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Resilience, Food Security Dynamics, and Poverty Traps in Northern Ethiopia

Analysis of a Biannual Panel Dataset, 2011–2013

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EXECUTIVE SUMMARY

Humanitarian assistance or safety net programs may be able to prevent mortality or reduce malnutrition in the face of shocks or crises, but households, their communities, and their institutions may still not fully recover from the effects of the shock. The ability of an individual, a household, a community, or an institution to "bounce back" in such a manner—to cope with adversity by adapting, learning, and innovating—has lately come to be termed "resilience." Particularly in the aftermath of major regional food security crises in the Greater Horn of Africa and the Sahel in 2011 and 2012, resilience has become an important operational concept in chronically vulnerable or food-insecure areas of the world, although its use in development far predates these crises.

This report summarizes the findings of the "Livelihood Change over Time" study conducted jointly by the Feinstein International Center at Tufts University in the US and the College of Dryland Agriculture and Natural Resources at Mekelle University in Ethiopia. Following two seasons of qualitative data collection, the LCOT study consisted of four rounds of a household survey over two years (two rounds in the "hunger" season and two rounds in the "postharvest" season) in four different locations in two *woredas* in Tigray, Northern Ethiopia.

The study tracked household food security status over time, as well as changes in livelihoods and in particular the dynamics of asset accumulation or loss. Over the course of the study, food security indicators improved steadily. We analyze the determinants of changes in food security status from round to round over time. While different indicators of food security tell a somewhat divergent story in terms of the estimates of prevalence, they tell a remarkably similar story in terms of change over time.

There was not a corresponding improvement in the level of assets at the household level. This suggests that asset accumulation in both livelihood zones studied may be complicated by the presence of poverty traps, and that most households may be below the critical threshold beyond which the poverty traps theory suggests that growth becomes self-sustaining. The poverty traps analysis confirms a low-level equilibrium in asset holdings over time. Households below this threshold tend to accumulate assets up to this level but then are unable to continue growing. Wealthier households show some tendency to regress back to this point. This trend is most evident in the period between the hunger season and the postharvest season—the precise period in which food security indicators show the most improvement.

These results tend to imply that the Productive Safety Net Programme (PSNP) is having the intended effect of protecting household food security, although it only shows up as a significant determinant of one of the measures of food security employed in the study. Protection of productive assets is the other major objective of the PSNP, and while an independent analysis of the determinants of asset levels was not conducted here, the levels of assets—even among the lower socio-economic strata—do not decline significantly, even during the hunger season.

Without a major effort to improve assets at the household level (programs such as the PSNP-Plus and other efforts), households seem to remain trapped at a fairly low level of accumulation. Our data suggest a "human capital first" strategy—households reported increased labor availability compared to non-working members over time across both *woredas* and across socio-economic strata. Programs aimed at minimizing the risk of shocks may also be important.

Contents

1.1 The Concept

Humanitarian assistance or safety net programs may be able to prevent mortality or reduce malnutrition in the face of shocks or crises, but households, their communities, and their institutions may still not fully recover from the effects of the shock. The ability of an individual, a household, a community, or an institution to "bounce back" in such a manner—to cope with adversity by adapting, learning, and innovating—has lately come to be termed "resilience." Particularly in the aftermath of major regional food security crises in the Greater Horn of Africa and the Sahel in 2011 and 2012, resilience has become an important operational concept in chronically vulnerable or food-insecure areas of the world, although its use in development far predates these crises.

Just as understanding livelihoods requires an in-depth analysis of institutional and policy factors, many analytical lenses are required for a complete understanding of resilience. First and foremost, the nature of hazards or threats to livelihood security must be understood. Much of the discussion about resilience in recent times has focused on adaptation to climate change (Mercer, 2010; Bahadur, 2011), but the hazards may be either "natural" or "man-made," and they can include both, especially in the context of protracted crises (FAO/WFP, 2010).

Second, the nature of livelihoods and the livelihood system must be understood, including the questions of how and why livelihoods change over time (Frankenberger et al., 2012). Resilience is not a static concept—it implies behaviors that take place over time. In addition, it is important to distinguish where shocks to livelihoods are exogenous or endogenous to the household. Exogenous shocks, such as drought or price increases, are not influenced by the household or individual's own characteristics. Endogenous shocks are influenced by the household or individual's own characteristics; for example, sickness is influenced by investments in health care or the household environment. This distinction is important when trying to address endogeneity concerns in estimation.

Third, governance, leadership, collective action, equity, inclusion, and social cohesion are all discussed as important factors contributing to resilience (Bahadur, 2011; Twigg, 2009). This implies an institutional analysis at both the micro- and macro-levels.

Fourth, there have long been programs and policy initiatives aimed at improving various components of resilience, and a constant challenge has been assessing the impact of these programs and policies on the ability of households to bounce back from shocks. We discuss such interventions further in the "Intervention" section.

1.2 Measurement

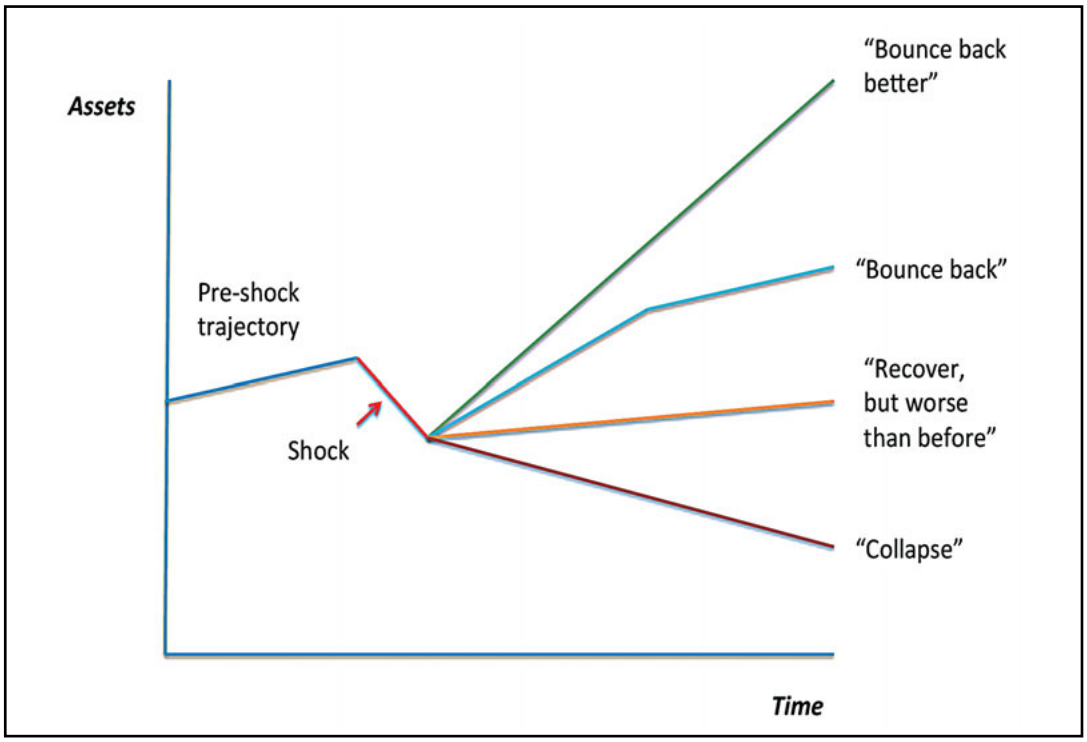
Academics and practitioners have yet to achieve a consensus on how to measure resilience. Only limited evidence exists on the determinants of households' ability to deal with setbacks—the central question of what makes households more or less resilient.

DFID (2011) breaks down the analysis of resilience into three categories: exposure to a hazard, sensitivity to its effects, and the adaptive capacity to deal with shocks. An analysis of resilience thus involves an analysis of hazards in a given context, an assessment of which groups are the most exposed, and an understanding of the nature of their vulnerabilities.

Frankenberger et al. (2012), following DFID, operationalize resilience by identifying four different potential pathways after a shock (or *between* shocks, since recurrent shocks are a characteristic of nearly all these situations). As shown in Figure 1, the potential pathways include an upward trajectory ("bounce back better"), a relatively flat trajectory ("bounce back"), a downward trajectory ("recover, but worse than before"), and a catastrophic decline ("collapse").

All of these imply a comparison not only with the *status quo ante*, but also with some kind of pre-existing trajectory that is interrupted by a

Figure 1. Resilience trajectories, based on Frankenberger et al. (2012)



shock. At its core, resilience is measured in the ability of households or communities to cope with setbacks and the way such setbacks change livelihood trajectories. Thus resilience is a dynamic measure: it is not just about measuring "outcomes," but about measuring changes in outcomes over time—and explaining those changes, particularly in light of specific programs or policies intended to enhance resilience.

Exactly which changes should be measured is also a complicated question. The conceptual framework offered by Frankenberger et al. (building on that of DFID), suggests a variety of household-level livelihood indicators and outcomes, as well as institutional factors and more conceptually complex measures such as exposure to hazards and the sensitivity of livelihoods to those hazards. Given the strong focus on food security in development policy, this study focuses specifically on changes—both seasonal and year-to-year—in food security outcomes. To capture the underlying changes in livelihoods, we also concentrate on household asset portfolios.

1.3 Intervention

Past programs that have focused specifically on resilience building as an objective have long fallen into something of a policy void between "development" and "humanitarian" funding streams. Livelihoods diversification, livelihoods improvement, and the reduction of risk are fundamentally developmental problems, not humanitarian problems *per se*. But humanitarian agencies have long been the main intervention vehicle working in chronically at-risk areas, and humanitarian budgets have often been the only actors flexible enough to work in such contexts. As a result, until recently there was both a funding and a conceptual "blind spot" regarding programmatic interventions that address resilience. Every time a major crisis occurs, policy attention turns to preventing the next one. In East Africa alone, there have been at least five major "crises" in the past twelve years—major drought crises in 1999–2000, 2002–03, 2005–06, and 2011–12, and the combination of drought and the global food price crisis in 2008. On the back of each of these crises, there has

been an effort at improving resilience or reducing the likelihood of the next crisis. But in many cases, this has yet to result in permanent funding or programmatic mechanisms that address this blind spot. Ethiopia offers an exception to this observation, in that the Productive Safety Net Programme (PSNP) has been in place for the past eight years. The Productive Safety Net Programme is a rural seasonal employment initiative aimed at creating productivity-enhancing community assets. It was developed in the aftermath of the 2002–03 food crisis (Devereux and Sabates-Wheeler, 2006). Improved pastoral early warning systems also arose from the 1999–2000 crisis (Save the Children-UK, 2005) and improved guidelines for livelihoods response to such shocks grew out of the 2005–06 drought (LEGS, 2009), as did the empirical validation of the Integrated Phase Classification system (IPC Partners, 2008). But it was really the PSNP that represented a major new initiative to address the question of resilience, both by guaranteeing a minimum level of food access to chronically food-insecure groups (to prevent malnutrition and prevent distress sales of assets during the hunger season), and by offering livelihood-enhancing interventions (to improve longer-term opportunities) (Devereux and Sabates-Wheeler, 2006).

Programmatically, resilience implies a link to both disaster risk reduction (DRR) and social protection (SP) interventions, although the two play slightly different roles. A recently launched "resilience strategy," jointly promoted by three UN agencies working in Somalia in the aftermath of the 2011–12 famine, has three pillars: (1) enhancing productivity (diversifying and intensifying productive activities at the household level); (2) improving access to social services (particularly health, education, and water, but also other services such as agricultural extension); and (3) providing predictable safety nets for social protection (conditional and unconditional transfers of food or cash to chronically or seasonally vulnerable households) (FAO/WFP/UNICEF, 2012). Other programs emphasizing resilience may focus on improved market access or enhancing value chain inclusiveness, improved natural resource management, improved drought management, and even improved conflict management (USAID, 2012). Some resilience strategies tend to emphasize the safety net element, while others emphasize risk reduction. Both have improved resilience as their objective, and both focus on enhancing livelihoods.

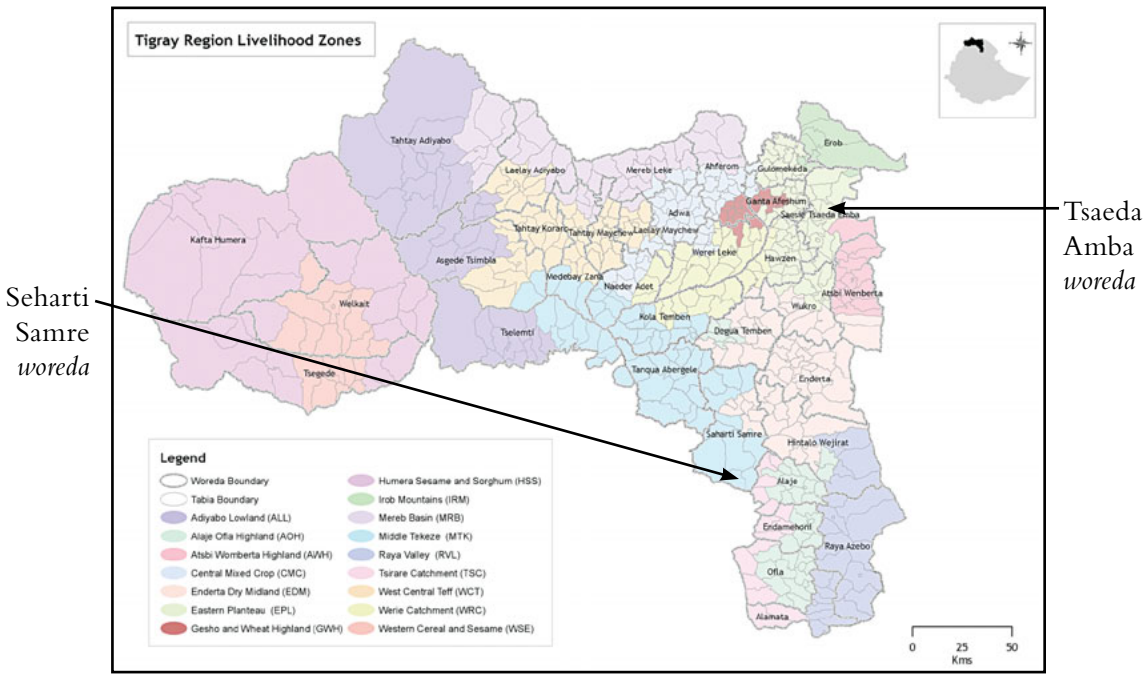
2.1 Livelihoods

Since 2009, a team from Tufts University has been studying "livelihoods change over time" (LCOT) in Northern Ethiopia, focusing specifically on Eastern and Southeastern Tigray. The research objective is to understand the determinants of food security in a relatively risk-prone context. Initially conducted in collaboration with World Vision, the research is funded by the Swedish International Development Agency (SIDA) and currently entails a partnership between the Feinstein International Center and researchers at the College of Dryland Agriculture and Natural Resources, Mekelle University, in Tigray. The earlier work with World Vision focused on disaster risk reduction programs and provided much of the qualitative background information for the current LCOT survey.

