



Shocks and household coping strategies in rural Ethiopia

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Shocks and household coping strategies in rural Ethiopia
(エチオピア農村におけるショックと世帯のリスク対応)

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Abbreviations

AAU	Addis Ababa University
ADLI	Agricultural Development Led Industrialization
AIDB	Agricultural and Industrial Development Bank
AMC	Agricultural Marketing Corporation
CDI	Consumer Price Index
CHUC	Clark-Hemming-Ulph-Chakravarty Family of Indices
CPI	Consumer Price Index
CRED	Centre for Research on the Epidemiology of Disasters
CRRA	Constant Relative Risk Aversion
CSAE	Centre for the Study of African Economies
CV	Coefficient of Variation
EA	Enumeration Areas
E.C.	Ethiopian Calendar
EM-DAT	Emergency Events Database
ERHS	Ethiopian Rural Household Surveys
ESRS	Economic and Social Research Council
ESS	Ethiopian Socioeconomic Survey
ETB	Ethiopian Birr
FFW	Food-for-Work program
FGT	Foster-Greer-Thorbecke measure index family of poverty index
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HHI	Herfindahl Indexes
HICES	Income and Consumption Expenditure Survey
IASC	Inter-Agency Standing Committee

IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
LOWESS	Locally Weighted Scatterplot Smoothing Estimator
MPI	Multidimensional Poverty Index
NOAA	U.S. National Oceanic and Atmospheric Administration
PA	Peasant Association
PPP	Purchasing Power Parity
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSNP	Productive Safety Net Program
RDPS	Rural Development Policies and Strategies
SIDA	Swedish International Development Cooperation Agency
SNNP	Southern Nations, Nationalities, and Peoples' Region
TLU	Tropical Livestock Unit
ROSCA	Rotating Savings and Credit Association
USAID	US Agency for International Development
USD	US dollar
USGS	US Geological Survey
WDI	World Development Indicator

1 Overview of the dissertation

Extreme poverty has been greatly reduced since 1990. Around 39 per cent of the global population lived below the USD 1.90 per day poverty line, but now only 10 per cent of the population (i.e., as of 2015) live below such extreme poverty. On the other hand, Sub-Saharan African countries have not yet achieved such a large poverty reduction, and now accommodates more than half of the extreme poor in the world. The number of poor population in Sub-Saharan Africa has increased by 9 million, and now 413 million people live under USD 1.90 a day. One of the factor behind the persistent poverty in Sub-Saharan Africa is their vulnerable income base to climate shocks. In this thesis, I investigated the mediating effects of various types of ex post risk coping strategies (i.e., risk sharing, formal credit borrowing and livestock destocking) and their heterogeneities among different subgroups.

In the case of Ethiopia, 26.72 per cent of the total population still live on less than USD 1.90 a day,¹ and the large majority of these poor populations live in rural areas (PovcalNet, n.d.). Their economy relies heavily on agriculture, where low-input and rain-fed farming are dominant. Hence, the vulnerability to natural disasters and other agricultural shocks are the major challenge for the country.

In this thesis, I look at how well rural Ethiopian households responded to climatic disasters, decomposing factors i.e., the ethnic and religious diversity of villages, access to formal credit, and the level of initial asset possession. Rural villagers have developed their coping strategies against idiosyncratic (i.e., illness, deaths, crop failure) as well as covariate shocks (i.e., rain failure). I found that the efficacy of each coping strategy is

¹ Internationally comparable poverty measures cited in this chapter are drawn from PovcalNet, the on-line tool for poverty measurement developed by the Development Research Group of the World Bank (<http://iresearch.worldbank.org/PovcalNet/home.aspx>)

heterogeneous, depending on religious groups, accessibility to formal sector credits, and initial asset holding.

Figure 1-1 describes the poverty types that each chapter covers. In Chapter 2, I first describe the composition of poverty in Ethiopia from the 1990s-2000s, decomposing poverty into chronic and transient poverty, and investigate the factors contributing to chronic poverty. In Chapter 3, I investigate two kinds of borrowing (i.e., credits from the formal sector and social networks) taken against transitory shocks and its role as against aggregate and idiosyncratic shocks. Chapter 4 addresses livestock destocking in the face of climatic disasters. Cattle, in particular, are an essential draught animal for sedentary farmers, and destocking them may jeopardize future consumption, cause the falling into an asset poverty trap and thus chronic poverty. While each chapter has its own contribution, the thesis as a whole provides a comprehensive insight into the poverty situation of Ethiopia through analyzing different types of poverty and the efficacy of several coping strategies in the face of the risk of each type of poverty.

[Insert Figure 1-1 here]

The reminder of this thesis is organized as follows. Chapter 2 discusses the vulnerability and poverty situation in rural Ethiopia during the 1990-2000s. National GDP per capita has steadily improved in these periods, but the rural poverty situation has been stagnant, and chronic poverty was dominant in rural Ethiopia. Households with favorable endowments such as a higher education level and larger livestock- and land-holdings are less likely to be chronically poor. The religious minority are more likely to be chronically poor. Also, I found that religious fasting practices and seasonal labour requirements explain a large part of the consumption variation: during the fasting season, household consumption decreases by 6 percentage points, and this effect is even larger where the large majority of resident households are Orthodox Christians.

Chapter 3 investigates how institutional lending contributed to consumption smoothing in rural Ethiopia aside from conventional social network lending from the 1990s-2000s. The late 1990s and the 2000s observe the expansion of institutional lending in rural Ethiopia. Rural Ethiopian households face volatile consumption in the face of idiosyncratic and aggregate shocks. Social network lending and formal sector lending has alleviated the adverse effect of death shocks, although credits from informal commercial/interlinkage lending did not. However, village-level accessibility to institutional lending has negative effects on consumption smoothing, suggesting that borrowers of institutional lending were more able to smooth consumption during idiosyncratic shocks. On the other hand, the non-borrowers in less liquidity-constrained villages actually were worse off.

Chapter 4 investigates the extent of livestock liquidation against above-normal and below-normal rainfall based upon the initial asset status. Asset-rich households liquidate their livestock asset more during drought times. On the other hand, when above-normal rainfall shocks occurred, asset-poor households decreased their livestock holdings more, although I could not see any increase in liquidation of the livestock of the asset poor. Asset-poor households are more vulnerable to above-normal rainfall, failing to protect their meager livestock asset, compared to asset-rich households.

Figure & Tables

Figure 1-1 Composition of poverty

	Poor		non-poor
	Chronic poverty	Transient poverty	
Stochastic poverty	Stochastically chronically poor - have more assets than asset poverty threshold, but remain chronically poor for bad luck during surveys.	Stochastically transiently poor - have more assets than asset poverty threshold, but are transiently poor for ups and downs during surveys	Stable non-poor
Structural poverty	Chronic structural poverty - have less assets than asset poverty threshold and observed as chronically poor	Structurally poor but stochastically improve their situation for good luck. - have less assets than asset poverty threshold but are transiently poor for some good lucks	

*Asset poverty threshold is set as the level of assets required to achieve an expected living standard equal to the poverty line.

Source: Based on Carter & Barrett (2006)

2 Growth and chronic poverty in rural Ethiopia

2.1 Introduction

Poverty in Ethiopia represents the typical poverty situation in East Africa. More than 80 per cent of the Ethiopian population relies on low-productivity rain-fed farming for their livelihoods, which are highly vulnerable to climatic disasters. The vulnerability of their incomes to adverse shocks and low productivity can both be causes of poverty prevalence in Ethiopia.

