricultural output return to their baseline paths within about four years as production recovers. GDP rebounds relatively quickly as well, returning to baseline by around the twenty-fifth quarter. Poverty, however, falls much more slowly. Even after ten years, it remains above the pre-shock path, indicating that many households continue to face welfare losses after headline economic indicators have normalised.

The slower decline in poverty reflects the difference between temporary market disruptions and more persistent losses in household assets and productive capacity. Food prices rise sharply during the drought but fall as production recovers. Many rural households, however, lose productive assets especially livestock through distress sales or drought-related losses as they try to maintain consumption. Rebuilding these assets takes time, leaving households with lower productive capacity and greater vulnerability even after prices and output return to normal.

These findings have important implications for the timing and design of policy responses. Common triggers for starting or ending emergency support such as inflation, food prices, agricultural output, and GDP — return to baseline within three to four years. Household welfare recovers more slowly. If support ends as soon as macroeconomic indicators normalise, assistance may be withdrawn while many households remain below their pre-shock welfare path. Recovery programmes should therefore extend beyond the emergency phase and gradually shift from consumption support to rebuilding productive assets, restoring livelihoods, and strengthening resilience.

Figure 3. Dynamic Macroeconomic Impacts of El Niño.



POLICY OPTIONS AND THEIR IMPLICATIONS

We evaluate a menu of policy responses: safety-net expansion through targeted transfers to poor households, agricultural investment through productivity-enhancing public spending, and monetary accommodation through a temporary reduction in interest rates. We also assess a combined policy package that deploys all three instruments simultaneously.[2] Each policy scenario is evaluated against a baseline Strong El Niño scenario without policy intervention. Figure 4 presents the resulting GDP and poverty trajectories under these alternative responses.

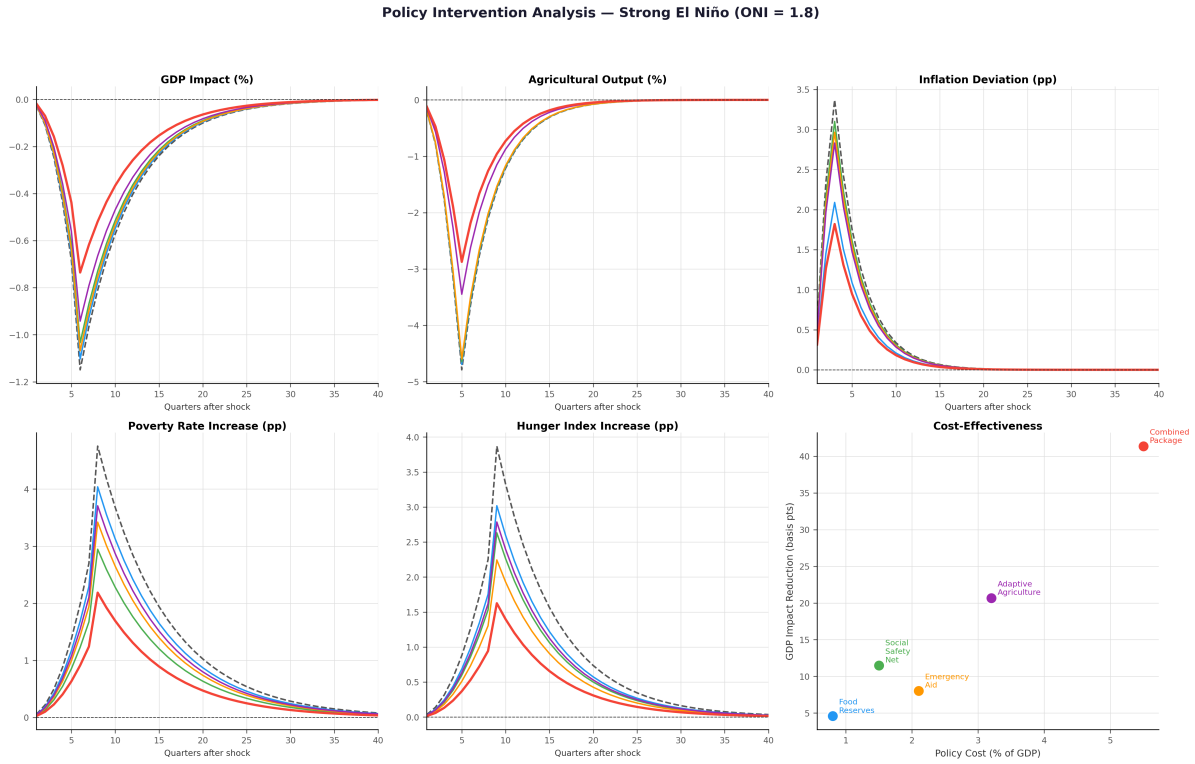
Safety-net expansion is the most effective tool for protecting vulnerable households, reducing the poverty impact by 38% at a cost of 1.5% of GDP.