The LCOT survey collects panel data twice a year, in the postharvest period and during the peak of the hunger season, from a sample of 300 households in two locations in Eastern and Southeastern Tigray. All four rounds of data collection have been completed, the first in August 2011, the second in February 2012, the third in August 2012, and the fourth and final round in February 2013; the time frame studied thus spans about 18 months. Figure 2 depicts the two study areas included in the survey: Tsaeda Amba *woreda* (district) in Eastern Tigray and Seharti Samre *woreda* in Southeastern Tigray.

Ethiopia has long been one of the most food-insecure countries in the world, but only in the past decade has the food security problem begun to be understood in terms of livelihoods, rather than simply as a food supply problem (Lautze et al., 2003). The World Bank notes that Ethiopia has had an average annual growth rate of 5–7 percent per capita since the crisis of 2002–03, and it has managed to keep inflation relatively low, at least until hit by the global food price crisis of 2008. However, while overall poverty levels have declined, the number of the chronically food insecure has grown in some areas and remained the same in others (World Bank, 2007; Oxfam/USAID, 2009; Government

Figure 2. Map of Tigray Region, showing study sites



Source: DPPA, 2008

of the Federal Republic of Ethiopia, 2011). Rural populations in Northern Ethiopia have long been vulnerable to droughts and other localized natural hazards. Of the major East African crises in recent years, the 2002–03 crisis and the 2008–09 crisis hit Northern Ethiopia hardest—the others were more focused on the pastoral areas of the country.

Tsaeda Amba

Tsaeda Amba *woreda* is a chronically vulnerable district located between the Irob Mountains on the border with Eritrea, the escarpment dividing Tigray and Afar Regions, and other drought-prone highland areas of Eastern Tigray. It consists of three different livelihood zones, each with a different agro-ecology and topography but similar kinds of livelihoods. We concentrate in this study on the Eastern Plateau livelihood zone. It is one of the chronically food-insecure *woredas* identified by the Government of Ethiopia. In 2009, over 73,000 of the roughly 150,000 residents of the district were included in the Productive Safety Net Programme. In addition to the chronically vulnerable caseload, 25,000 people were identified as urgently requiring food assistance in 2008–09, meaning nearly two thirds of the people living in the *woreda* needed food assistance to survive without serious asset depletion at the outset of the study (DPPA, 2008).

Livelihoods rely on raising highland crops (wheat, barley, and some maize) and livestock (particularly small ruminants and poultry, although some households have cattle for milk and meat as well as animal traction, and bee-keeping is increasingly the only production option open to landless households). Labor migration is also an important part of livelihood strategies, as there are only limited possibilities for off-farm diversification of livelihoods within Tsaeda Amba.

Even well-off households are only able to produce about 60 percent of their food needs from farming and have to rely on food purchase for the remainder; poor households rely on the market for up to 60 percent of their food needs, with 20 percent coming from food aid (mostly through the Productive Safety Net Programme). While better-off households get much of the income they need from the sale of livestock products, poorer households must rely on labor-based strategies (DPPA, 2008).

Seharti Samre

Seharti Samre *woreda* is in the Middle Tekeze livelihood zone in Southern Tigray. In contrast to the relatively higher areas of Tsaeda Amba, Samre *woreda* includes middle elevation areas (50 percent), lowlands (47 percent), and highlands (3 percent). The elevation in the *woreda* mostly ranges between 1,500 and 2,300 meters above sea level. Seharti Samre is one of the 22 drought-prone and chronically food-insecure *woredas* in the Tigray Region. As such, it tends to have a dryland agro-ecology and is less densely populated than Tsaeda Amba. Expected rainfall is lower, in the range of 350–700 mm per year. Like Tsaeda Amba, rainfall is unimodal (the *Kiremti* rains, concentrated in June, July, and August).

The farming calendar is similar to Tsaeda Amba, and the crops grown are similar except that there is less barley and teff, which tend to be grown only at higher elevations. Other significant crops are sorghum, finger millet, and maize (corn). Livestock are important to the farming system, but lower-wealth groups are unlikely to hold cattle; all but the poorest wealth groups have small ruminants. The PSNP supplements income for the very poor, poor, and middle-income groups (DPPA, 2006). Out of over 150,000 hectares, the land use pattern shows about 27.6 percent cultivated, 38.2 percent wasteland, 43.5 percent forest and shrub land, and 5.3 percent grazing land. About 9 percent of the cultivable land is potentially irrigable (Government of National State of Tigray, 2009). The total population of the *woreda* in 2009 was about 126,985, and since 1995 the area has shown a very high rate of population increase—close to 7.5 percent (REST, 2009). Given the constraints to livelihoods, the population is highly dependent on program support (food for work and food aid), which nearly 50 percent of all households in the *woreda* are reported to receive, and many households depend on seasonal out-migration to nearby towns.

2.2 Main Hazards

The major livelihoods hazards in the study area can be broadly classified into "natural" and human-made hazards. Table 1 presents a community ranking of hazards from the preliminary fieldwork.

Climatic and weather-related hazards
Drought is by far the most common weather-related hazard in the study area. These areas are characterized as chronically drought prone. Other weather-related hazards include flooding and, in the higher elevation areas, hail and frost. Participatory assessment at the beginning of the study indicated that weather-related shocks are becoming more frequent. Determining whether this is an effect of climate change was beyond the scope of the study, but numerous studies have tracked and projected the impact of climate change in Ethiopia, and climate change is a major influence on the Government of Ethiopia's disaster management policy (Oxfam/USAID, 2009).

Natural resource-related hazards
Environmental degradation is widespread in the study area, especially soil erosion, deforestation, and loss of ground cover. This has increased the losses of soil and ground water, making access to water a significant problem for both humans and livestock, and increasing the likelihood of run-off and flooding.

Disease-related hazards
The three main categories of disease hazards found in the study area are human diseases, livestock diseases, and crop pests. Human illnesses include a wide range of gastro-intestinal and respiratory diseases, and malaria at lower elevations. The prevalence of HIV is relatively low. The main livestock diseases include pasteurellosis, which affects mainly small ruminants, and blackleg, foot and mouth disease, and anthrax, all of which affect cattle. The major crop pests are rust, which affects barley and wheat, and shoot fly, which attacks teff and maize (DPPA, 2006).

Economic hazards
The rapid price inflation of basic food commodities hit the study area, as well as the rest of Ethiopia, very hard in 2008 and again in 2011. Inflation had previously been a less significant problem, but the recent volatility compounded already-existing high levels of indebtedness. A low level of baseline asset holdings—especially land but also livestock (these two categories, in addition to labor, make up the bulk of household productive assets)—exacerbates economic hazards. A high level of unemployment, particularly of landless youth, is the other frequently mentioned economic "hazard" (although technically unemployment would be an outcome, not a hazard).

Table 1. Cumulative Hazard Ranking 2009–10

Hazard	Overall Rank
Drought	1
Food price inflation	2
Population pressure	3
Geographic isolation/inaccessibility	4
Livestock disease	5
Human disease (including HIV/AIDS)	6
Flooding	7
Crop pests and diseases	8
Local conflict	9
Indebtedness	10
Frost ("cold wind")	11
Hail	12

Source: 2009–10 fieldwork

Population-related hazards
The Tsaeda Amba population has continued to grow, putting pressure on existing natural resources. This includes some reverse migration back to the study area of groups that had previously left to seek their fortunes elsewhere. As mentioned earlier, the population growth rate of Seharti Samre is one of the highest in the region (Government of National State of Tigray, 2009).

Conflict-related hazards
Localized resource conflicts were only infrequently mentioned as a hazard. There is also the memory of the conflict with Eritrea—now thirteen years in the past—and the displacement of people from the border area, and the return to the area of those who were expelled from Eritrea. The current situation in Seharti Samre is peaceful. However, the district was one of the most war-affected areas during the 17 years of civil war in Tigray Region. The *woreda* experienced the highest number of air raids during the civil war, and basic infrastructure was destroyed.

Note that most hazards listed in Table 1 constitute covariate risk—meaning these hazards threaten broad groups of the population at the same time. Others may threaten one individual, household, or community while not posing a threat to others nearby, and are thus idiosyncratic risks. These would include risks to human health, and possibly livestock health, as well as indebtedness. Hail and frost affect only high-elevation communities; conflict is so localized that, in this context, it also constitutes an idiosyncratic risk. The major hazards noted in Table 1 are tracked in the LCOT survey.

2.3 Programs and Policies to Build Resilience

Building livelihoods resilient to economic and environmental threats has been the focus of recent development efforts such as the Productive Safety Net Programme (PSNP) and the Disaster Risk Management/Food Security Sector (DRM/FSS) program. While some risks are beyond the control of communities or local authorities, some are amenable to mitigation through program and policy action. Beginning in 2005, the Productive Safety Net Programme has been implemented to address the issue of chronic food insecurity on a programmatic basis (i.e., not on the basis of annual assessments, humanitarian appeals, and emergency response). Concurrently, evolution away from a disaster-response approach towards a disaster risk management approach has been the policy of the Government of Ethiopia. Much of the emphasis has been on using the PSNP to pursue risk reduction interventions that utilize public works to achieve those ends—infrastructure construction and soil and water conservation chief among them.

Alongside the PSNP are many programs intended to enhance livelihood security, including the "household package" program, promoted by both government agencies and some non-governmental organizations. These programs typically involve one or more standard interventions (improved crop production inputs, livestock fattening, bee keeping, etc.) along with a standard loan agreement with a government extension office, a cooperative, or a micro-finance institution (Coates et al., 2010). Some areas have specific DRR programs piloted by NGOs, but are often implemented by the local Disaster Risk Management/Food Security Sector office (DRM/FSS—formerly the Disaster Preparedness and Prevention Agency). These specifically aim at improving community-based preparedness, early warning, and community-based risk reduction. Recently, rainfall index-based micro-insurance programs have been introduced in some areas of Tigray in response to the observation that taking out a loan for improved practices in itself constitutes a risk that many smallholders cannot afford to take (Oxfam America, 2010). This highlights one form of risk not often mentioned in the literature—that of attempting to improve livelihoods through large capital investments. We discuss this at greater length in the poverty traps section below.

3.1 The Conceptual Framework

In this paper, we propose a "livelihoods change" approach to study resilience. There are various conceptual frameworks for livelihoods analysis, but they all have several features in common. The classic approach (DFID, 1999) consisted of a model that begins with assets (natural resources, physical assets, financial assets, and human and social capital) held by a household or other social unit. The model then traces the way these assets are used in various livelihood strategies to achieve certain outcomes. These strategies may be agriculture or livestock-based strategies, labor-based strategies, or trade-based strategies, and they include, for example, specific choices such as crop mix, the use or non-use of fertilizers and other inputs, the buying and selling of livestock, and, critically, the allocation of labor. Outcomes include food security, nutritional status, health, shelter, education, etc. This whole process is shaped by the "vulnerability context" (largely factors outside of human control) and by "policies, institutions, and processes" (human-made factors, though outside the ability of affected households or communities to directly control). This is all conceived of—and measured—in a relatively linear way (most frameworks incorporate some feedback loops in a conceptual sense—but they are not frequently captured methodologically).

Typically, analysis considers *livelihood outcomes* such as food security and health as the objectives that people are trying to achieve. Assets and strategies are the means to the end of improved outcomes. Measures such as food security or health status reflect current conditions, but may be subject to rapid change. Other measures such as education capture longer-term outcomes and are less subject to rapid change—either positive or negative.

Most standard livelihoods analyses assess short-term correlates or causes of these livelihood outcomes. This represents an important first step to understanding resilience itself: the ability of a household to bounce back from transient shocks in order to steadily progress towards a higher measure of both current and long-term welfare. However, we argue that analysis of resilience must go further to track livelihoods over a more extended period of time.

Tracking livelihoods over time in chronically risk-prone or crisis-affected communities requires measures of change in *livelihood strategies*, and, critically, require measures of household *asset portfolios*—the total combination of assets held—and how these evolve in the medium term. In the medium to longer term, *livelihood policies and programs* directly affect changes in strategies and asset portfolios. Policies and programs are typically defined as efforts—usually by the state or governing body—to influence the choices and actions of individuals or collectivities of individuals towards some desired outcome. Typical examples of livelihood policies are the provision of credit or inputs at subsidized rates or the regulation of markets. Finally, *livelihood institutions* may change as well, enabling or constraining options at the individual, household, and community level. Institutions are usually defined as "the rules of the game," durable social, political, and economic norms broadly accepted and acted upon by everyone involved. The classic example of a livelihood institution is land and natural resource tenure, since it governs access to a critical livelihood asset, but social obligations and even marriage institutions can be seen as shaping livelihoods as well.

Measuring livelihood change over time must therefore somehow capture all these dynamics, and requires a different conceptual framework. Figure 3 outlines such a "livelihoods cycle" framework. Like most livelihood frameworks, it begins with assets, and considers how assets are used in different activities or strategies to produce income—whether in-kind or cash—and then considers whether "income" is consumed, saved, or invested (and how people cope when income is inadequate to achieve adequate consumption). But the results of the consumption or savings (or coping) also directly shape the asset portfolio that the household or social unit holds in the following iteration of the cycle. The

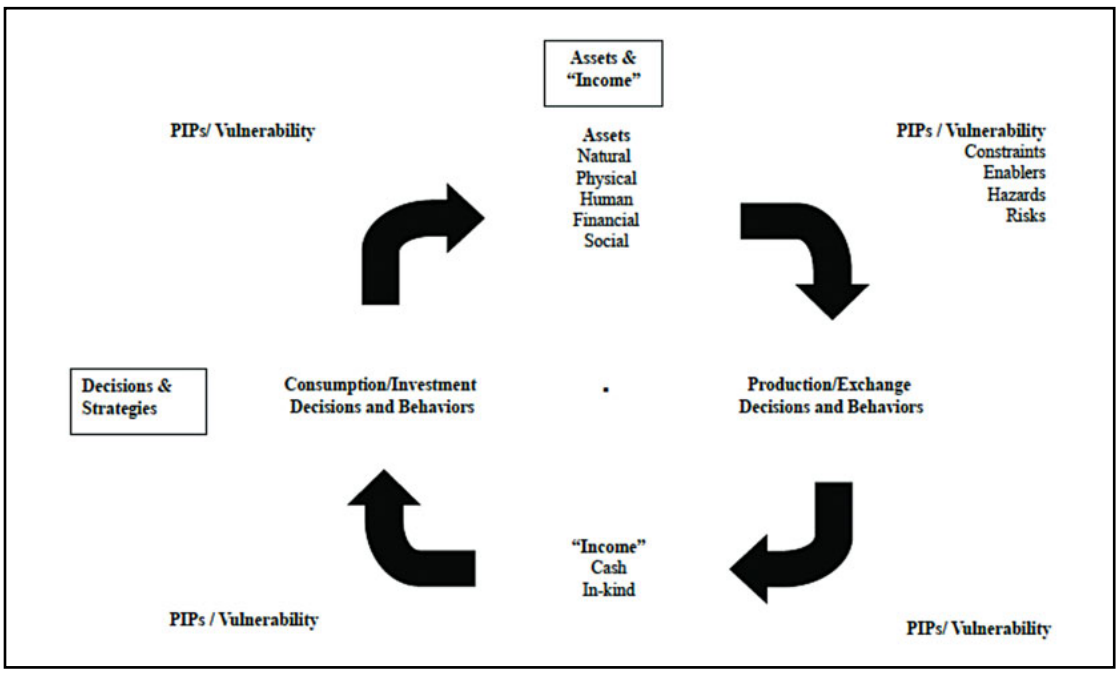
critical difference about a livelihoods cycle framework is the way in which livelihood outcomes shape asset portfolios (the opposite of the relationship depicted in static analysis).

