

THESIS BOOKLET

Climate Shocks, Food Security, and Human Capital Formation in Ethiopia

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I. Research Background and Justification for the Selection of the Topic

Human capital formation in developing economies is an intertemporal investment process that can be persistently disrupted by economic, environmental, and nutritional shocks. Since the foundational contributions of Schultz (1961) and Becker (1964), investments in education, health, and nutrition have been understood as forms of investment that generate returns over extended periods. Because these returns materialize over time, human capital investments are particularly vulnerable to interruptions that affect households' ability to sustain educational, nutritional, and productive activities.

Ethiopia provides a particularly relevant setting in which to examine these processes. The country's long-term development strategy has sought to transform a predominantly rain-fed agrarian economy into a more productive, resilient, middle-income economy (FDRE, 2011). At the same time, a large proportion of Ethiopian households remain dependent on climate-sensitive agricultural activities, while recurrent rainfall variability, drought, and food insecurity continue to affect household welfare. This creates a tension between long-term human capital and structural-transformation objectives on one hand, and short-term household-level shocks on the other.

Ethiopia has nevertheless experienced substantial improvements in several human development indicators over the past two decades. Primary school enrolment has moved toward universality (Woldehanna & Araya, 2016), and national child stunting prevalence declined from 58% in 2000 to 37% by 2019 (EPHI & ICF, 2021). These aggregate improvements, however, coexist with substantial inequalities across households and regions, and climate and nutritional shocks may continue to affect children's developmental trajectories even where households maintain stable long-term educational objectives.

This tension between aggregate progress and household-level vulnerability constitutes the central empirical motivation of the dissertation. It examines three related questions: whether short-term shocks alter the psychological foundations of human capital formation; whether climate vulnerability is associated with children's nutritional outcomes; and whether institutional support can protect household productive capacity against climate-related shocks.

The justification for the topic rests on three considerations.

- **Theoretical justification.** Each chapter engages a distinct theoretical debate, unified by the human-capital paradigm of Schultz (1961) and Becker (1964). Chapter 1 contrasts two

competing explanations. The scarcity hypothesis, grounded in behavioral economics, posits that poverty and food insecurity constrain the cognitive bandwidth available for long-term decision-making and thereby directly reduce aspirations (Banerjee & Duflo, 2011; Mani et al., 2013; Mullainathan & Shafir, 2013). By contrast, the structural-selection hypothesis posits that relatively stable factors, such as cognitive ability and temperament, parental preferences, valuation of education, and broader community influences (Appadurai, 2004; Dercon & Singh, 2013) jointly shape household food insecurity and educational aspirations. Under this hypothesis, any cross-sectional association between food insecurity and aspirations should attenuate once these factors are held constant. The two hypotheses therefore generate opposing predictions for within-child fixed-effects estimates, yet they had not previously been tested against each other using longitudinal Ethiopian data.

Chapter 2 draws on the IPCC's (2014) climate-vulnerability framework, which conceptualizes vulnerability as the joint product of exposure, sensitivity, and adaptive capacity. Despite its conceptual appeal, this framework has rarely been operationalized with all three dimensions measured simultaneously at the household level.

Chapter 3 contrasts two pathways through which agricultural extension may affect household outcomes. Under the productivity pathway, extension is expected to increase average output through technology adoption (Anderson & Feder, 2004). Under the climate-insurance pathway, by contrast, extension may reduce downside risk during shocks even in the absence of average productivity gains, particularly where high-input systems have risk-increasing properties (Alam et al., 2024; Just & Pope, 1979).

Sen's (1985, 1999) distinction between capabilities and aspirations provides the conceptual basis for the dissertation's concluding synthesis. It helps interpret the cross-chapter pattern in which households may maintain stable aspirations while lacking the capabilities needed to realize them.

- **Empirical justification.** Ethiopia offers a rich set of longitudinal and repeated cross-sectional datasets, including the Young Lives Study, the Ethiopia Demographic and Health Surveys, and the Ethiopia Socioeconomic Survey. These datasets enable analysis beyond simple cross-sectional comparisons. Their complementary structures allow the dissertation to account for observed heterogeneity and, where the research design permits, time-

invariant unobserved heterogeneity, thereby strengthening the empirical identification of relationships between shocks, household vulnerability, and human capital outcomes.

- **Policy justification.** Ethiopia's commitments to child nutrition through the Seqota Declaration and National Nutrition Program II (FDRE Ministry of Health, 2015, 2024), agricultural development, and climate resilience require evidence on the conditions under which households and children are most vulnerable to shocks. They also require evidence on whether interventions function primarily as general development instruments or as mechanisms that specifically protect households during periods of heightened risk.