Several studies on poverty dynamics have found that the determinants of chronic and transient poverty may differ, and thus effective policy instruments for each type of poverty also differ. For instance, Jalan and Ravallion (2000) found that the variables of asset accumulation are associated with both chronic and transient poverty, but those of the volatility of asset holdings are only associated with transient poverty. Moreover, the variables that are traditionally associated with poverty (i.e., low grain yields, low education levels, high ratio of younger children, lack of outside job opportunities, the region's attainments in education and health) have a high correlation to chronic poverty but not to transient poverty. Hence, a policy for those who suffer from the volatility of their incomes needs to include protection against adverse shocks, but for chronic poverty policy instruments need the component of long-term investment in human and physical capitals to fundamentally improve their income bases (Jalan & Ravallion, 2000).

Cross-sectional analysis only shows who the poor are at a certain point in time. Hence, to understand who are the chronically (or transiently poor) and to what extent they contribute to the total poverty of the country, we need to investigate poverty dynamics using panel dataset. However, poverty analysis using panel data has other problems. First, a panel is often not long enough to capture the stochastic and structural problems behind the poverty status of a household. Even though we observe that a household consistently lives below the poverty line, they may happen to have bad harvests during our survey

times (Carter & Barrett, 2006). Second, often those long panel surveys are not conducted in the same season for all rounds, which presents another difficulty in controlling the seasonality effect in consumption fluctuation.

Comprehensive household surveys with relatively long panels, such as the Ethiopian Rural Household Surveys (ERHS), are ideal for identifying transient and chronic poverty.² However, the ERHS surveys also did not take place during the same season in each round, and seasonal consumption fluctuations should be controlled. Dercon, Gilligan, Hoddinott, and Woldehanna (2009), Dercon, Hoddinott, and Woldehanna (2012), and Porter (2012a) addressed this problem by combining the long panel collected in Ethiopia and controlling seasonal effects for peak labour and/or postharvest seasons,³ and found that the seasonality explains a large proportion of the consumption variances in rural Ethiopia. I controlled religious fasting practice and village-level religions in addition to the peak-labour season in consumption growth regression and found that a large proportion of consumption growth is correlated to the fasts in the Christian dominant

² These data have been made available by the Economics Department, Addis Ababa University (AAU), the Centre for the Study of African Economies, the University of Oxford (CSAE) and the International Food Policy Research Institute (IFPRI). Funding for data collection was provided by the Economic and Social Research Council (ESRC), the Swedish International Development Agency (SIDA) and the United States Agency for International Development (USAID); the preparation of the public release version of these data was supported, in part, by the World Bank. AAU, CSAE, IFPRI, ESRC, SIDA, USAID and the World Bank are not responsible for any errors in these data or for their use or interpretation.

³ During ploughing and harvesting time (i.e., the peak labour season), agricultural households face higher returns for nutrition and have the incentive to increase their consumption. Similarly, during postharvest time, food prices are low and poor households that do not have good storage capacity might follow the “feast now, fast later” strategy (Dercon & Krishnan, 2000a)

villages. In this chapter, I investigate how the poverty situation in Ethiopia evolved from 1994 to 2009, and how much chronic and transient poverty contributed to that. Extending Ravallion's definition of chronic poverty (1988), I empirically analyze whether the growth paths of the chronically poor are fundamentally different from the non-chronically poor.

The remainder of this chapter is organized as follows. Section 2 explains the events and poverty situation during the early 1990s to late 2000s. The household panel data used for this study are described in section 3. Section 4 descriptively analyzes chronic and transient poverty in the sample villages. Section 5 describes the estimation methods used for modeling the determinants of consumption growth at the household level. I present and discuss the estimation results in Section 6. Conclusions are found in Section 7.

2.2 Events of the 1990s and the 2000s relevant for rural poverty and inequality

The population of Ethiopia is estimated at 102 million (as of 2016), the second most populous country of Africa after Nigeria accounting for 12 per cent of the population of Sub Saharan Africa, and it has continued to grow at an average annual rate of 2.7 per cent since 2000. Severe unemployment in urban areas, coupled with a strict land distribution system that keeps rural residents within their home villages has hindered labour migration to urban cities. Rural population accounts for 83 per cent of the total population (as of 2009). During the 1990s-2000s, per capita GDP had doubled from USD 177.99 in 1994 to USD 511 in 2016 (constant 2010 USD) (Figure 2-1),⁴ and the poverty headcount ratio measured by the international extreme poverty line of USD 1.90 PPP a day fell from 66.4

⁴ GDP per capita is calculated over all the urban and rural sectors contributing to the economy, although in the ERHS, “consumption” only counts rural residents’ private consumption.

per cent in 1995 to 33.5 per cent in 2010. However, even with this rapid improvement, nonmonetary welfare indicators still showed the low living conditions of a large proportion of the population: 28.7 per cent of young children were underweight (low weight for age) and 44.4 per cent were stunted (short for age), and adult literacy was still at a low level (39 per cent), as of 2012. Consistently, Ethiopia was the second poorest among 109 developing countries measured by the Multidimensional Poverty Index (MPI),⁵ as of 2014 (Alkire, Chatterjee, Conconi, Seth, & Vaz, 2014).

In terms of the structure of economy, the share of agriculture in GDP is substantially high (49 per cent of GDP in 2009), and its reliance on rainfed agriculture makes the Ethiopian economy vulnerable to droughts.⁶ After the drought of 2002, a drop of 12 per cent in agricultural output contributed to the decline of 3.8 per cent of real GDP, which was much larger economic damage compared with the 1999 Eritrean War (Bigsten, Shimeles, & Kebede, 2005).

[Insert Figure 2-1 here]

⁵ Accessibility to clean energy, improved sanitation facilities, and secure housing showed high deprivation in Ethiopia.

⁶ During 1990 to 2009, Ethiopia experienced 36 disasters (Appendix 2-2). 24 out of these 36 disasters affected more than 10,000 people, and those were mainly climatic disasters related to rainfall anomalies (Guha-Sapir & CRED, n.d.). Among all the droughts, the ones in 2003, 2008 and 2009 were the largest in scale. 2003 especially witnessed a serious drought, which brought about debates regarding the introduction of more efficient social protection, with the Productive Safety Net Program (PSNP) starting from 2005.

Poverty incidence in urban and rural areas measured as headcount ratios showed almost no difference (Bigsten et al., 2005; R. V. Hill & Porter, 2017). The difference in *urban* and *rural* poverty lies in inequality and vulnerability: the severity of *urban* poverty measured by the squared poverty gap has been intensified by increasing income inequality, although the *rural* poor have suffered vulnerability of their income base rather than the intensifying of inequality.

The economic conditions of Ethiopia during the 1990s were formed by both the legacy of socialist policy adopted by a military dictatorship under the *Dergue* regime and the market-led reforms undertaken by the new government. After the overthrow of the last emperor Haile Selassie's regime in 1974, Ethiopia's feudal land tenure system was reformed under the socialist government (the *Dergue* regime). The reform policy included the nationalization of farm-land and government-led management of agricultural production through peasant associations (PAs). As part of collective farming, the quota system was introduced, which forced farmers to sell a predetermined quantity (i.e., 50 to 100 per cent of their output) of specific grain to the Agricultural Marketing Corporation (AMC) at below-market prices. Each peasant association (PA) determined their AMC quotas based upon their own criteria: fixed quotas were enforced for all the households in some areas, although household specific quotas based upon household resource endowments (i.e., land and ox holdings, engagement in a nonfarm enterprise) were imposed in most of the areas (Franzel et al., 1989). The *Dergue* regime implemented land redistribution through PAs. Each PA, comprising one or a few villages, was responsible for the implementation of the land reform and held administrative powers within the villages. Private ownership of land was prohibited, and households had to register with

the PA to obtain the right to cultivate farm-land. Land distribution was implemented through criteria such as household size and the needs of each farmer until the late 1980s (Dercon, 1996). But even after that, registration with the PA remained essential for farm households.