Agricultural investment provides the strongest support for economic recovery, reducing GDP losses by 15% at a cost of 1.2% of GDP.

Monetary accommodation — moderate interest-rate easing — can bring GDP recovery forward by one to two quarters without direct fiscal expenditure. Lower real interest rates support investment and durable consumption as agricultural incomes recover.

Sequencing matters. A full simultaneous package would cost 5.5% of GDP, equivalent to roughly 70–90% of Ethiopia's annual tax revenue given a tax-to-GDP ratio of 6–8%.[3] This makes it unaffordable from domestic resources alone. A sequenced approach — starting with safety nets and food reserves, then scaling agricultural investment as the season develops — achieves 93% of the poverty reduction at 44% of the fiscal cost, or 2.4% of GDP. This domestically fundable tranche provides a realistic fiscal envelope for government planning.

Figure 4. Policy Experiments: GDP and Poverty Trajectories under Alternative Responses



[2] The simulations assume that the interventions do not generate short-run crowding-out effects, allowing us to isolate their potential impacts on economic recovery and household welfare.

[3] Based on Ministry of Finance and IMF Article IV data for 2022–24. Ethiopia's tax-to-GDP ratio has remained among the lowest in Sub-Saharan Africa.

POLICY RECOMMENDATIONS

1. **Activate early.** Early action is more cost-effective than crisis response. Activating safety nets and food reserves at the early-warning stage two to three months before harvest failure — lowers total fiscal costs by about 1.5% of GDP compared with a reactive response, because food prices remain lower and poverty has not yet risen sharply.
2. **Sequence the response.** A full simultaneous package would cost 5.5% of GDP, equivalent to roughly 70–90% of Ethiopia's annual tax revenue, given a tax-to-GDP ratio of 6–8% (MoF/IMF data). This makes it unaffordable from domestic resources alone. A sequenced approach starting with safety nets and food reserves, then scaling agricultural investment as the season develops achieves 93% of the poverty reduction at 44% of the fiscal cost, or 2.4% of GDP. This domestically fundable tranche provides a realistic fiscal envelope for government planning.
3. **Deploy monetary accommodation as a complement.** Moderate interest-rate easing during an El Niño episode can bring GDP recovery forward by one to two quarters without direct fiscal spending. Lower real interest rates support investment and durable consumption as agricultural incomes recover.
4. **Treat humanitarian aid as a contingent liability.** The humanitarian component, estimated at 1.9% of GDP, cannot be covered by domestic fiscal space alone, especially given Ethiopia's constrained access to external budget support. It should be treated as a contingent liability in fiscal planning and activated through emergency financing instruments only if a shock reaches Super El Niño scale, rather than treated as a pre-committed resource.
5. **Extend recovery support beyond macroeconomic normalisation.** Household welfare recovers far more slowly than headline indicators. Recovery programmes should extend beyond the emergency phase and gradually shift from consumption support to rebuilding productive assets, restoring livelihoods, and strengthening resilience — and should not be withdrawn when GDP or food prices return to baseline.

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