Taken in sum, the "vertical axis" of the livelihood dynamics framework in the figure below depicts assets and income (or "endowments" and "entitlements" in terms defined by Sen [1981]); the "horizontal axis" depicts strategies and choices that individuals or households make (or are forced to make). The right-hand side depicts production choices, and the left-hand side depicts consumption, savings, or coping choices.

Typically, a single iteration of the cycle might be the harvest-to-harvest period in an agricultural livelihood system (or it might be much shorter period in a livelihood system dominated by petty trade). However, livelihoods are rarely, if ever, totally dominated by a single strategy, particularly in highly risk-prone or crisis-affected areas. This makes the measurement issue particularly challenging and typically forces analysis to revolve around a dominant livelihood strategy, even while attempting to capture all strategies. A typical example would be a livelihood system dominated by agriculture and livestock production, but incorporating significant reliance on non-farm labor activities for income at certain times of the year.

This cycle framework focuses attention on several analytical relationships. One is the direct feedback between consumption, investment and savings decisions, and assets. For instance, consumption decisions largely shape human capital in the asset portfolio in the subsequent time frame (T_2, if T_1 is conceived as temporally defining the first cycle). That is, adequate food consumption, health care, etc. determine health and nutritional outcomes, as well as the ability to work. Savings can be manifested in assets of various forms, typically physical or financial assets. Other forms of "investment" can be manifested in social solidarity or social "capital"—sharing of food or other resources, for example. Coping behaviors, on the other hand, may well diminish assets in T_2. If food consumption is cut to meet other needs, if children are forced to drop out of school because of lack of money to pay fees, or more directly, if assets have to be sold to meet consumption needs, then assets will be depleted in T_2. But the point is that measuring outcomes such as food

Figure 3. A simplified "Livelihoods Cycle" framework



Source: Maxwell and Wiebe (1999)

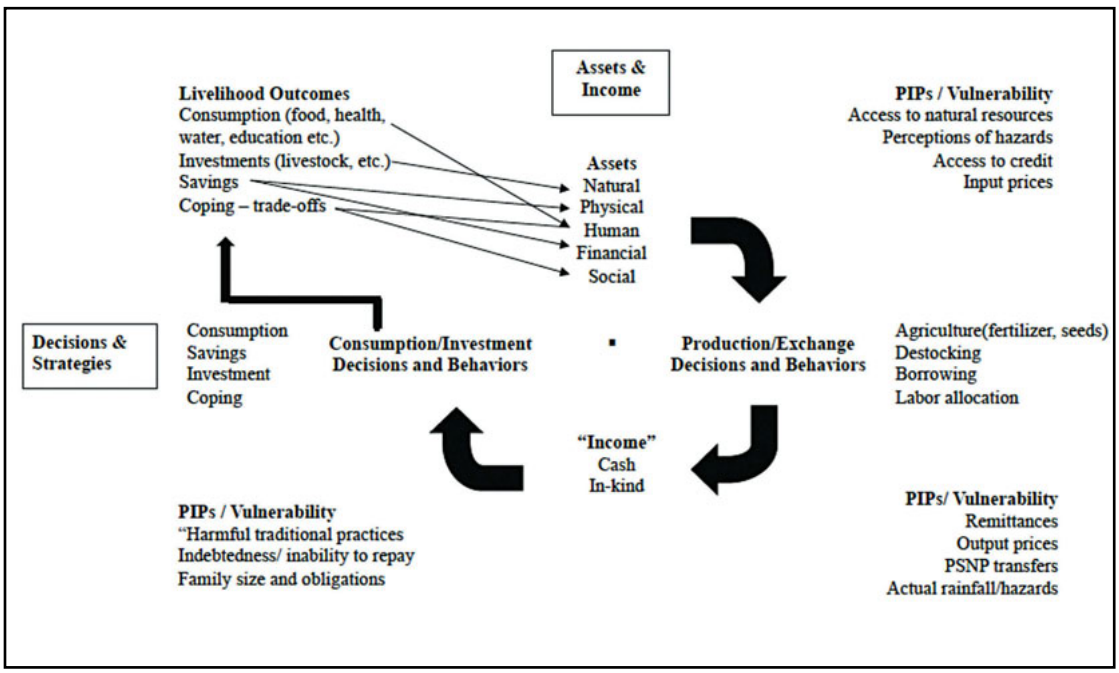
security or health status in T_1, at best, only partially captures this dynamic. The other important element of outcomes is the asset portfolio in T_2. These feedback loops occur repeatedly throughout the process of livelihoods change, both within and across years, and hence are extremely difficult to measure.

Depicting livelihoods in cyclical terms makes the impact of various forms of vulnerability much more explicit in the model. Institutions and policies governing access to natural resources of various kinds typically influence production decisions such as crop and livestock mix, use of inputs, and so on (that is, they influence the upper right quadrant of Figure 3). Prices of inputs, access to credit and technology, and perceptions of hazards such as the likelihood of drought or limited rainfall also influence production decisions. All these factors shape the way various assets (land, labor, etc.) are used in production strategies. Actual levels of rainfall in an agricultural or pastoral livelihood system influence how much production is obtained from decisions made (lower right quadrant of Figure 3, and actual prices determine how much income is derived from production). An altogether different set of factors shape the way in which consumption and savings decisions are made. Debt obligations, other social obligations, and family size—as well as perceptions about longer-term hazards that may require short-term sacrifices—all shape these decisions (lower left quadrant). And finally—as already noted—choices about consumption, savings, and coping shape the asset portfolio in T_2. Similarly, programs and policies affect choices differently. Input or price subsidies would influence decisions about production; safety nets or social protection mechanisms would influence both income levels and (in the case of in-kind food support) directly affect outcomes like food security.

A more detailed depiction of the conceptual framework tailored to the specific context of our study area in northern Ethiopia, incorporating many of the key factors discussed above, is shown in Figure 4.

Measuring the various parts of the cycle—and particularly measuring the relationships among them precisely—would require massive amounts of data. First, as noted, the feedbacks (or the way in which one short-term outcome influences the next short-term decision or action) occur

Figure 4. A detailed "Livelihoods Cycle" framework, adapted for Tigray, Ethiopia



constantly throughout the cycle—they do not simply occur cumulatively at the end of the cycle as depicted in even the relatively detailed Figure 4. Second, people anticipate problems and know how to foresee at least some of the threats to their livelihoods and thus take certain actions before actual shocks occur.

In terms of resilience, the challenge is to first gain an understanding of what the hazards or shocks are within or to a given system. The next step is to ascertain how shocks impact the various stages of the livelihoods cycle: how different types of assets are affected by a given shock; how production, exchange, consumption, and investment decisions are altered; how policies and programs mitigate the risk or impact of hazards, and so on. Lastly, we can use this improved understanding to identify which groups are the most exposed or the least resilient, and in what ways. The present study focuses on these issues and, as detailed in Section 4, constructs a model estimating relationships between initial asset endowments, the intervening variables illustrated in the cycle, and outcome measures of household resilience.

3.2 Analytical Approach

We perform three types of analysis. First, we describe how household welfare evolves over time, using a broad set of indicators. Second, we look at the determinants of food security dynamics between the postharvest and the hunger season, examining the underlying changes in livelihoods that affect food security. Third, we employ the "poverty traps" framework of Carter and Barrett (2006) and Barrett and Carter (2013) to test for the presence of multiple asset equilibria. The initial section below details the methodologies for the first two of these tasks; the second section does the same for the poverty traps analysis.

3.2.1 Household Welfare and Food Security Dynamics

In this research, we propose using change over time of various indicators of household welfare to measure resilience. The twice-a-year panel allows us to look at resilience trajectories between the hunger season and the postharvest season *and* from year to year. As noted earlier, the hunger season brings various recurring shocks, e.g., food price inflation, illnesses, and so on.

For purposes of measurement, in the descriptive section we focus on change over time of eight indicators of food security outcomes and household well-being. (For a more detailed discussion on how these indicators are constructed, see Maxwell et al., 2013.) They are as follows:

1. *Coping Strategies Index (CSI)* and *Reduced Coping Strategies Index (rCSI).* The Coping Strategies Index, developed by Maxwell (1996), looks at the behaviors exercised by households in order to cope with a food deficit. Questions about eleven types of behaviors—ranging from changes in dietary patterns to alternative strategies for obtaining food—and their frequency are asked of households, and the resulting score ranges from 0 to 108. The index combines the frequency and severity of coping strategies, so the higher the index score, the more food insecure the household is. In addition to the standard Coping Strategies Index, we also utilize the reduced Coping Strategies Index (rCSI), which measures less severe coping behaviors.

2. *Household Food Insecurity and Access Scale (HFIAS)* and *Household Hunger Scale (HHS).* The HFIAS, developed by Coates et al. (2007), focuses on three dimensions of food access: *anxiety* about not being able to procure sufficient food, the inability to secure adequate *quality* of food, and the experience of insufficient *quantity* of food intake. Nine questions about these topics are used to calculate a score ranging from 0 to 27, with higher scores indicating greater food insecurity. We also utilize the related Household Hunger Scale, a subset of questions from the HFIAS which focuses on severe outcomes.

3. *Food Consumption Score (FCS)* and *Household Dietary Diversity Scale (HDDS).* The Food Consumption Score is a measure of dietary diversity developed by the World Food Programme (Wiesmann et al., 2006 WFP, 2009). It asks about frequency of

consumption over the past month for cereals and tubers, pulses, vegetables, fruit, meat and fish, milk, sugar, and oil. The scale ranges from 0 to 64, with 0–12 considered poor food consumption, 12.5–20 considered borderline food consumption, and scores above 20 considered adequate food consumption. (Note that, unlike HFIAS and CSI, higher FCS indicates improved food security.) The HDDS asks the same questions as the FCS, but does not weight the food categories, as does the FCS.

4. *Self-reported welfare measures.* We also ask households to self-assess their food security and livelihood security over the six months preceding the survey (that is, since the last survey) on a simple Likert scale. Refer to Appendix A for the exact wording of the questions.

5. *Illness Score.* The illness score is a measure of the number of days in the past six months that all household members have been unable to perform normal activities due to illness and injury. The score is expressed in per-capita terms, and is on a scale of 1 to 5, with "1" being almost no days missed, and "5" representing more than 25 days missed per household member. At this stage of the research, illness score is our preferred measure of human capital, as other indicators (e.g., literacy, years of schooling, physical ability to perform work) are less likely to change over the time frames studied.

6. *Value of productive assets: land, livestock, and tools.* This indicator is the summed value of all productive assets owned by the household, defined as land, livestock, and tools. Land "ownership" values are imputed from rental rates, as technically all land in Ethiopia is owned by the government, and there is no land market from which actual exchange value can be measured. Yet land is clearly the major productive asset in the livelihood system, so "value" is inferred from existing land rental rates. Productive asset value is our preferred measure of physical and natural capital.

7. *Net debt.* This is a measure of the household's outstanding debt obligations, minus any existing savings. We choose to include this measure for the reason that onerous debt is the one of the chief obstacles to households rebuilding after the experience of a shock, and thus low debt load is a key indicator of resilience.

8. *Income (with per-capita daily expenditure as the best measureable proxy for income).* This variable takes into account all expenses reported by the household for the six-month period preceding the survey, divided by household size. The intent is to use per-capita daily expenditure as a proxy variable for income; direct reporting of income is often plagued with measurement difficulties (Deaton, 1997).

Shocks that test household resilience are both exogenous and endogenous to the household; they include the recurring annual climatic, price, and health shocks experienced during the hunger season. Our intent is to interpret changes in the above indicators across years—that is, from hunger season to hunger season and from harvest season to harvest season—as representing the household's (in)ability to improve or maintain their food security and asset stocks.

In the analytical sections that follow, we first look descriptively at changes in potential determinants of the above welfare measures. For both outcome measures and determinants, we disaggregate trends by the two livelihood zones studied as well as four wealth groups. We then look at the determinants of the first three measures—food security outcomes—using the following measurement and estimation strategy.

As noted above, in order to estimate the relationships below, two rounds of data collection took place each year. The first was in August, at the height of the hunger season and shortly after the planting time, when key agricultural production decisions are made. This round is referred to as the *hunger season* round. The second data collection round is in February, during the *postharvest* season. This is the time of the year when household income receipts are concentrated, and the majority of investment

decisions are being made. This round will be referred to as the postharvest round. The data collection rounds are denoted by number; odd numbers represent hunger season rounds and even numbers postharvest season rounds.

We are primarily interested in two distinct questions embedded with the livelihood cycle:

1) Given their postharvest asset base, and given household decisions and exogenous factors, what severity of food insecurity do households experience during the hunger season?

2) Given their experience of food insecurity in the hunger season, and given household decisions and exogenous factors, are households able to protect and build assets?

Together, these two questions portray household resilience: the ability to cope with shocks and protect their asset stocks. The second question is discussed in the next poverty traps section. The first question can be formalized as follows:

$$W_t = f(A_{t-1}, D_t^C, D_t^P, P_t^O, S_t, T_t) \qquad (1)$$

where household welfare in the current round (W_t) is a function of the household's asset stock in the previous round (A_{t-1}), as well as household consumption decisions (D_t^c), household production decisions (D_t^p), output prices (D_t^o), livelihood shocks (S_t), and program transfers (T_t) in the months preceding the current round (picked up by retrospective questions in the current round's survey—hence the *t* subscript).

We focus on three measures of W_t in the current analysis: *coping strategies* (Y^1), as measured by the Coping Strategies Index, *household food access* (Y^2), as measured by the Household Food Insecurity and Access (HFIAS) scale, and *dietary diversity* (Y^3), as measured by Food Consumption Score (FCS). (See Appendix A for a description of all variables and how they are constructed.) Note that all three, by affecting the short- and long-term health of family members, also have effects on the household's human capital stock.