The year 1991 was the end of the decade of red terror and the socialist regime *Dergue*. Ethiopia announced itself as a federal state comprising nine ethnicity-based regional states and two chartered cities, each of which would have semi-autonomy. The conflicts with Eritrea and Somalia, and a severe famine in 1984 caused the Ethiopian economy to deteriorate during the *Dergue* regime. But inefficient economic policies, and excessive state control over corporate and farm activities also weakened the Ethiopian economy during the *Dergue* regime. The new administration shifted from central planning to a market-led economy. Bilateral and multilateral aid drastically increased. Abolishment of the ban for wage labour, coupled with the promotion of a market economy, increased off-farm job opportunities. Before 1989, wage labour was forbidden, and reciprocal labour sharing arrangements were commonly observed. Due to this change in the factor market in 1994, household involvement in crafts for sale, trading and wage employment has largely increased since 1994 (Dercon 2002). Also, the removal of the heavy tax imposed by the *Dergue* regime on the rural population (i.e., voluntary contribution and a membership fee for peasant associations) contributed to the improvement in the welfare of the rural population.

The most direct benefit from the reform was the increase in agricultural output prices (Dercon, 2002). Food market reform began in 1990, which removed two notorious measures: the quota systems and the inter-regional trade taxes. Those reforms led to a

large real income gain for the farmers in grain-surplus areas; the AMC purchase price was set lower than local market prices, which were already extremely low, due to limited interregional grain trade. In addition, the removal of restrictions on private grain trade generated downward pressure on grain prices in deficit areas (Dercon 2002). As local markets are more closely interconnected, seasonal fluctuation in crop prices became smaller.

2.3 Ethiopian Rural Household Surveys (ERHS)

The first 1989 survey was collected in Amhara, Oromia and the Southern Ethiopian People's Association (later known as the Southern Nations, Nationalities, and Peoples' Region, SNNP) by the International Food Policy Research Institute (IFPRI), covering about 450 households from seven villages. The initial aim of the survey was to examine the effect of the 1984-1985 famine on the welfare of the rural population, and the villages were selected from the areas which suffered from the famine and the following droughts that occurred between 1987 and 1989 (Webb, Von Braun, & Yohannes, 1992a). Later, the Centre for the Study of African Economies (CSAE) of Oxford University and Addis Ababa University revisited six out of seven original villages in 1994, with the aim of initiating panel surveys. The survey was expanded to cover 1,477 households⁷ from the

⁷ Though cultural diversity in Ethiopia makes it harder to define a household, following Dercon & Krishnan (1998), I define a household as "those usually present in the household in one house."

total of 15 villages in 1994,⁸ adding nine additional communities from the Amhara, Oromia, SNNP and Tigray regions. Stratification was conducted, based upon four farming systems (i.e., northern highlands grain-plough complex, central highlands grain-plough complex, southern cereal villages, and southern non-cereal *enset* villages⁹ (Dercon & Krishnan, 1998)). A self-weighting sample was obtained regarding the farming system. Although the data are not nationally representative, the sample represents the non-pastoralist farming system, as of 1994. Surveyed households were randomly selected from each village, stratified by female-headed and male-headed households. The pastoral and urban populations were not covered by this survey. Sample attrition from 1993a to 2009 is as low as 16.1 per cent (approximately 1.1 per cent per year) over 15 years.

[Insert Table 2-1 here]

⁸ The distribution of sampled villages within Ethiopia is described in the map of Appendix 2-1.

⁹ Agriculture studies distinguish two different agricultural cultivation methods, namely, plough farming and hoe culture (Westphal, 1975). The northern and central highlands commonly practice ox-plowing, due to their thick vertisols (black volcanic soils) (Webb, Von Braun, & Yohannes, 1992b), but some southern cereal villages practice hoe culture. In southern non-cereal *enset* villages, a perennial root crop, *enset* (false banana) is consumed as a staple crop. *Enset* is often called a "famine crop," due to its high productivity per unit area, long storability and high resilience to drought (Feleke, Kilmer, & Gladwin, 2005). Where *enset* is planted as a main staple crop, cereals are often planted during the minor rainy season, although people are less reliant on those cereals. Southern cereal villages and southern non-cereal *enset* villages produce cash crops such as coffee and *chat*.

[Insert Table 2-2 here]

As each regional state was created to represent a particular ethnic group, more than 80 per cent of our samples from the Amhara, Oromia and Tigray regions consist of their representative ethnic group (more than 80 per cent) (Table 2-1). The SNNP samples are more diverse in ethnicity, as this area originated from the merger of five different ethnic divisions (*kililochs*).

Orthodox Christians are the majority in Ethiopia, consisting of 53 per cent of our sample, and Orthodox Christians are dominant in Tigray and Amhara (Table 2-2). Muslims and Protestants are prevalent in Oromia and the SNNP respectively. Since the Amhara king, Menelik II, conquered Oromia and the SNNP, the Amhara have constructed their Orthodox churches in newly conquered areas. However, minority ethnic groups were often reluctant to convert to being Orthodox Christians. Instead, some of the minority groups in the SNNP chose to convert to being Protestants when Protestantism was introduced after World War II (Yoshida, 2009). In our sample villages, the minority groups are often peacefully assimilated into the majority population through intermarriage. However, tensions between different religions (Debre Birhan, Amhara) and ethnic groups (Tufe Kechemane, Oromia) were observed. The Arrsi Oromo (in Oromia)¹⁰ have had long-lasting inter-ethnic friction with the Amhara since the Amhara Emperor Menelik II conquered this region at the end of the 19th century. In general, SNNP is the most heterogeneous in terms of religion and ethnicity, and the northern regions (Tigray and Amhara) are ethnically and religiously more homogenous.

¹⁰ The Arrsi Oromos were previously pastoralists but turned into tenants farmers who were obliged to pay a certain proportion to the settlers.

2.4 Poverty and Welfare

For the following descriptive and empirical analysis, I use consumption as a welfare indicator rather than income, since income is highly variable over time compared to consumption expenditure. Rural households often adopt various coping strategies against adverse income shocks, and partially offset the fluctuation in income through informal risk sharing and self-insurance. Consumption aggregates include food consumption (own-production, purchased food, and gifts) and non-food consumption. Non-food consumption is restricted to direct consumables (e.g., matches, soap, and clothes). Monthly food consumption values are derived from the questions on food consumed during the week before the surveys. Non-food consumption does not include either lumpy infrequent expenditure (e.g., education, health and ceremonial expenses) or expenditure on taxes and contributions to funeral associations (*iddir*). Price differences across villages are adjusted using the local market food index. All the consumption aggregates were deflated to 1994 prices. Using the cost-of-basic-needs approach, ERHS surveys set a poverty line at the level of consumption with which a person can purchase a bundle of food items equivalent to 2,300 kcal per adult: 50 birrs per capita per month at the value of 1994 prices.

[Insert Table 2-3 here]

Table 2-3 provides an overview of the poverty and welfare situation during the survey periods. Three poverty measures: the headcount ratio (P0), the poverty gap (P1) and the squared poverty gap (P2) measures all belong to the Foster-Greer-Thorbecke (FGT)

family of poverty measures (Foster, Greer, & Thorbecke, 1984). Each measure was calculated separately for 1994a, 1994b, 1995, 1997, 1999, 2004 and 2009. Unfortunately, survey months differ widely by location and rounds (Table 2-6). The timing of interviews in the years 1994b and 1997 was during or right after the harvest season (i.e., October to December). Thus, changes in marginal utility for nutrition during peak-labour seasons might be reflected, and consumption was possibly overstated.¹¹ These seasonality effects will be investigated further in Section 5. The headcount ratio shows the proportion of the poor to the total population and hence the *incidence* of poverty. Suppose the number of the poor population is q in a population of size n . The headcount ratio P1 is equal to q/n . The headcount ratio is widely used to assess the progress of poverty reduction over time, although the ratio is insensitive to any decrease in the welfare of those who are already poor and thus does not meet the “monotonicity axiom” (Sen, 1976). The poverty gap (P1), on the other hand, measures the mean distance from the poverty line for the poor (normalized by poverty threshold z), showing how far below the poverty line the household falls, hence the *depth* of poverty, i.e., $P_1 = \frac{1}{n} \sum_{i=1}^q \left(\frac{z-y_i}{z} \right)$. A drawback of the poverty gap is insensitivity to the distribution among the poor: the progressive transfer from the richer poor to the poorer poor does not affect P1 (and P0), and thus P0 and P1 violate the “transfer axiom” (Sen, 1976). The squared poverty gap (P2) shows the *severity* of poverty by penalizing a drop in consumption level of the poor who are far below the poverty line, i.e., $P_2 = \frac{1}{n} \sum_{i=1}^q \left(\frac{z-y_i}{z} \right)^2$. Contrary to the P0 and P1, the squared poverty

¹¹ Seasonality from the labour peak season was observed in the study of Dercon & Krishnan (2000b).

gap (P2) is sensitive to inequality among the poor.