The dissertation examines human capital formation through three complementary mechanisms: the psychological foundation of educational aspirations in Chapter 1, the biological foundation of child nutrition in Chapter 2, and the productive foundation of household agricultural income in Chapter 3. Chapter 1 uses child fixed-effects models to distinguish persistent differences across children and households from changes within the same child over time. Chapter 2 combines Demographic and Health Survey data with spatially linked climate indicators and employs multilevel models to examine the relationship between climate vulnerability and child nutrition. Chapter 3 combines household fixed-effects models with propensity score matching to examine the relationships among agricultural extension, agricultural production, and drought exposure.

The dissertation's central argument is that short-term shocks do not affect all dimensions of human capital formation in the same way. Educational aspirations appear relatively stable in the face of temporary food insecurity, whereas the nutritional conditions required to translate aspirations into future capabilities remain substantially more exposed to climate-related stress. Institutional support, particularly agricultural extension, is associated with some protection against drought-related losses. The dissertation therefore distinguishes between psychological resilience and material resilience, while maintaining appropriate caution about the strength of the evidence for institutional buffering.

II. The methods used

Chapter 1: Household Food Insecurity and Adolescents' Educational Aspirations

Data are drawn from the Younger Cohort of the Young Lives Ethiopia study, using Rounds 1–5 (2002–2016). The analytic sample comprises 1,873 adolescents observed at ages 12 and 15 in Rounds 4 and 5, respectively, yielding 3,644 child-round observations. Educational aspirations are examined in relation to household food insecurity, measured using the Household Food Insecurity Access Scale (HFIAS), a validated tool developed by USAID's Food and Nutrition Technical Assistance (FANTA) III project (Coates et al., 2007).

Three estimation strategies are compared: cross-sectional OLS, value-added models (VAM) incorporating lagged aspirations, and child fixed-effects models that exploit within-child variation over time and remove the influence of time-invariant child and household characteristics. The fixed-effects specification serves as the central identification strategy.

Chapter 2: Climate Vulnerability and Child Stunting

The study pools data on 23,542 children from the 2011, 2016, and 2019 Ethiopia Demographic and Health Surveys (EDHS), linked to CHIRPS v3.0 precipitation estimates, ERA5-Land temperature reanalysis, and Harmonized World Soil Database soil characteristics. Following the IPCC (2014) vulnerability framework, a composite Climate Vulnerability Index (CVI) is constructed from three dimensions: exposure, measured using rainfall and temperature anomalies; sensitivity, measured using water and sanitation access, rural residence, female headship, and birth spacing; and adaptive capacity, measured using maternal education and household wealth. The index adapts the multiplicative formulation of Mahapatra et al. (2021). Multilevel logistic regression models with random effects for region and soil class are estimated, adjusting for child, maternal, household, and survey-year characteristics. Climate exposure is aggregated at the region-year level to reduce concerns arising from the displacement of DHS cluster coordinates.

Chapter 3: Agricultural Extension as Climate Insurance

The chapter uses a balanced panel of 3,222 rural households from Panel I of the Ethiopia Socioeconomic Survey (ESS/LSMS-ISA), observed in 2011/12, 2013/14, and 2015/16, yielding 9,666 household-wave observations. Extension participation is measured using two survey indicators: formal enrollment and receipt of advisory services. Household fixed-effects models

estimate the association between lagged extension participation and log-transformed harvest, fertilizer adoption, irrigation adoption, and production risk. An interaction between extension participation and drought exposure tests whether these associations differ under adverse climatic conditions. Propensity score matching and a probit selection model are used as complementary approaches to assess whether the findings may reflect selection on observables or drought-targeted programme placement.

III. Scientific results of the dissertation

Chapter 1: Household Food Insecurity and Adolescents' Educational Aspirations

- Cross-sectional estimates from Pooled OLS, VAM, and PSM consistently indicate a statistically significant negative association between household food insecurity and adolescents' educational aspirations (*Pooled OLS*: $\beta = -0.0593$, $SE = 0.0172$, $p = 0.002$).
- After controlling for time-invariant child and household characteristics using child fixed effects, the estimated association becomes statistically indistinguishable from zero ($\beta = -0.0245$, $SE = 0.0497$, 95% CI: $-0.122, 0.073$).
- The attenuation of the statistically significant association to a null estimate under the fixed-effects specification is consistent across wealth strata, suggesting that the observed cross-sectional relationship is primarily driven by persistent differences between children and households, rather than by within-child changes associated with short-term food insecurity.
- The findings provide evidence of *aspirational resilience*, indicating that Ethiopian adolescents' educational goals appear anchored in stable structural factors rather than adjusted in response to transitory food insecurity.