We have various measures of *A*. Human capital is measured by the variables *proportion of literate household members* (X^1), *average educational attainment of household members* (X^2), *average illness score of household members* (X^3), and *fraction of dependents in the household* (X^4).[1] Natural assets are measured by *access to community resources* (X^5). Physical assets are measured by the variables *access to improved water sources* (X^6), *total value of livestock, productive assets, land, and housing* (X^7), and *access to improved sanitation* (X^8). Financial capital is measured by *net debt* (debt minus savings) (X^9). Social capital is measured by the variables *strength of support network* (X^{10}) and *social participation in community organizations* (X^{11}).

Household production decisions D_P are measured by *proportion of expenditure devoted to productive investments* (agricultural and livestock inputs as well as land rental) (X^{12}), *crop diversity* (X^{13}), and *input intensity* (X^{14}). Household consumption decisions D_C are measured by *proportion of expenditure devoted to food purchase* (X^{15}).

Output prices P^O are assumed to be homogeneous across households in a particular kebele (sub-district), and thus the variable is a kebele-round control variable. Hazards are measured in both a covariate and household-specific sense. Rainfall is the key covariate measurement variable and is captured in the livelihood zone dummy. *Livelihood shock impact* (X^{16}) is measured through the aggregate self-reported impact of various key hazards, including drought, agricultural and livestock pests and diseases, flooding, hail, frost, and human illness. Program transfers are measured by the *cash value of received program transfers* (X^{17}), primarily comprised of benefits from the Productive Safety Net Programme (PSNP).

The estimation model that looks at food security outcomes, suggested by Equation (1) and utilizing the measurement variables described in the previous paragraphs, can be expressed in general form as follows:

$$Y = \alpha + \sum_{k=1}^{n} \beta_k X_{ki} + \varepsilon; i = 1,...,n \qquad (2)$$

[1] We use this measure instead of the more commonly used dependency ratio to avoid division by zero issues at the household level.

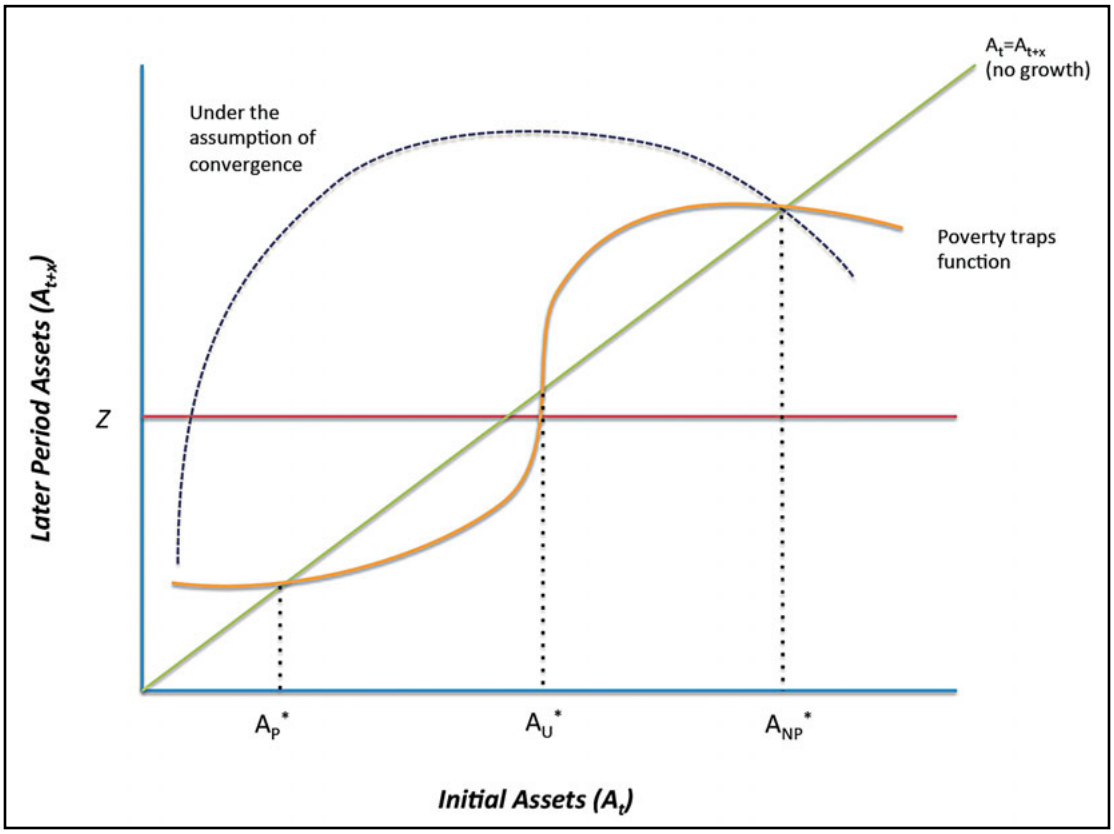
Where household food security Y is determined by some linear combination of variables, each denoted by X_k, where k takes on values between $k=1,\ldots K$; α is the scalar intercept term; i denotes households; β is a vector of the parameters of all included X variables; and ε is the error term, which is assumed to be normally distributed with mean zero and constant variance σ^2. The model is estimated using ordinary least squares. Note again that the asset variables in (2) will be lagged. We estimate separate specifications for each round.

3.2.2 Asset Poverty Traps

In addition to looking at food security, we also look at one of the key determinants of welfare outcomes: asset dynamics. Specifically, we employ the methodology used by Carter and Barrett (2006) and Barrett et al. (2006) to test for the presence of poverty traps in our dataset. The concept of poverty traps relies on the notion of an S-shaped asset function with multiple equilibria (Figure 5 below). The function maps the relationship between initial assets (A_t) and assets in a later period (A_{t+x}). The traditional assumption of convergence assumes that poorer households experience greater marginal returns to capital (shown in the figure as a curved dashed line with declining slope). The implication is that all households will converge in the long run to a unique non-poor equilibrium, depicted here as $A_{NP}^{\star}$, which lies above a assumed asset poverty line Z. If asset stocks do not grow between the two periods, the linear function portrayed by the diagonal from the origin holds.

A situation in which poverty traps exist, however, suggests multiple equilibria. In the example above, there are three equilibria: two stable equilibria, one poor $A_P^{\star}$, the previously mentioned non-poor equilibrium $A_{NP}^{\star}$, and one unstable equilibrium at $A_U^{\star}$. Households with initial period assets below the unstable equilibrium will converge to the lower stable equilibrium—they lie below the diagonal, and thus the next period asset stock will be smaller than the present period stock. This process will continue until they reach $A_P^{\star}$, where the present period and next period stocks are equal. Those above the unstable equilibrium will gain assets

Figure 5. Poverty traps model, adapted from Adato et al. (2006)



until they reach $A_{NP}^{\star}$, the higher stable equilibrium. Asset dynamics are thus bifurcated around the critical threshold $A_{NP}^{\star}$.

The poverty traps hypothesis is an elegant means to test whether household resilience depends on prevailing asset stocks. If poverty traps do not exist, then households should be resilient at any level of assets—that is, shocks only temporarily reduce asset stocks and households return to their original growth trajectory. If poverty traps do exist, then household resilience depends on the magnitude of the shock and whether assets fall below a critical threshold.

Poverty traps exist because of missing or imperfect markets, particularly credit and insurance markets. In such conditions, households are unable to obtain or protect the amount of capital needed to push themselves above the critical threshold. The "rich get richer" phenomenon may be observed in such situations, as households above the critical threshold—especially those just above the threshold—can experience large marginal returns to investment as they progress towards the higher equilibrium.

If multiple equilibria do indeed exist, they can help distinguish whether a change in household welfare is due to stochastic or structural factors, an especially relevant question in a context of pronounced seasonality of income flows and food security. The effects of random chance amplify the observed volatility in welfare dynamics in panel datasets, as well as the variation in welfare in cross-sectional datasets. Focusing on structural factors will thus more meaningfully capture the long-term expectation for household welfare. As noted in the earlier discussion of the livelihoods conceptual framework, in this research we focus on food security outcomes as the welfare indicator of interest and asset stocks as the key structural determinants of welfare.

We test for S-shaped asset dynamics by regressing assets from the current round against assets from the previous round, for each livelihood zone. The simple bivariate specification can thus be summarized as follows:

$$A_t = \beta_1 A_{t-1} + \varepsilon \quad (3)$$

where A_t represents asset stocks in the current round, A_{t-1} represents asset stocks in Round 1, the β coefficient is estimated from the data, and ε is the error term. Our preferred measure of assets is the market value of productive assets—land, livestock, tools, and housing, using 2011 prices, minus net debt (debt – savings). The disadvantage of this approach is that human and social capital, for example, cannot be included, as can be done in methods that either weight assets by the strength of their partial correlation with welfare measures or perform factor analysis to create composite asset indices (McKay and Perge, 2013). However, because our primary concern is with short-term dynamics, we focus on physical, natural, and financial assets, which fluctuate more than human and social capital. All of these can be easily combined using prevailing market prices. We estimate the equation above non-parametrically, allowing the data to dictate functional form. We utilize locally weighted estimator scatterplot smoothers (Lowess) with bandwidth 0.4 (i.e., 40 percent of the local data is used to specify the function at any given point) to smooth the function (Naschold, 2013). Note that, in the results section below, we also look at asset changes between Round 4 and Round 1, that is:

$$A_{t+3} = \beta_1 A_t + \varepsilon \quad (4)$$

where A_{t+3} represents asset stocks in Round 4 and A_t represents asset stocks in Round 1.

4.1 Livelihood Dynamics

We first look at round-by-round means of key livelihood variables. The data are disaggregated by livelihood zone and wealth group. Please refer to Appendix A for a discussion of how indicators are constructed, ranges of the scales, and categorical interpretations of the scores.

4.1.1 Descriptive Dynamics by Livelihood Zone

4.1.1.1 The Eastern Plateau

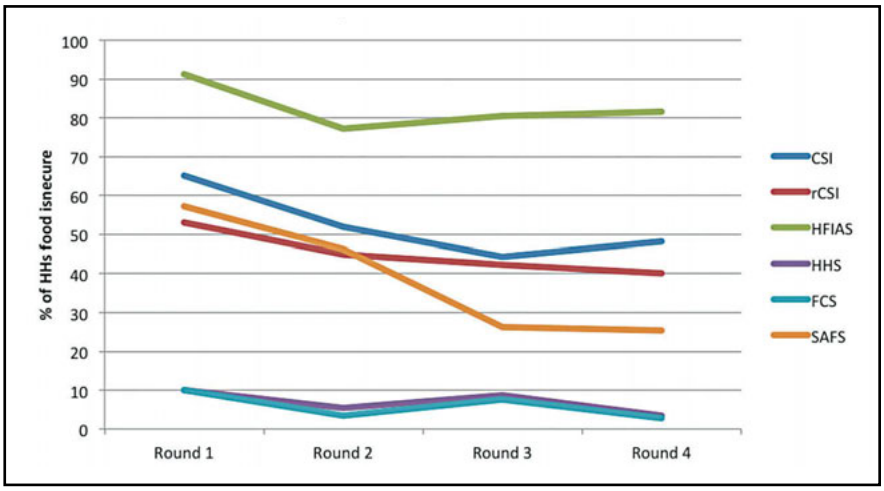
The following table summarizes means of key livelihood outcomes by round for the Eastern Plateau livelihood zone. The results for non-food security indicators are mixed. The livelihood security measure does show improvement between Rounds 1 and 2 but is stagnant in subsequent rounds. Health, as measured by illness score, improves between Rounds 1 and 3 before worsening slightly in Round 4. Debt decreases by almost 70 percent between Rounds 1 and 3 before increasing again in Round 4, although it remains well below the baseline level. The asset and expenditure measures are perhaps the most puzzling of all. The value of the productive asset stock declines steadily throughout the survey period even as food security outcomes improve. Because we do not measure the value of human capital in our productive asset measure, this may simply reflect a shift from land-based to wage labor or petty trade-based livelihoods: household welfare may indeed be increasing despite an erosion of physical and natural capital stock. However, the expenditure data do not reflect such improvement. Expenditure more than doubles between Round 1 and Round 2, partially due to the hunger vs. harvest season effect, but then falls afterward, even between the Round 3 hunger season and the Round 4 harvest season. Expenditure in the Round 4 harvest is 42 percent lower than in the Round 2—again, a surprising result given the improvements in food security.

Table 2. Welfare variables, Eastern Plateau, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS (self-assessed livelihood security)	3.13	2.75	2.77	2.75
Illness score	1.71	1.62	1.52	1.54
Total value of productive assets per capita (ETB)	3078.90	2635.26	2438.25	2322.02
Net debt (debt − savings) (ETB)	800.59	669.77	249.54	383.10
Per-capita daily expenditure (ETB)	4.29	10.00	6.95	5.77
CSI	19.60	13.96	13.83	12.94
rCSI	10.15	8.21	8.04	7.28
HFIAS	9.62	7.93	7.00	7.40
HHS	0.57	0.35	0.39	0.25
FCS	23.12	25.62	25.74	27.77
HDDS	14.61	15.79	16.29	16.71
SAFS (self-assessed food security)	2.72	2.59	1.95	2.18

All seven of the food security indicators—from CSI to SAFS in the table above—show signs of significant improvement between Rounds 1 and 4. Though the lion's share of the gains comes between the Round 1 hunger season and the Round 2 harvest season, in general these gains are maintained through Round 4. The figure below illustrates this, with scale scores being converted into binary outcomes of "food secure" and "food insecure" to assist in comparison.[2] Despite the agreement between indicators on the general trend, there are marked differences between indicators. First, note that there is wide variation in the percentage of households identified as food secure across indicators; for example, HFIAS tends to show the highest prevalence and HHS and FCS the lowest. This reflects the differences in the dimensions of food security captured by each indicator, as well as the methodology of indicator construction (see Maxwell et al., forthcoming; and Vaitla et al., forthcoming for details). In addition, some indicators (rCSI, SAFS) show a monotonically improving situation, while others suggest stagnation or deterioration between the Round 2 harvest season and the Round 3 hunger season (HFIAS, HHS, FCS) and/or between Round 3 and Round 4 (CSI, HFIAS).

Figure 6. Food security outcomes, Eastern Plateau, by round



[2] HDDS does not have commonly accepted food secure/insecure cutoffs, and so is not included here.

The table below, again for the Eastern Plateau livelihood zone, illustrates changes in household variables that will later be tested as determinants of the welfare outcomes discussed above.