These three FGT poverty measures can be generalized into equation (1) by taking a parameter $\alpha = 0, 1$ or 2 , according to the values within each parenthesis. Although Ethiopia in general experienced steady economic growth from 1990-2000s (see Figure 2-1), the surveyed households experienced substantial fluctuation in FGT poverty indicators. The years 1995 and 2009 witnessed rapid increases in all the poverty measures. The headcount ratio in the survey samples increased by 8 percentage points in 1995 and 17 percentage points in 2009 compared to the previous years. The poverty gap and the squared poverty gap also increased, and thus not only the nonpoor became poor but also the poor became poorer. The stochastic dominance approach confirms that the years 1995 and 2009 have unambiguously more poverty than the other years, regardless of what value the poverty line takes. A first-order stochastic dominance relation confirms that not only the headcount ratio but also the poverty gap and squared poverty gap¹² follow the same poverty orderings (Figure 2-2). The intensified poverty in 1995 and 2009 can be explained by high inflation during these periods. The food price index computed with reference to 1994 showed a rapid increase in food prices in 1995 and 2009. 2009 in particular witnesses over 300 per cent increase in food prices compared to those in 1994, partly because of two heavy droughts taking place consecutively in 2008 and 2009, as well as global food price hikes in 2008 (Stifel & Woldehanna, 2016). The food price index is fairly well represented in the increase in the national Consumer Price Index (299 per cent),

¹² The mean gap measure, the Watts index and the CHUC indices also follow the poverty ordering.

compared with the level in 1994.¹³ High food prices was one of the most frequently cited shocks which respondent households experienced in the past five years, answered by 993 households in 2009 survey (Figure 2-3¹⁴). A large increase in input prices and droughts followed in 2009.

[Insert Figure 2-2 here]

[Insert Figure 2-3 here]

Those poverty measures show the poverty status of the sampled households at one point in time and do not show how the poverty status of a household evolves. Some households enjoy a better consumption level on average but drop their consumption level at any point in time due to temporary income shocks under liquidity constraints. Other households endure persistently low consumption levels over time, and some good harvests raise their consumption level only temporarily above the poverty line. To decompose this change in poverty status into *transient* and *chronic poverty*, I employed

¹³ National consumer price index (base=2010) is available at the World Development Indicator (WDI) website. In Ethiopia, consumer price index was 30.97 in 1994 which rose to 90.48 in 2009. To rescale this CPI to 1994 value, I calculated $\frac{90.48}{30.97} \times 100 = 299$.

¹⁴ Graph 3 depicts the frequencies of 10 common shocks. Shock data used here are based upon recall questions on the shocks experienced by the surveyed households in the past five or ten years collected in 2004 and 2009 respectively. Probably because of diminishing memories for the further past events, the number of reported shocks decrease as we trace back to the earlier years. However, the proportion of surveyed households reporting drought in 2002 and 2008, and food price hike in 2008 are still worth to mention.

Ravallion's (1988) approach. Extending Friedman's permanent income hypothesis, Ravallion (1988) defined chronic poverty as the state where household permanent welfare (i.e., the intertemporal mean of household consumption or income) is below the poverty line. By his definition, the chronically poor include not only the "always poor" whose welfare are always below the poverty line but also households whose time-mean consumption is below the poverty line, although the "sometimes poor" may be chronically poor, such as when their consumption dropped sharply during the survey periods (Baulch & Hoddinott, 2000; Jalan & Ravallion, 2000).

Generalized FGT poverty measures are calculated as follows:

$$P_{\alpha,t} = \frac{1}{n} \sum_{i=1}^{q_t} \left(\frac{z - y_{it}}{z} \right)^{\alpha}, \quad (1)$$

where y_{it} is household consumption of household i , z is the poverty line, n is the total number of households in the panel data, q_t is the total number of poor households and α is the parameter for FGT poverty measures. Then, calculate P_{α} *total poverty* as equation 2, following Kurosaki's (2002) notation. Calculate $P_{\alpha,t}$ for all the T periods and compute time-means over time as:

$$P_{\alpha} = \frac{1}{T} \sum_{t=1}^T P_{\alpha,t}. \quad (2)$$

Then calculate the mean of y_{it} over time ($\bar{y}_i$). Define the total households whose time-mean consumption is below P_{α} as q^* . Then *chronic poverty measures* can be calculated as:

$$C_{\alpha} = \frac{1}{n} \sum_{i=1}^{q^*} \left(\frac{z - \bar{y}_i}{z} \right)^{\alpha}. \quad (3)$$

The households with a time-mean consumption below the poverty line are chronically

poor. The difference between *total poverty* (P_α) and *chronic poverty* (C_α) is *transient poverty* (T_α).

Each survey witnessed an approximately 33 to 53 per cent poverty headcount ratio (Table 3). We can decompose the headcount ratios into four groups of poverty: (1) those who are currently poor and chronically poor, (2) those who are currently poor but not chronically poor, (3) those who are not currently poor but chronically poor, and (4) those who are neither currently poor nor chronically poor (Jalan & Ravallion, 1998). Comparing the first two categories of the currently poor, I found that the number of the first group of the currently and chronically poor surpassed that of the second group of the transient poor, except for the periods in 1995 and 2009. The increase in the headcount ratio in 1995 and 2009 was transient, induced by temporal consumption fluctuations during these periods. Among all the surveyed households, approximately 30 per cent were chronically poor, with an intertemporal mean consumptions below the poverty line. Overall, it can be said that the poverty situation in Ethiopia in the 1990s and 2000s was mostly chronic in nature.

If I assume households are risk averse, an increase in risk would increase transient poverty. However, not all poverty measures meet this property. Ravallion (1988) showed that when poverty measures are strictly convex in y_{it} and $p(y, z) = 0$ for all $y > z$, an increase in risk will increase transient poverty if the welfare function is concave in a risky variable. The poverty measures strictly convex in y_{it} are obtained when $\alpha > 1$. Hence, the squared poverty gap (P2) meets this property.

Table 2-4 shows the squared poverty gaps disaggregated into several major household characteristics. Larger households had a larger squared poverty gap over the periods and had higher chronic poverty than smaller households. On the other hand,

poverty amongst small households is more transient, probably reflecting their vulnerability to the shortage of an able-bodied labour force when these households face idiosyncratic shocks such as illness or death of household members. When the poverty measure over the level of agricultural asset holdings is compared, those households with smaller land or ox holdings consistently experienced a larger squared poverty gap during the surveyed periods, leading to relatively more chronic poverty among them than their counterparts. However, households with more than two oxen intertemporally experienced much smaller squared poverty gaps. A two-ox threshold seems to sharply demarcate the nonpoor from the poor more than any other category of subgroup. The households which had access to the Food-for-Work program (FFW)¹⁵ experienced a larger squared poverty gap than those without access to FFW, confirming that FFW targeted the poorest in each village. Accessibility to all-weather roads was associated with less severe poverty, although those households with access to all-weather roads relatively suffer more transient poverty. Ethnicity and religious minority groups (categorized as “others”) are more likely to experience a larger squared poverty gap and chronic poverty.