Chapter 2: Climate Vulnerability and Child Stunting

- A one-standard-deviation increase in the household Climate Vulnerability Index (CVI) is associated with 27% higher odds of stunting (aOR = 1.27, 95% CI 1.20–1.34, $p < 0.001$).
- Decomposing the CVI into its three components shows that the association is driven primarily by sensitivity (OR = 1.87, 95% CI: 1.55–2.24, $p < 0.001$) and adaptive capacity (OR = 0.53, 95% CI: 0.47–0.59, $p < 0.001$), with greater adaptive capacity associated with lower odds of the adverse nutritional outcome. Climate exposure alone is not independently significant (OR = 0.35, 95% CI: 0.06–2.15, $p = 0.259$). These results suggest that social

and economic vulnerability may be more closely associated with nutritional outcomes than climatic exposure per se.

- A CVI $\times$ survey-year interaction is statistically significant under model-based inference (OR = 1.02, 95% CI: 1.01–1.03), but the more conservative design-based confidence interval includes the null (95% CI: 1.00–1.03). The results therefore provide limited evidence that the association between climate vulnerability and nutritional outcomes strengthened over time, with this pattern concentrated in the adaptive-capacity component rather than in climate exposure.
- The positive CVI–stunting association holds across all four livelihood zones (Urban OR = 1.70; Highland OR = 1.30; Mixed OR = 1.29; Pastoral OR = 1.20).
- **Interpretation:** Nutritional outcomes appear to be shaped less by climate exposure alone than by households' social and economic capacity to cope with climatic stress, pointing policy toward investments in maternal education, and household resources.

Chapter 3: Agricultural Extension as Climate Insurance

- Household fixed-effects estimates show that extension participation is associated with 15.0% lower harvest on average ($\beta = -0.163$, SE = 0.058, $p = 0.005$). The negative association remains statistically significant after propensity score matching ($\beta = -0.191$, $p = 0.004$; approximately –17.4%). These findings are consistent with negative selection, whereby extension services are more likely to reach households facing greater vulnerability, rather than indicating that extension participation itself reduces harvest.
- Extension participation is also associated with lower harvest volatility across survey waves ($\beta = -0.059$, $p = 0.001$), independent of any single drought episode.
- A probit selection model shows baseline drought exposure does not significantly predict extension placement, ruling out simple drought-targeting as the sole explanation for the negative main effect.
- An extension $\times$ drought interaction is positive and significant ($\beta = 0.485$, SE = 0.144, $p < 0.001$; robust to PSM: $\beta = 0.584$, $p < 0.001$). Combined with the negative main effect, this implies a net 31.8% higher harvest for extension participants specifically during drought years, even though the unconditional (non-drought) association remains negative.

- The buffering interaction is not reproduced under a contemporaneous, rather than lagged, specification ($\beta = -0.030$, $p = 0.778$).
- No candidate mechanism is statistically confirmed as a buffering channel. Irrigation ($\beta = 0.047$, $p = 0.175$), fertilizer adoption ($\beta = -0.019$, $p = 0.557$), crop diversification ($\beta = -0.072$, $p = 0.725$), and livestock holdings ($\beta = -0.154$, $p = 0.557$) are all statistically non-significant.
- Similarly, no statistically significant heterogeneity is detected by household size, credit access, or education, indicating that the buffering association does not differ detectably across these subgroups.
- Thus, extension participation shows a real but partially unresolved association with reduced drought-related losses.

Cross-Chapter Synthesis

- The three chapters show that different dimensions of human capital formation respond differently to shocks. Educational aspirations appear psychologically resilient (Chapter 1), whereas nutritional status is acutely and unequally vulnerable, with variation driven mainly by household sensitivity and adaptive capacity rather than climate exposure itself (Chapter 2). Institutional support shows a real but only partially robust buffering association during drought, against a background of a significant negative average association (Chapter 3).
- Methodologically, the systematic divergence between cross-sectional and fixed-effects estimates (Chapter 1), and between average and drought-conditional estimates (Chapter 3), demonstrates the value of panel-based, within-unit identification for drawing credible conclusions about shocks and interventions in this setting. Cross-sectional evidence, which dominates much of the existing literature on Sub-Saharan Africa, risks materially mischaracterizing both the nature of vulnerability and the effectiveness of policy responses.
- The three studies therefore suggest that policies aimed at strengthening human capital in climate-vulnerable settings should combine long-term investments in education, nutrition, and productive capacity with mechanisms that protect households against environmental and economic shocks.

IV. Main References

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V. List of Own (or Co-authored) Publications on the Topic

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