Table 3. Determinants of welfare, Eastern Plateau, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	5.50	5.84	6.17	6.44
Dependency ratio	0.995	0.955	0.789	0.723
Access to community resources	1.46	0.94	1.00	0.97
Support network score	3.19	4.26	4.62	4.58
Social participation score	4.99	5.13	4.13	5.01
% of expenditure for productive investments	27.32	12.72	14.57	10.29
% of expenditure for food purchase	16.67	41.69	39.65	38.32
Aggregate impact of shocks	22.46	20.39	16.68	19.16
PSNP benefits received per capita (ETB)	133.00	137.81	143.79	82.38
% of households with improved water access	80.7	83.9	81.9	76.2
% of households with improved sanitation	27.3	27.5	29.5	42.2
% of literate adult HH members (> age 14)	49.6	50.9	56.5	55.0
Average years schooling/HH member	2.53	2.47	2.41	2.34
Crop diversity index	0.519	0.572	0.457	0.532
Input intensity	.216	.236	.253	.242

We see differing trends across the indicators. Household size is steadily increasing, although the reasons for this are not clear; dependency ratio is also falling extremely rapidly, suggesting that the household size increase is not driven by higher fertility but rather perhaps by reduced out-migration. Access to community resources declined after the first round. Support networks appear to have expanded considerably after Round 1, and participation in social organizations is relatively constant, with the exception of a dip during the Round 3 hunger season. The expenditure data are difficult to interpret. Households appear to have spent considerably more in Round 1 on livestock, tools, and other productive investments than in subsequent rounds. The trend is reversed for food expenditure, which is much lower as a percentage of total expenditure in Round 1 than the other three rounds. This is strange given the commonly observed pattern across the world of lower percent food expenditure as household food security improves. Shocks fluctuate considerably, with households experiencing the worst conditions in Round 1 and the best in Round 3.

We see also that PSNP benefits dropped off considerably in Round 4, as explained further below in the discussion section. Access to safe water worsened slightly in Round 4, although sanitation improved considerably between Rounds 3 and 4. Literacy and years of education are fairly steady across rounds. Crop diversity is

largely unchanged. Input intensity increased slightly after Round 1, but has been constant since, suggesting that agricultural development is not driving the improvement in food security.

4.1.1.2 Middle Tekeze

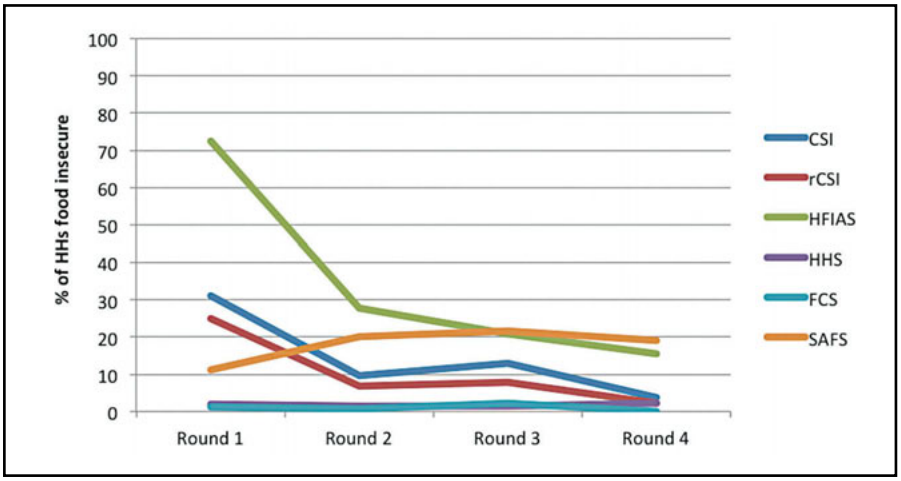
The following table shows the key welfare outcomes for the Middle Tekeze livelihood zone. The non-food security indicators show some distinct differences from the Eastern Plateau. While, as in the other livelihood zone, the total stock of productive assets declines over the course of the survey—again, a strange outcome given improving food security—the decline is much less pronounced, and households in the Middle Tekeze are generally much wealthier. Debt load shows dramatic dynamics across the rounds, with hunger season (Rounds 1 and 3) indebtedness being much higher than the subsequent harvest seasons: debt decreases 22 percent between R1 and R2, increases 83 percent between R2 and R3, and then falls 33 percent again in the last round. Expenditure dynamics follow expected hunger/harvest season patterns, with the exception of the final harvest round, in which expenditure falls 13 percent from the previous hunger season.

Table 4. Welfare variables, Middle Tekeze, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS	2.46	2.15	2.29	1.97
Illness score	1.42	1.25	1.16	1.17
Total value of productive assets per capita (ETB)	6328.96	6428.64	5921.46	5893.07
Net debt (debt − savings) (ETB)	1469.79	1144.08	2098.94	1394.20
Per-capita daily expenditure (ETB)	5.74	8.48	7.89	6.90
CSI	10.58	2.75	4.05	1.63
rCSI	6.09	1.32	1.88	0.81
HFIAS	6.24	1.55	1.84	1.65
HHS	0.18	0.07	0.07	0.09
FCS	32.27	35.80	35.62	38.00
HDDS	19.91	21.97	21.96	23.57
SAFS	1.70	1.90	1.86	1.89

As in the Eastern Plateau, we see significant improvement in food security outcomes, particularly between Round 1 and Round 2. Note also that, in general, the food security situation in the Middle Tekeze is considerably better than that in the Eastern Plateau. Again, we see some difference between the indicators, as the figure below shows. HFIAS again generally shows the highest prevalence, although food insecurity according to this indicator declines precipitously between Rounds 1 and 2. The most difficult measure to interpret is SAFS; self-reported food insecurity is much lower than in the Eastern Plateau and actually increases over the life of the survey, unlike the other food insecurity indicators. SAFS, CSI, rCSI, and FCS all show a small spike in food insecurity during the Round 3 hunger season.

Figure 7. Food security outcomes, Middle Tekeze, by round



We now describe in the table below changes in the determinants of these welfare outcomes.

Table 5. Determinants of welfare, Middle Tekeze, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	5.96	6.51	6.78	6.98
Dependency ratio	0.972	0.763	0.680	0.656
Access to community resources	1.67	1.54	1.46	1.60
Support network score	5.54	5.38	9.81	6.18
Social participation score	6.24	5.86	5.24	5.76
% of expenditure for productive investments	30.56	20.64	22.14	15.64
% of expenditure for food purchase	8.44	34.36	33.07	32.27
Aggregate impact of shocks	17.97	18.54	13.78	15.66
PSNP benefits received per capita (ETB)	124.75	114.73	126.00	22.80
% of households with improved water access	79.6	74.7	66.2	64.0
% of households with improved sanitation	35.5	26.0	14.4	31.6
% of literate adult HH members (> age 14)	47.0	54.1	66.7	54.2
Average years schooling/HH member	2.45	2.29	2.62	2.33
Crop diversity index	0.437	0.436	0.389	0.486
Input intensity	.294	.357	.316	.354

As in the Eastern Plateau livelihood zone, we see that household size steadily increases and dependency ratio falls over the life of the survey. Note that the second trend is even more dramatic in the Middle Tekeze: dependency ratio falls by 33 percent between Rounds 1 and 4. Access to community resources stays fairly stable. Support network scores show some volatility, with a much higher figure for Round 3 than the others. Social participation stays fairly constant, with a slight dip in Round 3. Again, expenditure trends show a counter-intuitive trend: percent expenditure on productive investments is almost halved between Round 1 and Round 4, while expenditure on food jumps considerably after Round 1 and then changes very little. Shocks in Rounds 3 and 4 are reduced in comparison to the first two rounds.

It is clear that PSNP enrollment strongly declined in the fourth and final round; average benefits decline by over 80 percent between Rounds 3 and 4. Unexpectedly, safe water access declines monotonically each round, falling to a low of 64 percent of households by the end of the survey. Access to improved sanitation stays low throughout, reaching its lowest level in Round 3. Literacy improves slightly but years of schooling do not, and both exhibit fluctuations across rounds. Given the long-term nature of educational data, such movements are difficult to explain without reference to changes in household rosters. Crop diversity increases in Round 3 (lower values indicate greater diversity) but falls again in Round 4. Input intensity is lower in hunger season rounds.

4.1.2 Descriptive Dynamics by Wealth Group

We now look at these same variables disaggregated by wealth group. Per-capita productive asset values are used to determine wealth groups, as follows: < 2500 ETB (very poor), 2500–4999 ETB (poor), 5000–7499 ETB (middle), ≥ 7500 ETB (better-off). These cut-offs are based on those used in our earlier work but expressed in per-capita terms (Vaitla et al., 2012). This earlier work was itself based on previous livelihood profiling done by the Government of Ethiopia (DPPA 2008).

4.1.2.1 Very Poor

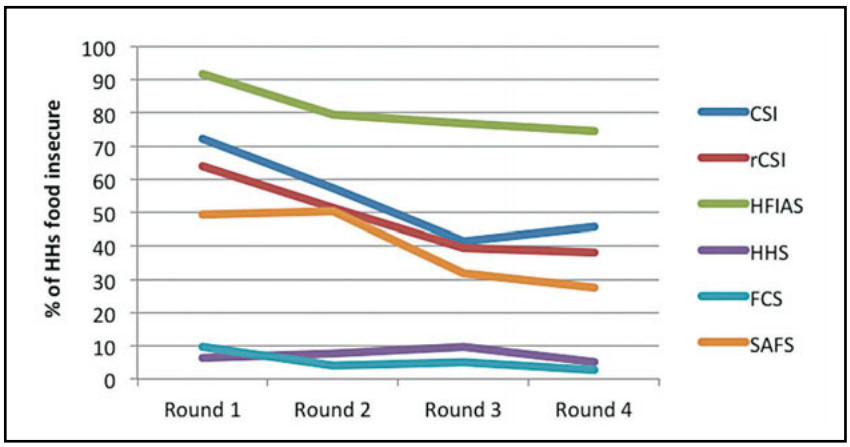
Key welfare variables across all rounds for very poor households are given in the table below. We see households report an improvement in livelihood security with each successive round, and illness falls. The decline in productive assets seen in the livelihood zone tables is seen strongly here: between Rounds 1 and 4, the value of productive assets falls by about 9 percent. As we will see in the tables to follow, the very poor and the middle groups suffer net losses in productive asset value, while the poor and the better-off groups gain slightly. While we may speculate that the change in the middle group may be driven by a change to non-land-based livelihoods, that explanation is not likely to hold for very poor households. We also see in the table below that debt for the very poor increased in Rounds 2 and 3, but declined to well below Round 1 levels by Round 4. Expenditure per capita rises until Round 3, and then falls 12 percent in Round 4.

Table 6. Welfare variables, very poor households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS	3.08	2.82	2.91	2.68
Illness score	1.58	1.47	1.43	1.41
Total value of productive assets per capita (ETB)	1563.20	1325.61	1322.04	1429.56
Net debt (debt − savings) (ETB)	729.78	1185.73	1205.87	437.41
Per-capita daily expenditure (ETB)	4.37	5.02	6.29	5.53
CSI	20.78	16.02	12.78	12.30
rCSI	11.35	9.27	7.47	6.96
HFIAS	9.63	8.43	6.71	7.12
HHS	0.41	0.43	0.42	0.29
FCS	24.15	25.90	26.90	27.85
HDDS	15.31	15.61	16.92	17.01
SAFS	2.62	2.76	2.17	2.20

The food security indicators show consistent improvement. Unlike other wealth groups, the Round 1 to Round 2 change does not dominate the overall trend. Rather, CSI, rCSI, and SAFS all show significantly higher food security in Round 3 as compared to Round 2, and HFIAS also slightly improves. These dynamics are illustrated in the binary food security outcomes graph below.

Figure 8. Food security outcomes, very poor households, by round



The determinants of these welfare variables are presented in the table below. We see that household sizes increase appreciably as dependency ratio falls. Access to community resources stays somewhat constant. Again, we see an unexpected spike in the size of the support network, as well as a considerable fall in social participation, in Round 3. Expenditures on productive investments are considerably higher in the hunger season. Food expenditures increase substantially after the first round. Shock impacts lessen from Rounds 1 to 3 before rising again in Round 4.

Table 7. Determinants of welfare, very poor households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	6.24	6.62	6.64	6.9
Dependency ratio	1.123	0.983	0.832	0.766
Access to community resources	1.13	1.01	1.09	1.04
Support network score	3.97	4.38	6.92	4.37
Social participation score	5.33	5.25	4.06	4.95
% of expenditure for productive investments	27.64	10.84	15.79	10.90
% of expenditure for food purchase	14.03	44.51	39.40	39.14
Aggregate impact of shocks	21.99	20.10	15.87	18.84
PSNP benefits received per capita (ETB)	135.40	144.00	134.71	74.40
% of households with improved water access	82.1	84.5	84.6	79.7
% of households with improved sanitation	38.9	24.3	22.1	25.2
% of literate adult HH members (> age 14)	48.4	51.6	53.0	53.5
Average years schooling/HH member	2.35	2.49	2.11	2.18
Crop diversity index	0.563	0.617	0.456	0.589
Input intensity	.217	.234	.249	.240

We see that PSNP benefits, fairly constant in the first three rounds, decline considerably in the fourth. Given that this entire group remains very asset-poor, the decrease in benefits may represent exclusion error. Beyond a puzzling decrease in access to safe sanitation between Rounds 1 and 2, there is little change in access to safe water and sanitation. Literacy increases slightly over the course of the survey, although Round 3 and 4 years of schooling decline from the Rounds 1 and 2 means. Crop diversity fluctuates but input intensity much less so.

4.1.2.2 Poor

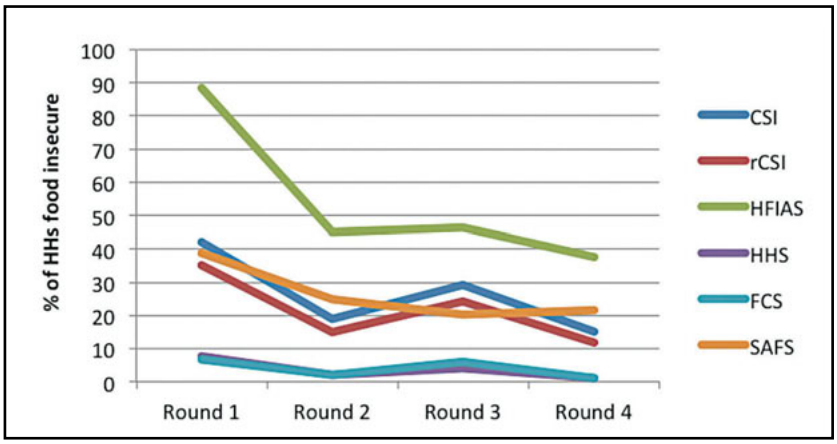
Poor households also report a significant, monotonic improvement in livelihood security. Unlike the very poor group, the total per-capita value of productive assets increases slightly between Rounds 1 and 4, despite a dip in Round 3. These gains are wiped out, however, by the increase in debt: though net debt falls in Rounds 2 and 3, it increases greatly between the last two rounds. A similar pattern holds with respect to expenditure. Households increase expenditure by over 50 percent between Rounds 1 and 2, but much of this gain is lost by Round 4.