[Insert Table 2-4 here]

[Insert Table 2-5 here]

The poverty profile was largely heterogeneous over geographical locations (Table 2-5). Table 2-5 summarized the village-level characteristics in ascending order of the headcount ratio. The poverty incidence is slightly more prevalent in the SNNP region.

¹⁵ The FFW programme was the largest food assistance scheme in Ethiopia, on which 80 per cent of food assistance resources was spent. The aim of the project was to address food insecurity through provision of public work employment.

The provision of FFW was largely observed in the three villages with the highest chronic poverty prevalence, although some villages without severe chronic poverty also received the workfare support. To investigate the association between the prevalence of poverty and adverse rainfall shocks, I included the levels and variances of rainfall in Table 2-5. Levels and variances of rainfall are respectively represented by the *woreda* (district) long-term mean rainfall and the coefficient of variations (CV)¹⁶ calculated over 15 years (1994-2009). Monthly cumulative rainfalls at *woreda*-level were calculated and estimated by the United States Geological Survey (USGS) using satellite images. Surveyed villages experienced a main rainy season, *kiremt* in summer (June-September) and a minor rainy season, *belg* in spring (February-May). Southern and south-central parts of the country receive both *belg* (February-May) and summer *kiremt* (June-September) rains and conduct double cropping (Table 2-6), but several villages often observed late and insufficient *belg* rain and did not plant any crops in those years. The long-term means and CVs of the nearest *kiremt* and *belg* seasons preceding the survey were calculated for each PA. Unfortunately, ERHS surveys were not conducted in the same months over the locations and rounds. Hence, the main rainy seasons relevant to the surveys did not always coincide with the survey years (Table 2-6). Depending on the rounds and locations, zero to 11 months passed from the last *kiremt* rainy season at the point of the surveys.

Both levels and variances of *kiremt* rain seem to weakly affect the prevalence of chronic poverty. Smaller long-term mean rain during *kiremt* is associated with the prevalence of chronic poverty. Five villages with less than 300 mm long-term *kiremt* mean rainfall experienced a high prevalence of chronic poverty. Although less obvious, high

¹⁶ Defined as $\left(\frac{SD_{Woreda}}{MEAN_{Woreda}} \right) \times 100$

variances of *kiremt* rain also seem to be associated with high chronic poverty. Five villages with large rainfall CVs above 30 per cent during the *kiremt* season have had high chronic poverty. Variations and levels of the minor rainy season (*belg*) do not have a clear association with chronic poverty. This is because the surveyed households rely for 80 per cent of their income on agriculture and 94 per cent of agricultural income relies on *kiremt* rains for crop production. Our sample shows that *kiremt* has relatively larger and less volatile rainfall than *belg*, further supporting this logical explanation.

[Insert Table 2-6 here]

Inconsistencies in the surveyed months require further consideration regarding seasonality effects. In 1997 and 1999, most of the households were surveyed from July to November after the harvest of *belg* rain (Table 2-6). From July to November, *belg*-receiving areas are usually still in good condition after the harvest of *belg*. On the other hand, single cropping areas were experiencing a lean season during this period, i.e., from mid-June to early September. This large time gap may be unavoidably reflected in the household consumption patterns and eventually in the poverty patterns of each village. The seasonality effects will be investigated using month fixed effects, as well as several time-effect dummies regarding PA specific peak-labour dummies and Christian fasting season dummies.

[Insert Table 2-7 here]

First, I regress initial household and village characteristics during the 1994 survey on whether the household is chronically poor. Table 2-7 reports the marginal effects of probit regressions. I first control village fixed effects and explicitly control village-level explanatory variables possibly determining chronic poverty. As village-level ethnic and religion variables, Herfindahl Indexes (HHI) are calculated to control the degree of dominance of the majority group religion and ethnicity in each village. In addition to the village-level ethnic and religious variables, household-level ethnic and religious minority dummies are introduced to control whether the minority households are more likely to be chronically poor, all things being equal.

Favorable household characteristics such as education level, livestock- and land-holdings have negative significant effects on the possibility of being chronically poor at 1 per cent significance levels. A large negative effect of formal education participation suggests that if one more person participates in formal education in addition to the average number of household members participating in formal education, the household is 5 per cent less likely to be chronically poor. Although being a religious minority and living in religiously fragmented villages associated with chronic poverty, those of ethnic minority and ethnic HHI variables do not have significant parameters. The reason for this may be that the ethnicity is, rather, an externally determined category, and religions are determined by the choice of households. For instance, in the SNNP, ethnicity is much more diversified than in any other region, and each ethnic group has different livelihoods and cultures, which cause stigma for certain occupations. Those in the minority group discriminated against often choose new religions as a way to establish their identity (Yoshida, 2009), and religious diversity rather than ethnicity may better represent their minority identity. The southern ethnic groups, *Gurage* and *Wolaita* are more likely to be chronically poor, although those effects might not be ethnicity-specific but location-specific. In the ERHS sample, 97 per cent of *Gurage* and 88 per cent of *Wolaita* live in Imidibir and Gara Godo villages respectively, where we observed the severest chronic

poverty, and thus I can not distinguish whether these disadvantages lie in the ethnicity or the village where they live.

2.5 Empirical strategies

Applying a standard growth model, I investigate the equation (4). $\ln y_{i,t}$ is logged real monthly consumption per capita of household i at round t . If consumption grows toward the convergence conditional on household and village characteristics, the parameter β_0 takes negative values¹⁷ (conditional β -convergence). Village dummies capture fixed characteristics of the peasant association (PA), such as common climate and geographical conditions. Other sources of growth from $t-1$ to t are exogenous levels of physical and social capital k_{it-1} . The consumption smoothing theory predicts that transitory shocks do not affect current consumption where credit market functions so that households can supplement the reduced income by borrowing. Only large adverse shocks to permanent income would affect optimal consumption. Previous studies often observed persistent large effects of past adverse events on current consumption growth (Dercon, 2004). Thus, exogenous rainfall shocks (S) at points t and $t-1$ are controlled as:

$$\ln y_{i,t} - \ln y_{i,t-1} = \alpha + \beta_0 \ln y_{i,t-1} + \beta_1 k_{it-1} + \beta_2 S_{it} + \beta_3 S_{it-1} + \beta_4 \mathbf{X}_{it} . \quad (4)$$

Previous studies based on ERHS data used woreda-level log changes in annual rainfalls. However, only the rainfalls within the specific periods preceding planting matter for good harvests. Thus, I control adverse *kiremt* and *belg* rainfall shocks explicitly and

¹⁷ β -convergence is achieved when we observe the parameter of initial per capita income (in this case β_0) take a negative value, confirming poorer households grow faster than rich households. Another convergence, σ -convergence, is achieved when the variance of per capita income shrinks over time. The variance of per capita consumption decreases over time in our sample and we could observe the tendency of σ -convergence (See Appendix 2-4).

use their percent deviations from long-term means.

A problem of equation (4) is that time gap between each round of the ERHS survey was not evenly spaced, and the $\ln y_{i,t} - \ln y_{i,t-1}$ does not represent the per year growth rate of consumption the per capita but *per round* growth rate. The length of each round widely varied, from three months (between 1994b and 1995) to five years (between 1999, 2004 and 2009), and thus it is not appropriate to treat the changes in each variable as we do with evenly-spaced panel data. Previous studies annualized dependent variables and either used only four rounds with five equal year gaps, i.e., 1994a, 1999, 2004 and 2009 (Dercon et al., 2012) or imposed a strict assumption on the changes in independent variables (Dercon et al., 2009; Porter, 2012). I use the second method in my main analysis and will present the first method in Appendix 2-6. Round 2 (1994b) was omitted in both cases since the round divides round 1 (1994a) and round 3 (1995) with less than one year. In case we can observe only t and $t-2$, the annual consumption growth estimate will be obtained by adding (4) and (5) (i.e., lagged (4)) and dividing by two, as:

$$\ln y_{i,t-1} - \ln y_{i,t-2} \quad (5)$$

$$= \alpha + \beta_0 \ln y_{i,t-2} + \beta_1 k_{it-2} + \beta_2 S_{it-1} + \beta_3 S_{it-2} + \beta_4 X_{it-1},$$

$$(\ln y_{i,t} - \ln y_{i,t-2})/2 \quad (6)$$

$$= \alpha + \frac{\beta_0 (\ln y_{it-1} + \ln y_{i,t-2})}{2} + \frac{\beta_1 (k_{it-1} + k_{it-2})}{2}$$

$$+ \frac{\beta_2 (S_{it} + S_{it-1})}{2} + \frac{\beta_3 (S_{it-1} + S_{it-2})}{2} + \frac{\beta_4 (X_{it} + X_{it-1})}{2}.$$

The left-hand side is annual average consumption growth, and the right-hand side is the average level of explanatory variables. Generalizing equation (6) to obtain an annual average growth estimate between t and $t-p$, we can write

$$(\ln y_{i,t} - \ln y_{i,t-p})/p \quad (7)$$

$$= \alpha + \frac{\beta_0 (\ln y_{it-1} + \ln y_{i,t-2} + \dots + \ln y_{i,t-p})}{p} + \frac{\beta_1 (k_{it-1} + k_{it-2} + \dots + y_{i,t-p})}{p}$$

$$\begin{aligned}
& + \frac{\beta_2(S_{it} + S_{it-1} + \dots + S_{it-(p-1)})}{p} + \frac{\beta_3(S_{it-1} + S_{it-2} + \dots + S_{it-p})}{p} \\
& + \frac{\beta_4(X_{it} + X_{it-1} + \dots + X_{it-p})}{p}.
\end{aligned}$$

Since we can observe only t and $t-p$ ¹⁸, we can not obtain all the right-hand side variables. Here we impose the assumption that changes in y , k , S , and X are relatively slow, and thus $y_{it-1} \approx y_{it-p}$ and so do k , S and X . Then we can rewrite (7) as follows:

$$\begin{aligned}
& (\ln y_{i,t} - \ln y_{i,t-p})/p \\
& = \alpha + \beta_0 \ln y_{i,t-p} + \beta_1 k_{i,t-p} \\
& + \beta_2 S_{it-(p-1)} + \beta_3 S_{it-p} + \beta_4 X_{it-p}.
\end{aligned} \tag{8}$$

Introducing error term ϵ_{it} , we can obtain the following equation:

$$\begin{aligned}
& (\ln y_{i,t} - \ln y_{i,t-p})/p \\
& = \alpha + \beta_0 y_{i,t-p} + \beta_1 k_{i,t-p} \\
& + \beta_2 S_{it-(p-1)} + \beta_3 S_{it-p} + \beta_4 X_{it-p} + \epsilon_{it-p}.
\end{aligned} \tag{9}$$

Error term (ϵ_{it}) consists of time-invariant household and village fixed effects (μ_i) and a time-varying (u_{it}) white noise error term with a mean of zero (Islam, 1995). By equation (9), we expect that all the households converge to their own steady-state consumption levels, determined by their household and village characteristics (“conditional convergence”). Since some of those characteristics are not observable, we have good reason to believe that those unobservable fixed effects (μ_i) partly determine the steady states and might correlate to y_{it-p} . Hence $E(y_{it-p}\mu_i) \neq 0$ and $E(y_{it-p}\epsilon_{it-p}) \neq 0$. To address this potential endogeneity, I use a fixed effects model.

In addition, I control village-round fixed effects and month fixed effects. Village-round fixed effects are introduced to control time-varying village- and round-level unobservables. With rain shock variables, village-round fixed effects control aggregate

¹⁸ Annual rainfall S_{it} data are available and then I can use $S_{it-(p-1)}$.

shocks, except for the rain-induced shocks. The effects of seasonality will be first controlled by month fixed effects, and then will be decomposed by two seasonality dummies representing fasting and peak-labour seasons (i.e., ploughing and harvesting seasons).

I would like to explore whether the chronically poor, as well as the non-chronically poor, were similarly responsive to idiosyncratic and covariate adverse shocks, and benefited from a favorable economic environment such as access to FFW and distance to town. I include interaction terms in equation (4) to describe potential differential effects between the chronically poor and the rest of the sample. The dummy variable of chronic poverty is defined as those households with real intertemporal mean consumption per capita below the poverty line, ETB 50 at the 1994 price¹⁹. Dercon, Hoddinott, and Woldehanna (2012) similarly investigated whether the chronically poor benefit from agricultural extension services and all-weather road as the rest did. This paper extended their study to include rainfall variables specific to the agricultural calendar, other favorable economic conditions and shocks. If the chronically poor are more vulnerable to the shocks, all things being equal, negative coefficients in their interactions with shock variables would be expected. Similarly, if the chronically poor did not take advantage of favorable economic conditions while others did, negative coefficients in their interactions with economic infrastructure variables and positive coefficients in the main effects of economic opportunities would be expected.

To avoid a potential endogeneity problem (i.e., program placement effect), I use a village-level FFW access mean rather than a household-level FFW access variable. The village-level FFW access mean variable represents the average probability to gain access

¹⁹ To compare this poverty line with the global poverty line (USD 1.25 per day at 2005 PPP), I calculate $\frac{ETB50}{GDP\ PPP\ converter, (LCU/USD)} \times \frac{2005\ PPP\ conversion\ factor}{PPP\ conversion\ factor\ at\ 2005} = ETB\ 50 \div 1.80 \times \frac{2.25}{2.14} = 29.21, PPP\ constant\ USD\ (2005\ price)$. This is equivalent to USD 0.97 (PPP, 2005 price).

to FFW within the village, calculated by excluding household i . In addition to the rainfall per cent deviation from the long-term average, I include a dummy for idiosyncratic crop shocks equal to one if a household experiences at least one of the following shocks during the *kiremt* rain season: low temperature, wind/storm, flood, plant disease, insects, livestock trampling, birds/other animals and weed damage.

Seasonality will be first controlled by survey month fixed effects as month-specific intercepts but will be explicitly investigated through introducing seasonality variables (Christian fasting & peak-labour dummies). Conventionally, seasonality is considered as a constraint on consumption smoothing. For instance, high seasonal agricultural income fluctuation under a situation such as lack of efficient storage for harvested crops, insufficient market integration, and liquidity constraints, can result in a seasonal fluctuation in consumption if there is lack of sufficient market integration, storage capacity for harvested crops and more liquidity constraints. However, households may strategically fluctuate their consumptions aligned with their seasonal preference and price variation (Paxson, 1993), as well as a profit maximization strategy related to nutrition-productivity linkage (Dercon & Krishnan, 2000b). While seasonality is cyclical and predictable, transitory shocks are unpredictable to households, and may decrease their consumption to a larger extent under liquidity constraints.

The majority of Ethiopians (53.5 per cent in our samples) are Orthodox Christians who faithfully conduct 180-250 days of fasting per annum. An Orthodox Christian begins fasting at the age of 13 and abstains from meat and dairy products on fasting days. The particularly faithful Christians often abstain from eating and drinking before 3 pm during these periods. The association of consumption and fasting practice was not well investigated, except that Hirvonen, Taffesse, and Worku Hassen (2016) observed a large reduction in calorie intake as well as dietary diversity among the Ethiopian urban population during fasting months. Fasting is qualitatively different from the other seasonalities such as peak-labour season, when conserving a healthy labour force for

labour-intensive agricultural work is an essential survival strategy for the poor. The Orthodox Christians follow seven official fasts. I created a fasting dummy for when the survey took place during the times of the four long fasts (fast of the Prophet, fast of Assumption of the Virgin Mariam, fast of Hudadi, fast of the Apostles) (Appendix 2-5). The fasts shorter than seven days are not likely to be reflected in monthly consumption expenditure and are not included.