Table 8. Welfare variables, poor households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS	2.87	2.45	2.35	2.28
Illness score	1.47	1.35	1.34	1.34
Total value of productive assets per capita (ETB)	3507.34	3598.14	3366.21	3541.27
Net debt (debt − savings) (ETB)	1411.29	602.47	320.54	1676.76
Per-capita daily expenditure (ETB)	4.72	7.26	7.69	5.98
CSI	15.26	5.23	9.34	4.99
rCSI	8.05	2.77	4.86	2.54
HFIAS	8.05	3.39	4.25	3.17
HHS	0.41	0.14	0.15	0.08
FCS	26.39	31.75	31.22	35.05
HDDS	16.55	19.52	19.62	21.33
SAFS	2.33	2.05	1.80	2.02

There is considerable disagreement between the food security indicators on dynamics over the four rounds. All the indicators show a strong improvement between the first and second rounds, but the subsequent movements differ. HFIAS and SAFS stay relatively constant, while the rest of the indicators show a hunger season worsening in Round 3 and recovery in Round 4.

Figure 9. Food security outcomes, poor households, by round



The determinants of these welfare outcomes show similar trends as to the very poor group. Household sizes increase while the dependency ratio falls. Support networks expand, particularly between Rounds 2 and 3. We also see a steady decrease in productive investment spending and the familiar jump in food expenditures after Round 1. The greatest change in shock impact—a 22 percent reduction—occurs between Rounds 2 and 3.

Table 9. Determinants of welfare, poor households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	5.93	6.3	6.56	6.94
Dependency ratio	0.980	0.767	0.679	0.608
Access to community resources	1.69	1.23	1.2727	1.3763
Support network score	4.32	4.58	6.04	5.86
Social participation score	5.77	5.73	4.9293	5.5
% of expenditure for productive investments	27.72	20.13	17.06	14.71
% of expenditure for food purchase	13.53	36.73	37.07	33.72
Aggregate impact of shocks	20.17	20.11	15.61	16.91
PSNP benefits received per capita (ETB)	122.65	108.03	122.20	50.34
% of households with improved water access	83.5	83.0	77.8	62.4
% of households with improved sanitation	25.2	30.0	24.2	38.7
% of literate adult HH members (> age 14)	50.0	53.1	58.3	56.1
Average years schooling/HH member	2.62	2.26	3.10	2.40
Crop diversity index	0.460	0.465	0.414	0.451
Input intensity	0.281	0.332	0.302	0.342

Again, PSNP benefits decrease, although this group remains asset-poor. Access to safe water deteriorates, although access to safe sanitation improves. Literacy increases slightly, but the average years of schooling fall considerably between Rounds 3 and 4. Crop diversity does not change, and input intensity fluctuates only slightly over the course of the survey.

4.1.2.3 Middle

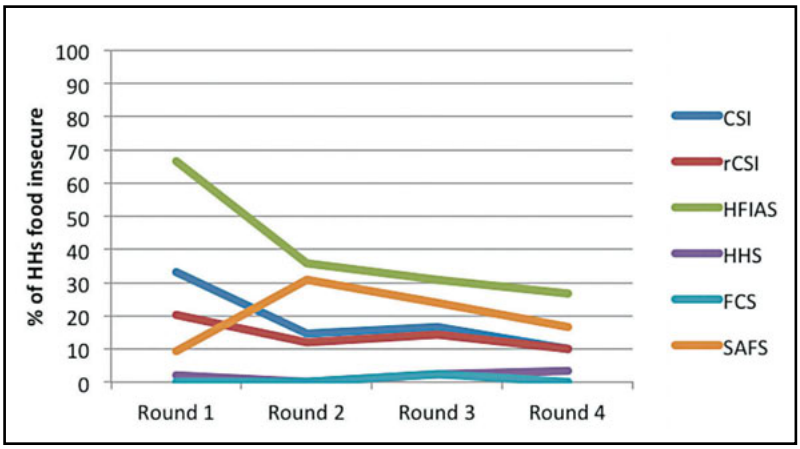
There is clear hunger/harvest season variability in livelihood security among middle-income households. As with the very poor group, the total value of productive assets per capita diminishes. Debt is strongly concentrated in the hunger season Rounds 1 and 3, and the final round debt load is quite modest. Per-capita expenditure more than doubles between the first two rounds, but then falls precipitously between Rounds 2 and 3 and decreases even further in Round 4.

Table 10. Welfare outcomes, middle wealth households, by round

VARIABLE	MEANS by ROUND 1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS	2.47	2.14	2.4	2.1
Illness score	1.46	1.53	1.24	1.35
Total value of productive assets per capita (ETB)	6158.07	5983.97	5959.28	5971.61
Net debt (debt − savings) (ETB)	1468.15	899.33	2129.59	182.30
Per-capita daily expenditure (ETB)	5.50	12.44	7.99	7.22
CSI	9.56	3.29	4.52	3.30
rCSI	5.37	2.50	2.64	2.13
HFIAS	6.26	2.38	2.29	2.63
HHS	0.13	0.02	0.21	0.20
FCS	32.40	33.54	34.55	37.33
HDDS	20.07	21.19	21.40	22.87
SAFS	1.67	2.08	1.81	1.97

The graph below transforms the above food security scores into binary outcomes. All indicators except SAFS show an improvement from Round 1 to Round 2. Both HFIAS and SAFS show a slight decline over the course of the final three rounds, while the other indicators show a hunger season increase in food insecurity in Round 3.

Figure 10. Food security outcomes, middle wealth households, by round



We see the familiar increase in household size, but the fall in dependency ratio is not as drastic as with the very poor and poor groups. Again, the size of support networks increases until Round 3, and then falls. As with the very poor group, expenditure for productive investments is higher in the hunger season rounds, and food expenditures are relatively stable between Rounds 2 and 4, with a slight hunger season increase in Round 3. Shocks decline until Round 3, and then increase slightly in the final round.

Table 11. Determinants of welfare, middle wealth households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	5.54	5.64	5.74	6.17
Dependency ratio	0.948	0.852	0.711	0.779
Access to community resources	1.91	1.39	1.21	1.71
Support network score	4.74	5.62	7.81	5.57
Social participation score	6.56	4.90	5.43	6.23
% of expenditure for productive investments	28.38	19.28	23.01	12.11
% of expenditure for food purchase	8.95	32.00	35.91	33.07
Aggregate impact of shocks	18.81	19.81	14.36	15.80
PSNP benefits received per capita (ETB)	114.96	138.98	116.02	22.93
% of households with improved water access	68.5	73.8	69.0	70.0
% of households with improved sanitation	25.9	23.8	16.7	30.0
% of literate adult HH members (> age 14)	53.2	55.4	45.5	58.5
Average years schooling/HH member	2.82	2.45	2.04	2.48
Crop diversity index	0.421	0.407	0.412	0.463
Input intensity	0.263	.376	.316	.356

PSNP benefits fall drastically to just 23 ETB/person in Round 4. Literacy improves but years of schooling decrease. Crop diversity is slightly less (higher numbers mean less diversity) in the final round, and input intensity increases significantly, particularly between Rounds 1 and 2.

4.1.2.4 Better-Off

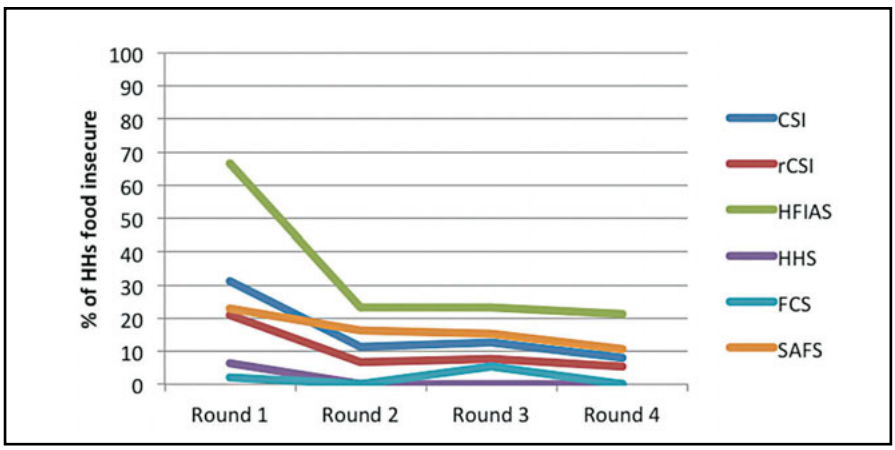
As with the middle wealth group, there is a clear worsening of households' self-perception of livelihood security in the hunger seasons. Household member health significantly improves over the course of the survey. Like the poor group, better-off households increased the per-capita value of their productive asset stocks. Net debt followed a seasonal pattern, with much higher debt load in the hunger seasons. Unlike all other wealth groups, the better-off group increased their per-capita expenditure over the course of the survey, despite a slight dip in Round 3.

Table 12. Welfare outcomes, better-off households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
SALS	2.38	1.93	2.21	1.87
Illness score	1.89	1.46	1.28	1.19
Total value of productive assets per capita (ETB)	11653.82	11605.02	11570.06	12027.30
Net debt (debt − savings) (ETB)	1021.54	996.78	1821.37	883.27
Per-capita daily expenditure (ETB)	6.55	8.50	8.32	9.06
CSI	10.21	2.61	4.21	2.13
rCSI	5.15	1.36	2.15	1.08
HFIAS	6.27	1.79	1.90	2.03
HHS	0.50	0.07	0	0.05
FCS	32.31	36.67	33.83	39.03
HDDS	19.54	22.6	20.50	24.21
SAFS	1.79	1.71	1.63	1.59

As with other wealth groups, food security improved over the course of the survey. Most of this change occurred between the first and second rounds. Only HFIAS suggested that more than one-tenth of better-off households remained food insecure by the final round.

Figure 11. Food security outcomes, better-off, by round



The determinants of these outcomes are listed in the table below. Unlike the other three wealth groups, the better-off group does not see a monotonic increase in household size. After reaching a peak of 6.5 members in Round 3, households decrease slightly in size. In addition, dependency ratio declines much less than in the other groups, albeit from a lower Round 1 baseline. The same expenditure trends are observed, however—a decline in productive investment spending and an increase in food expenditures. Shock impact reaches a low in Round 3 before increasing again in Round 4.

Table 13. Determinants of welfare, better-off households, by round

VARIABLE	MEANS by ROUND			
	1 (hunger 2011)	2 (harvest 2012)	3 (hunger 2012)	4 (harvest 2013)
# HH members	4.48	5.55	6.51	5.92
Dependency ratio	0.712	0.768	0.611	0.630
Access to community resources	1.76	1.66	1.45	1.401
Support network score	4.90	5.71	10.00	6.82
Social participation score	4.92	6.07	4.77	5.71
% of expenditure for productive investments	35.18	20.34	22.08	15.04
% of expenditure for food purchase	11.39	31.97	27.62	28.74
Aggregate impact of shocks	18.42	16.10	13.98	16.32
PSNP benefits received per capita (ETB)	145.05	116.56	188.59	20.05
% of households with improved water access	81.3	68.2	41.0	63.2
% of households with improved sanitation	37.5	27.3	25.6	15.8
% of literate adult HH members (> age 14)	39.2	50.9	52.4	52.5
Average years schooling/HH member	2.20	2.15	2.63	2.65
Crop diversity index	0.439	0.441	0.368	0.470
Input intensity	0.273	0.284	0.296	0.315

PSNP benefits decline precipitously between Rounds 3 and 4; given that most better-off households are above the income poverty line, this likely represents a correction of program inclusion error. Safe water access fluctuates wildly, but over the course of the survey declines, as does safe sanitation access. Better-off households are the only group for which literacy and years of schooling improve. Crop diversity decreases but input intensity increases.

4.1.3 Multivariate Models of Food Security Outcomes

In this section, we analyze the determinants of food security outcomes by estimating Equation (3). Note that food security outcomes could be conceptualized as a particular type of asset: human capital. We perform regressions for transitions between all rounds, i.e., between Round 1 and Round 2, Round 2 and Round 3, and Round 3 and Round 4. We perform separate regressions for each food security outcome variable: CSI, HFIAS, and FCS. In interpreting the coefficients, note that *higher* CSI

and HFIAS scores and *lower* FCS scores imply greater food *insecurity*. In order to preserve degrees of freedom, we also choose between alternative measures of our variables, although we run the same models with all possible alternatives. Those with greater explanatory power are chosen. Specifically, we choose average years of schooling/HH member as a measure of human capital; access to improved water sources and value of productive assets per capita as a measure of physical capital; strength of support network as a measure of social capital; and proportion of expenditure devoted to investment and agricultural input intensity as a measure of production decision-making. We thus exclude literacy, access to sanitation, access to community resources, participation in community organizations, and crop diversity in the regressions below. Dummy variables for kebeles are also included to capture observed price and climatic effects. Note that some of the variables are lagged and others are not, following the logic outlined in the methodological section. All variables coming from the same round as the dependent variable are retrospective and refer to the experience of the household in the six months preceding the survey, or approximately since the previous round of the survey.

4.1.3.1 Round 1 to Round 2

The determinants of food security outcomes in Round 2 are summarized in the table below. Note that Round 2 was a postharvest season.

Table 14. Determinants of food security outcomes in Round 2 (first postharvest season)

		CSI		HFIAS		FCS	
	Round	Beta	t	Beta	t	Beta	t
(Constant)		9.707	2.355	4.208	2.228	31.628	8.253
Average schooling/HH member	1	-0.344	-0.893	-0.22	-1.203	0.126	0.341
Household illness score	1	0.487	0.675	0.13	0.386	-1.05	-1.53
Fraction of dependents in HH	1	-0.022	-0.725	0.001	0.051	0.016	0.551
Household with improved water access?	1	-2.395	-1.526	-1.138	-1.574	3.021**	2.069
Productive asset values per capita (1000 ETB)	1	-0.439**	-2.287	-0.122	-1.384	-0.051	-0.284
Net debt per capita (1000 ETB)	1	0.483	0.949	0.23	0.982	-0.054	-0.113
Support network score	1	0.166	1.268	0.013	0.211	-0.038	-0.307
% expenditure on productive assets	2	-0.066*	-1.897	-0.035**	-2.179	0.036	1.084
Input intensity	2	-2.453	-0.878	-2.242*	-1.724	16.041***	6.077
% expenditure on food	2	-0.001	-0.031	0.02	1.236	-0.055*	-1.705
Aggregate disaster impact	2	0.463***	3.902	0.265***	4.838	-0.33***	-2.971
PSNP benefits per capita (1000 ETB)	2	0.755	0.192	0.466	0.256	-12.646***	-3.418
Amdi dummy		-9.037***	-5.212	-5.386***	-6.662	4.477***	2.723
Nebar dummy		-7.932***	-4.067	-4.373***	-4.82	6.672***	3.627
Raeile dummy		0.196	0.117	0.023	0.03	-2.115	-1.349
Adjusted R^2		*0.291*		*0.393*		*0.355*	

***p<0.01, **p<0.05, *p<0.10

The three food security indicators are all strongly determined by disaster impact; other than the kebele dummy variables, disaster impact is the only variable to have a significant effect on all food security indicators. The magnitude of effect is also considerable: recall that disaster impact is measured on a scale of 1 to 50. Thus a one point increase in disaster impact lifts CSI by 0.463 points, HFIAS by 0.265 points, and reduces FCS by -0.33 points. Amdi Weyane and Nebar Hadinet kebeles are in the Middle Tekeze livelihood zone, and so unobserved price, environmental, infrastructural, and climatic factors clearly have a positive impact on food security across livelihood zone. Input intensity and water access are also important for dietary diversity. Unexpectedly, productive assets per capita only seem to matter for coping strategies, and even this effect is of minor magnitude: a 1000 ETB increase in productive assets only reduces coping strategies by less than half a point. Increasing expenditure on productive assets, as a percentage of total expenditure, matters for improving both CSI and HFIAS, but not FCS. It would appear that, for food security during the first postharvest season, the impact of disasters, prices, and climate dominate the determination of food security.