[Insert Table 2-8 here]

Descriptive statistics on household and community characteristics for the sample are reported in Table 2-8. Means for subsamples of chronically poor and non-chronically poor are tested and presented. Interestingly, annual consumption growth per capita is not statistically different between the chronically poor and the non-chronically poor. This is contrary to what transition dynamics predict, that the poorer grow faster than the richer. The chronically poor tend to have larger dependency ratio and household size. Also, the chronically poor have less educated household members, smaller oxen and land holdings, and larger accessibility to FFW. Slightly more female-headed households face chronic poverty than male-headed households.

2.6 Empirical findings

Consumption growth regression results are shown in Table 2-9. Negative coefficients for the lagged dependent variables confirm the conditional convergence of the consumption growth path. Consistent with descriptive statistics, larger households, female-headed households, less educated households, and households with fewer livestock and land holdings tend to have smaller consumption growth. Both lagged *kiremt* and *belg* rainfall shocks in the previous years have negative and significant coefficients. For example, a severe lack of *kiremt* rainfall during the previous year (50 per cent negative

deviation from long-term mean, similar to the ones observed in 1995 and 2009) reduces annual consumption growth by 10 per cent. The main effects of idiosyncratic crop shocks are not consistently negative, although the coefficients for their interaction term with the chronically poor dummy have relatively large negative effects on the consumption growth. Experiencing one of these idiosyncratic shocks reduces about 1 percentage point losses in the consumption growth of the chronically poor. Villages with larger average accessibility to FFW have negatively significant coefficients on consumption growth, confirming that FFW targeted the poor and food-insecure villages. Interaction between FFW and the chronically poor dummy is not significant, suggesting that consumption of the chronically poor does not have clear positive association with FFW access. This confirms that FFW transfer might address transient poverty, although it does not address chronic poverty.²⁰ Distance to the nearest town in kilometers has negative coefficients consistently throughout different specifications: 1km further from the nearest towns costs villagers losses of 4 percentage points in consumption. The chronically poor are negatively affected by the remoteness even more. Being chronically poor in a remote village costs an additional 1 percentage point reduction in consumption growth. In sum, the results from Column 3 suggest that the chronically poor responded to idiosyncratic shocks, as well as favorable economic conditions, differently. The fasting dummy is significant for all the specifications: during the fasting season, household consumption decreases by 6 percentage points. This effect is even larger where more than 50 per cent of households are Orthodox Christians, adding an additional 7 percentage point reduction in consumption. This might be because during fasting periods, production of meat and dairy products stops and those products become almost inaccessible to any households. The village-level peak labour dummy, also has positive and significant coefficients,

²⁰ Dercon & Krishnan (2002) also observed that FFW targeted a larger population than it should have and the poorest did not receive what they needed (i.e., inclusion error).

supporting the previous observations by Dercon & Krishnan (2000a, 2000b). During the peak-labour season, household labour forces engage in labour-intensive agricultural work, and the increase in food consumption would contribute to the increase in aggregate consumption.

[Insert Table 2-9 here]

2.7 Conclusion

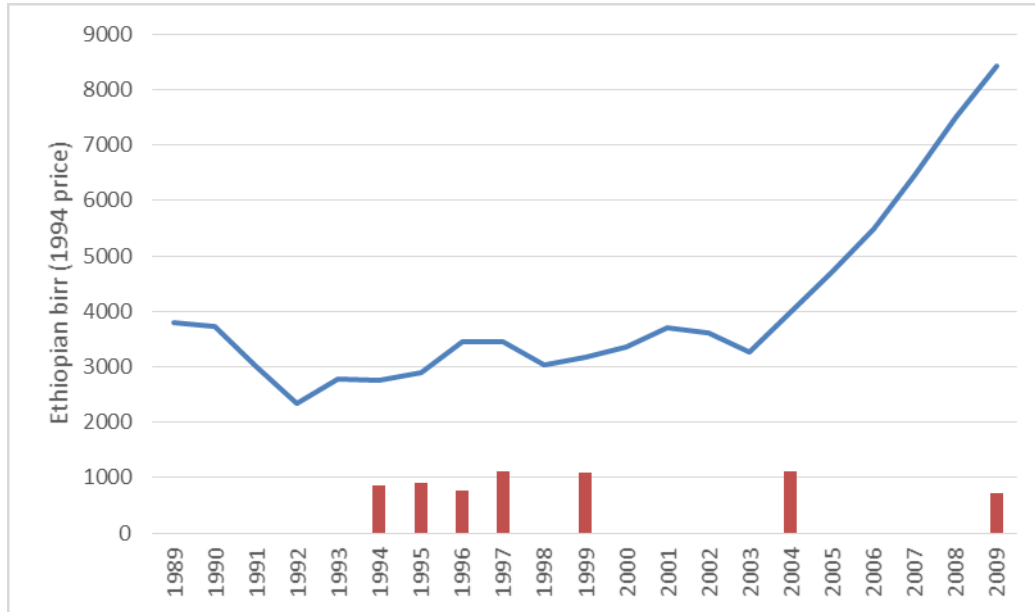
Favorable poverty reduction policies targeted at transient poverty and at those living in chronic poverty are different. Transient poverty is a problem of vulnerability and should be addressed through protection from adverse income shocks and relaxing liquidity constraints. In addition, tackling chronic poverty needs to increase intertemporal mean incomes of the poor through various policy instruments such as investment in human capital and the promotion of new agricultural technologies. Hence, understanding the extent of chronic and transient poverty and the determinants of each type of poverty is essential. In Ethiopia, we observe that the currently and chronically poor are 20 per cent of our sample households, and more than half of those observed living in poverty in 1994-2009 were chronic in nature. The intensity of both poverty and chronic poverty seems to correlate with various household characteristics. Larger households were more likely to face severer poverty regarding the squared poverty gap and to be found in chronic poverty. Moreover, small households seemed more vulnerable to the shortage of an able-bodied labour force when the households face idiosyncratic shocks such as illness or death of household members. Lack of productive asset holdings such as land and oxen is associated with a larger squared poverty gap and more chronic poverty.

I confirmed this tendency through empirical analysis and found the chronically poor were more adversely affected by idiosyncratic crop shocks and remoteness than their counterparts. Idiosyncratic crop shock in particular has large negative coefficients for the

chronically poor, possibly contributing to divergence of consumption growth between the chronically poor and the non-chronically poor. Religious fasting practices and seasonal labour requirements explain a large proportion of consumption variation: during the fasting season, household consumption decreases by 6 percentage points, and this effect is even larger where the large majority of resident households are Orthodox Christians.

Figures & Tables

Figure 2-1 Trends in the growth of survey consumptions and national GDP per capita



Source: ERHS & WDI. Author's calculation.