4.1.3.2 Round 2 to Round 3

The table below depicts the determinants of Round 3 (hunger season) food security.

Table 15. Determinants of food security in Round 3 (second hunger season)

	Round	CSI		HFIAS		FCS	
		Beta	t	Beta	t	Beta	t
(Constant)		6.829	1.496	0.236	0.142	25.107	6.099
Average schooling/HH member	2	0.125	0.268	0.122	0.717	0.037	0.088
Household illness score	2	2.461***	2.609	1.508***	4.396	-1.539*	-1.808
Fraction of dependents in HH	2	-0.01	-0.299	-0.002	-0.196	0.033	1.076
Household with improved water access?	2	-4.244**	-2.393	-0.181	-0.281	1.087	0.677
Productive asset values per capita (1000 ETB)	2	-0.249	-1.384	-0.092	-1.398	0.311*	1.914
Net debt per capita (1000 ETB)	2	0.861	0.918	0.022	0.066	-1.541*	-1.826
Support network score	2	-0.368*	-1.705	-0.102	-1.301	0.553***	2.839
% expenditure on productive assets	3	0.006	0.165	0.001	0.088	-0.012	-0.398
Input intensity	3	-7.43*	-1.75	-5.618***	-3.639	15.892***	4.122
% expenditure on food	3	0.039	1.085	0.039***	3.004	-0.115***	-3.543
Aggregate disaster impact	3	0.501***	3.781	0.265***	5.502	-0.035	-0.291
PSNP benefits per capita (1000 ETB)	3	0.49	0.15	0.394	0.332	-7.507**	-2.548
Amdi dummy		-4.295**	-2.281	-2.306***	-3.366	6.888***	4.052
Nebar dummy		-6.128***	-2.624	-2.571***	-3.026	5.595***	2.653
Raeile dummy		1.437	0.79	0.699	1.057	-0.169	-0.102
Adjusted R^2		*0.251*		*0.43*		*0.329*	

***p<0.01, **p<0.05, *p<0.10

Again, we see that the three food security outcomes have some similar determinants, and some differences. Greater household illness leads to food insecurity for all three indicators, with the largest effects on CSI. The magnitude of effect is also significant; the range of the illness variable is 1–5, with higher scores representing greater illness (see Appendix A for interpretation of increased illness values). Thus a one-point increase in illness lifts CSI by around 2.5 points, HFIAS by 1.5 points, and lowers FCS by about 1.5 points. Access to safe water lowers CSI by over 4 points, but has no significant effect on the other two food security measures. Again, a larger stock of productive assets has little effect on food security, with only FCS affected. Support networks improve CSI and FCS, and the effects are large, given the range of the support network variable. Input intensity is measured on a scale of 0 to 1, with 1 representing all land planted with improved seeds, irrigated, and fertilized with both organic and inorganic fertilizer. Given this scale, the effects of input intensity on food security are moderately large: a change from zero improved inputs to a system fully managed with improved inputs reduces CSI by over seven points, HFIAS by nearly six, and increases FCS by over four points. Food expenditure affects both HFIAS and FCS, but not in the direction expected: higher expenditure on food (as a percentage of total expenditure) is correlated with greater food insecurity, perhaps because poorer households are more likely to spend more on food. This is similar to PSNP benefits, which are correlated with less dietary diversity. This may be caused by targeting of poorer households, although given the wide set of control variables used, the result remains surprising. Again, disasters affect all three indicators strongly.

4.1.3.3 Round 3 to Round 4

Finally, we look at another transition from hunger season to postharvest season, and the determinants of food security outcomes in the latter.

Table 16. Determinants of food security in Round 4 (second postharvest season)

	Round	CSI Beta	CSI t	HFIAS Beta	HFIAS t	FCS Beta	FCS t
(Constant)		5.313	1.342	4.18	2.181	30.586	7.08
Average schooling/HH member	3	0.374	0.99	0.139	0.762	0.047	0.115
Household illness score	3	2.183***	2.62	1.291***	3.213	-2.961***	-3.271
Fraction of dependents in HH	3	0.017	0.609	-0.001	-0.09	0.021	0.685
Household with improved water access?	3	0.358	0.27	0.291	0.452	-0.118	-0.082
Productive asset values per capita (1000 ETB)	3	-0.332*	-1.947	-0.171**	-2.085	0.613***	3.309
Net debt per capita (1000 ETB)	3	2.5***	2.657	1.529***	3.374	-4.217***	-4.13
Support network score	3	-0.111	-0.717	-0.119	-1.599	0.07	0.418
% expenditure on productive assets	4	0.011	0.396	-0.007	-0.47	0.059*	1.865
Input intensity	4	-2.92	-0.808	-1.61	-0.925	3.685	0.939
% expenditure on food	4	0.015	0.476	0.018	1.224	-0.019	-0.56
Aggregate disaster impact	4	0.169	1.445	0.079	1.406	0.034	0.265
PSNP benefits per capita (1000 ETB)	4	3.646	1.329	1.771	1.34	-9.369***	-3.145
Amdi dummy		-9.084***	-5.872	-4.557***	-6.08	5.603***	3.317
Nebar dummy		-7.86***	-3.82	-4.073***	-4.063	5.774***	2.556
Raeile dummy		0.411	0.279	-0.437	-0.612	-1.867	-1.16
Adjusted R^2		*0.317*		*0.364*		*0.323*	

***p<0.01, **p<0.05, *p<0.10

Unlike in Round 2, in the impact of illness in Round 3 on is a powerful determinant of food security in Round 4, regardless of how it is measured. Dietary diversity is especially strongly affected by illness. Productive assets per capita have a significant effect on all three indicators, and again particularly on FCS, in contrast to previous rounds. Debt also plays a role here, with an increase of 1000 ETB in debt reducing FCS by over 4 points, and increasing CSi by 2.5 and HFIAS by 1.5 points. PSNP benefits only affect dietary diversity, and again in the opposite direction expected. Unlike in previous rounds, disasters are not correlated with food security—perhaps because the impact of the hunger season in Round 3 was very mild. The kebele dummies retain their significance.

4.2 Asset Poverty Traps

In this section, we take a closer look at asset dynamics and specifically the question of whether households are able to protect and build assets in the face of shocks.

4.2.1 Transition Matrices

Before testing for the presence of poverty traps, we take a look at simple asset poverty dynamics in each

livelihood zone. The transition matrices below show how each household's per-capita productive asset stocks changed from Round 1 to Round 4, using the wealth groups discussed earlier. Note that these wealth groups, unlike those in the previous sections, take into account per-capita net debt, which is subtracted from the value of other productive assets. The percentages pertain to row totals; i.e., 85.5 percent of households who were very poor in Round 1 stayed very poor in Round 4.

Table 17. Wealth group transition matrices, disaggregated by livelihood zone

Eastern Plateau	R4 Very Poor	R4 Poor	R4 Middle	R4 Better-off
R1 Very Poor	59 (85.5%)	9 (13.0%)	0	1 (1.4%)
R1 Poor	28 (52.8%)	20 (37.7%)	5 (9.4%)	0 (0.0%)
R1 Middle	6 (46.2%)	5 (38.5%)	0 (18.2%)	2 (15.4%)
R1 Better-off	2 (33.3%)	3 (50.0%)	0	1 (16.7%)
Middle Tekeze	**R4 Very Poor**	**R4 Poor**	**R4 Middle**	**R4 Better-off**
R1 Very Poor	13 (50.0%)	12 (46.2%)	1 (3.8%)	0
R1 Poor	6 (19.4%)	19 (61.3%)	4 (12.9%)	2 (6.5%)
R1 Middle	5 (13.9%)	16 (44.4%)	8 (22.2%)	7 (19.4%)
R1 Better-off	3 (7.7%)	5 (12.8%)	7(17.9%)	24 (61.5%)

We see some similarities between the two livelihood zones. Upward mobility is limited: only 17 of 141 (12.1 percent) households in the Eastern Plateau and 26 of 132 (19.7 percent) households in the Middle Tekeze experienced an improvement in wealth class. In contrast, nearly one-third of households in both livelihood zones slipped into a lower wealth group. This suggests that asset accumulation in both livelihoods may be complicated by the presence of poverty traps, and that most households may be below the critical threshold bifurcating asset dynamics.

4.2.2 Bivariate Analysis

We now proceed to looking at the shape and potential equilibria of the asset accumulation function. We first look at the bivariate relationship between asset stocks in Round 1 and Round 4, disaggregated by livelihood zone. We then look at the transitions between each round, i.e., Round 1 and Round 2, Round 2 and Round 3, and Round 3 and Round 4.

The x-axis in each graph represents the asset values in a prior round, and the y-axis in a subsequent round. For example, in the first two graphs below, the x-axis is assets per capita in Round 1, and the y-axis assets per capita in Round 4. The 45-degree diagonal is also shown as a dashed line; this line represents the situation if household asset values did not change between the two periods. Rare extreme values were removed from the figures for clarity of presentation. The regression fit line in each graph is estimated non-parametrically using Lowess smoothing with a bandwidth of 0.4.

Figure 12. Asset dynamics, Round 1 to Round 4, Eastern Plateau

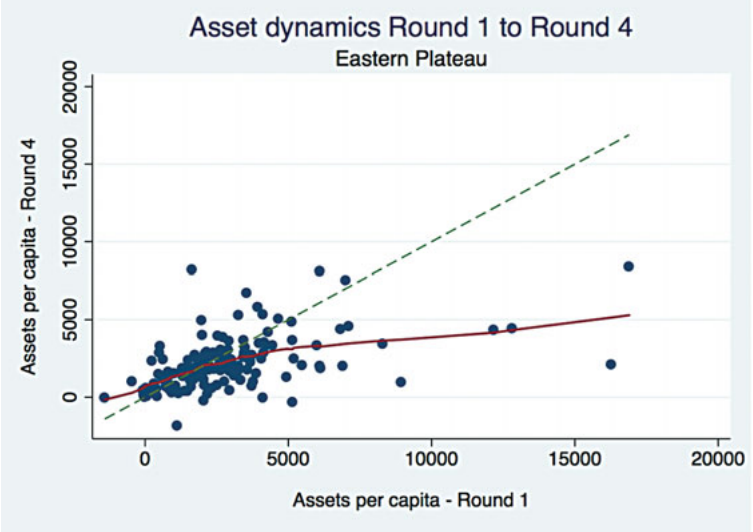
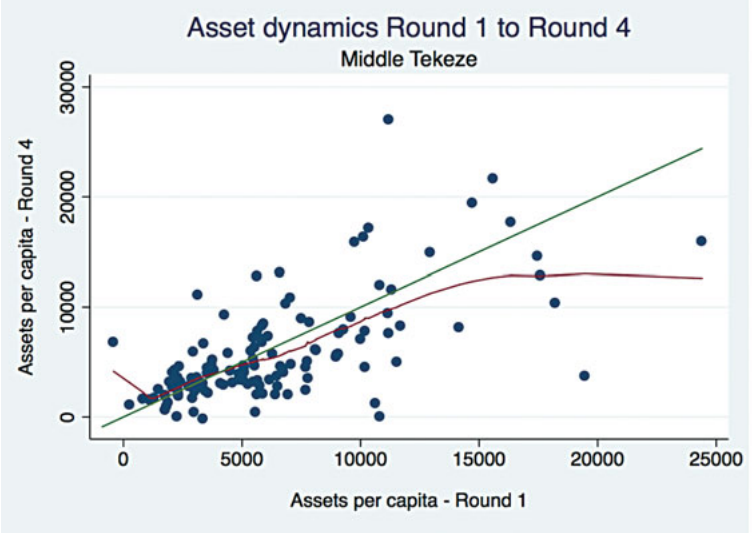


Figure 13. Asset dynamics, Round 1 to Round 4, Middle Tekeze



Neither livelihood zone shows evidence of multiple equilibria. In the Eastern Plateau, the equilibrium wealth level appears to be around 2500 ETB/person, and in the Middle Tekeze just below 5000 ETB/person. Note that these levels are very low, especially the former; in PPP-adjusted terms, this equates to about $352 and $704. Clearly there are structural factors preventing sustained growth, and in fact most households saw their assets eroded over the course of the survey, as illustrated by the number of data points below the diagonal in each figure. In the Eastern Plateau, the expected amount of losses proportional to existing assets steadily increases after 3000 ETB, as shown by the decreasing slope of the fit line.

We now take a disaggregated look at asset dynamics between each round, which tend to confirm the single "poor equilibrium" story. The first two figures below represent asset changes between Round 1 (first hunger season) and Round 2 (first postharvest season) in each livelihood zone. Note that for the remaining figures the y-axis represents the round immediately after that shown on the x-axis.

Figure 14. Asset dynamics, Round 1 to Round 2, Eastern Plateau

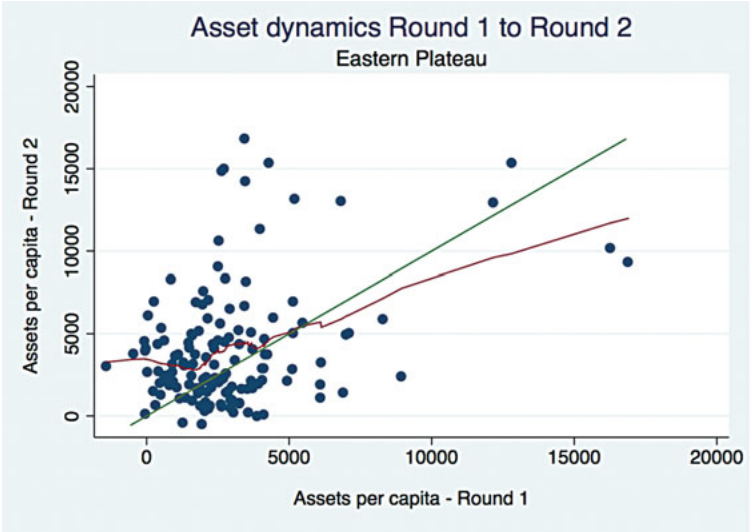
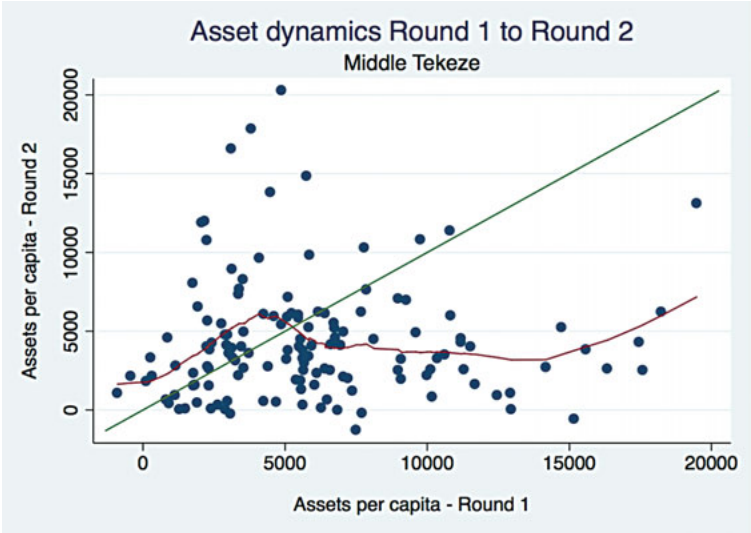


Figure 15. Asset dynamics, Round 1 to Round 2, Middle Tekeze



Both figures show a low-level equilibrium around 5000 ETB/person, although the lack of data points makes the location of this higher equilibrium difficult to discern. Note that low-wealth households are seen to be accumulating to this point.

We now turn to the transition between Round 2 (first postharvest season) and Round 3 (second hunger season). In the figures below, assets per capita for Round 2 are on the x-axis and assets per capita for Round 3 on the y-axis.

Figure 16. Asset dynamics, Round 2 to Round 3, Eastern Plateau

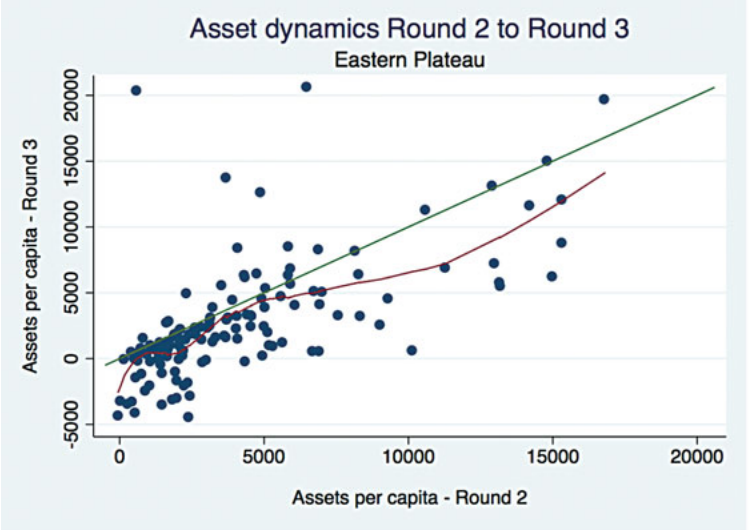
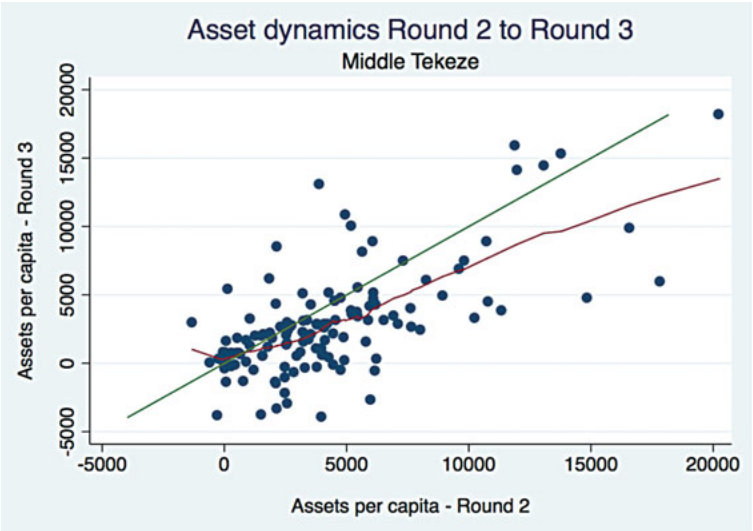


Figure 17. Asset dynamics, Round 2 to Round 3, Middle Tekeze



S-shaped asset dynamics appear to exist in the Eastern Plateau graph, but we see that the regression line is below the diagonal for the entirety of the wealth distribution. We see no equilibrium at all; households are losing assets as they transition from the postharvest to the hunger season. Our earlier descriptive results show that increased debt between Round 2 and Round 3 is likely not the reason for this declining asset stock (recall that we include debt in the valuation of asset stock in this section). Note also that many low-asset households fall into negative wealth by Round 3, and in fact the great majority of households lose wealth, as shown by the number of data points underneath the diagonal.

The Middle Tekeze also shows a single equilibrium point. Assets decline at a rate proportional to initial wealth as the slope of the regression line decreases. The differences between hunger-to-harvest season (Round 1 to Round 2) and harvest-to-hunger season (Round 2 to Round 3) are stark: in the first scenario, low-income households were able to accumulate assets, while in the latter they were not.

The graphs below depict the final transition, from the Round 3 hunger season to the Round 4 postharvest season.

Figure 18. Asset dynamics, Round 3 to Round 4, Eastern Plateau

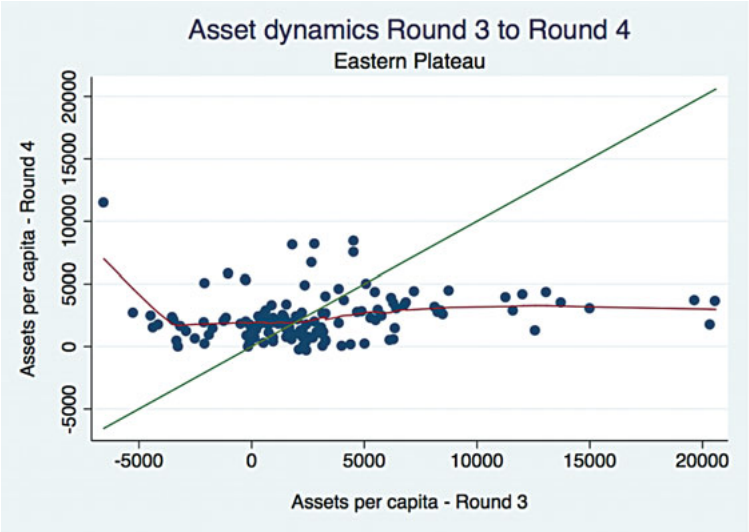
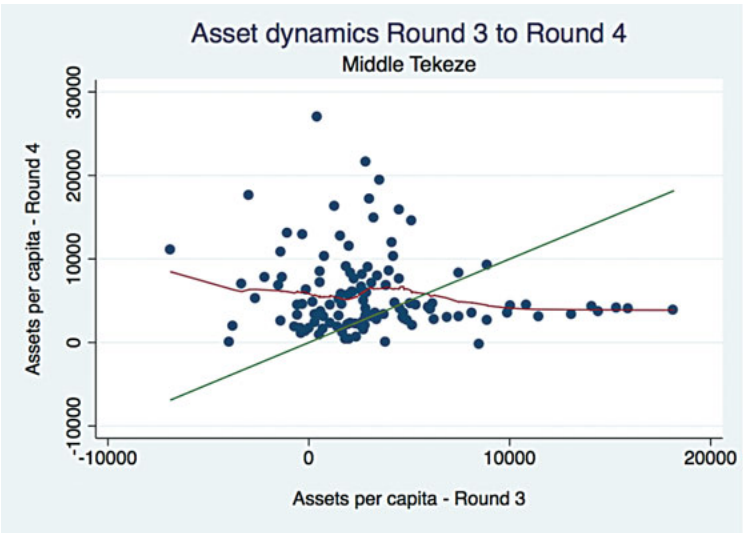


Figure 19. Asset dynamics, Round 3 to Round 4, Middle Tekeze



There appear to be strong single equilibria in both livelihood zones, at around 2500 ETB/person in the Eastern Plateau and 5000 ETB/person in the Middle Tekeze. Again, poor households tend to accumulate assets and wealthy households to lose assets up to this point. The difference between this hunger-to-harvest transition and the one seen between Round 1 to Round 2 is that wealthier households tend to lose assets at a much more rapid rate; the slope for both lines after crossing the diagonal is essentially flat.

5.1 Discussion

These results paint a puzzling picture in many ways. All the food security indicators depict improving access to food, decreasing levels of coping, and increased dietary diversity over the four rounds of the survey. Conditions in Round 1 were relatively bad—food prices were high and the previous harvest had not been good. But conditions improved thereafter, and the second hunger season captured by this survey was fairly mild. These observations hold true across geographic and socio-economic sub-groups within the sample. So, the key outcome of food security is generally improving over time.

It should be noted that while the food security indicators tell a somewhat divergent story in terms of the estimates of prevalence, they tell a remarkably similar story in terms of change over time. In addition, contrary to the expectations of many observers, the self-assessment measure not only depicts the same trends over time, it actually suggests a lower prevalence of food insecurity than some of the other measures. For a more detailed analysis of the food security indicators, see Maxwell et al. (2013).

The determinants of food security status vary by outcome indicator and round. The aggregate impact of shocks is a significant determinant across all rounds of the survey and for most of the socio-economic and geographic subgroups. And it is clear that conditions are simply better in the Middle Tekeze *woredas* compared to the Eastern Plateau *woredas*. Beyond that, there are few clear patterns: asset portfolios seem to be significant to different food security outcomes at different times—and to all of them in the last round—but without a clear overall pattern. PSNP benefits are a significant determinant of dietary diversity, but not the other outcomes. The intensive use of inputs is significant in Round 2 and 3, but not in Round 4; the level of illness is significant in Round 3 and 4. Few single determinants emerge from the regression analysis to suggest themselves across the board as areas for significant program investments or policy initiatives.

The asset portfolio of households tends to be holding steady on average, although in some cases households with very low levels of assets see an increase over time. The poverty traps analysis confirms the general observation of a "poverty" equilibrium but no evidence of multiple equilibria. Indeed, per-capita asset levels seem to be declining over time, across wealth groups and across geographic sub-groups. At face value, this would imply a "consumption-smoothing story" (if food consumption indicators are improving but per-capita asset levels declining). But that does not really capture the overall dynamics depicted here, because consumption smoothing would imply some kind of a shock that threatened either production or consumption (or both)—and with the exception of events that occurred prior to Round 1, no such shock really occurred during the years of the research.

For reasons that the data themselves do not explain, the average size of households (again, for the most part across socio-economic and geographic sub-groups) is increasing over time, driven for the most part by an increase in the economically active age group. With household asset portfolios more or less stable, the increase in household size is driving down per-capita assets.

It should be noted that the "value of productive assets" measure includes only the self-estimated value of natural, physical, and financial assets. There are separate measures for human and social assets in the regression analysis (mostly not significant determinants of food security outcomes), but these are not captured by the poverty traps analysis. Hence the story line that seems to emerge from these data is one of increasing human capital and improved food security (at least in terms of current status) over time, relatively stable household levels of assets, but declining per-capita assets. Achieving improved food security at a time of growth in household members is no small accomplishment, but these results seem to confirm the hypothesis of the livelihoods cycle framework—that outcomes in one time frame determine the asset portfolios in the subsequent time frame. But the emphasis here is on human assets, not on more

easily valued financial or physical assets.

It is not clear from these data why household size is increasing and dependency ratio is declining. These short-term results seem unlikely to be driven by changes in fertility or other long-term demographic changes, given that dependency ratio is also falling over the course of the survey. The implication would be that labor opportunities elsewhere are decreasing and economically active household members who had been working elsewhere are returning to their households of origin—or else that they perceived their opportunities were better at their households of origin. The food security analysis tends to bear out this perception. But without a detailed, member-by-member analysis of movement in and out of households and the reasons for it, this is not possible to confirm.

The poverty traps analysis confirms a low-level or "poverty" equilibrium in asset holdings over time. Even households below this threshold tend to accumulate assets up to this level but then are unable to continue growing. Wealthier households show some tendency to regress back to this point as well. This trend is most evident in the period between the hunger season and the postharvest season—the precise period in which food security indicators show the most improvement. The data tend to suggest an equilibrium level at around or slightly below per-capita asset holdings of about ETB 5000. It is not clear what seems to prevent accumulation above this level, but the hope of present livelihood interventions generating sustained economic growth appears not to have borne out in this dataset.

5.2 Policy Implications

These results tend to imply that the Productive Safety Net Programme is having the intended effect of protecting household food security, although it only shows up as a significant determinant of dietary diversity (FCS). Protection of productive assets is the other major objective of the PSNP, and while an independent analysis of the determinants of asset levels was not conducted here, the levels of assets—even among the lower socio-economic strata—do not decline significantly, even during the hunger season (another piece of evidence to negate the "consumption-smoothing" story).

But it seems clear that, absent a major effort to improve assets at the household level (programs such as the PSNP-Plus and other efforts), households remain trapped at a fairly low level of accumulation. It is possible that there is a "human capital first" story here, but while our data may suggest this, they are insufficient to confirm it. Programs aimed at minimizing the risk of shocks may also be important. The qualitative field work that preceded the survey suggested that the "household package" program promoted to address the question of asset accumulation came with higher risks—debt and more inputs, as well a perceived greater vulnerability to moisture stress and other potential shocks. Programs intended to address at least some of these risks—in particular rainfall index insurance—have been implemented in Tigray, but not in the areas where this survey took place. Given the poverty traps analysis and the importance of shocks as a determinant of food security, these programs and other risk-reducing measures should be investigated more.

A longer longitudinal analysis and a broader geographic scope are needed to explore in more detail the mechanisms of household resilience uncovered in these study areas. However, the results of even this relatively short-term longitudinal study suggest the dynamic nature of livelihoods and the effects of this dynamism on human welfare. The processes outlined in the earlier livelihoods framework appear to be operating in the areas studied, and increasing the impact of development interventions depends critically on more precise knowledge of constraints to livelihood growth.

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