Table 2-1 Ethnicity by regions

Ethnicity	Region				Total
	Tigray	Amhara	Oromia	SNNP	
Amhara	0	88.28	8.4	1.13	31.25
Oromo	0	2.3	81.98	1.36	23.66
Tigrawai	88.67	0	5.93	0	10.64
Gurage	0	0	0.49	15.16	4.68
Other	0.67	5.44	0.74	5.2	3.59
Gedeo	0	0	0	28.51	8.54
Gamo	10.67	0	0	12.22	4.75
Kembata	0	0	1.23	14.93	4.81
Woliata	0	0	1.23	21.27	6.71
Hadiya	0	0	0	0.23	0.07
Argoba	0	3.97	0	0	1.29
Total	100	100	100	100	100

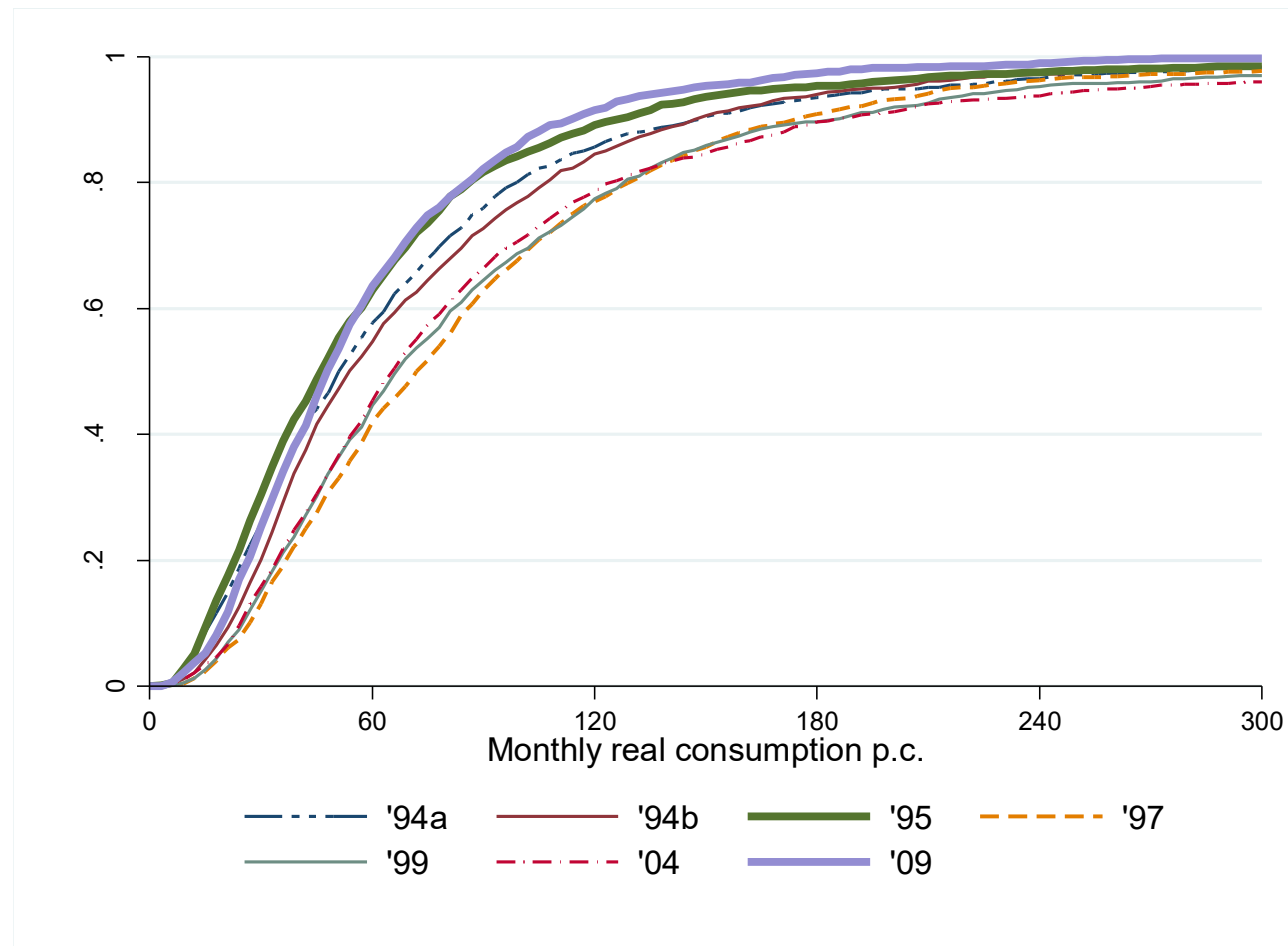
Source: Author's calculations from ERHS.

Table 2-2 Religion by regions

Religion	Region				Total
	Tigray	Amhara	Oromia	SNNP	
None	0	0.22	0	2.04	0.69
Orthodox christian	84	87.42	33.83	25.62	53.51
Catholic	2	1.3	3.48	8.39	4.13
Muslim	14	11.06	58.46	2.95	22.01
Other christian	0	0	0.25	0.45	0.21
Protestant	0	0	3.98	56.46	18.23
Traditional	0	0	0	2.72	0.83
Other	0	0	0	1.36	0.41
Total	100	100	100	100	100

Source: Author's calculations from ERHS.

Figure 2-2 Poverty incidence curve



Source: Author's calculations from ERHS.

Table 2-3 Poverty statistics 1994-2009

Balanced panel povety statistics

	Mean real cons per capita	Median real cons per capita	Headcount ratio	Poverty gap	Squared poverty gap	Poor in current year and chronically poor (%)	Poor in current year and not chronically poor (%)	Not poor in current year and chronically poor (%)
1994a	70.078	51.597	0.477	0.211	0.120	24.787	22.913	5.111
1994b	71.624	52.621	0.471	0.175	0.086	25.043	22.061	4.855
1995	60.415	44.862	0.557	0.246	0.140	27.342	28.365	2.555
1997	90.950	70.489	0.331	0.117	0.058	20.187	12.947	9.710
1999	86.921	63.911	0.365	0.133	0.066	20.358	16.184	9.540
2004	91.773	64.794	0.357	0.131	0.067	19.165	16.525	10.733
2009	59.112	47.564	0.525	0.207	0.110	24.787	27.683	5.111

Source: Author's calculations from ERHS.

Table 2-4 Breakdown of Squared Poverty Gap by different groups

Variable	Poverty squared gap										% of transient poverty to total poverty	obs
	1994a	1994b	1995	1997	1999	2004	2009	total poverty	chronic poverty	transient poverty		
Small HH (<6 persons in HH)	0.08	0.05	0.09	0.04	0.04	0.06	0.11	0.07	0.01	0.05	0.81	521
Large HH (≥6 persons in HH)	0.15	0.12	0.18	0.07	0.08	0.08	0.11	0.11	0.04	0.07	0.66	653
Large land holdings (≥ 1Ha)	0.09	0.06	0.09	0.04	0.04	0.03	0.05	0.06	0.01	0.05	0.80	644
Small land holdings (< 1Ha)	0.15	0.12	0.20	0.08	0.10	0.11	0.19	0.14	0.05	0.09	0.66	530
Ox-holdings (≥ 2 oxen)	0.04	0.02	0.05	0.01	0.01	0.01	0.03	0.03	0.00	0.02	0.95	89
Ox-holdings (< 2 oxen)	0.13	0.09	0.15	0.06	0.07	0.07	0.12	0.10	0.03	0.07	0.70	1085
Received FFW more than once	0.16	0.12	0.21	0.09	0.09	0.10	0.18	0.14	0.05	0.08	0.61	199
Received FFW only once	0.19	0.12	0.19	0.07	0.09	0.07	0.14	0.13	0.04	0.09	0.71	336
FFW not received	0.07	0.06	0.09	0.04	0.05	0.06	0.07	0.06	0.01	0.05	0.76	639
Had access to all-weather road in 1994a	0.12	0.07	0.13	0.05	0.06	0.05	0.09	0.08	0.02	0.06	0.73	829
Did NOT have access to all-weather road in 1994a	0.12	0.11	0.17	0.08	0.07	0.11	0.17	0.12	0.04	0.08	0.67	345
Head's religion (Orthodox)	0.10	0.06	0.12	0.04	0.05	0.04	0.10	0.07	0.02	0.05	0.71	633
Head's religion (Muslim)	0.16	0.11	0.13	0.06	0.06	0.09	0.08	0.10	0.03	0.07	0.73	259
Head's religion (Others)	0.14	0.11	0.20	0.09	0.12	0.11	0.16	0.13	0.04	0.09	0.68	282
HH ethnicity (Amhara)	0.05	0.03	0.06	0.02	0.03	0.01	0.04	0.04	0.00	0.03	0.89	363
HH ethnicity (Oromo)	0.10	0.07	0.08	0.04	0.04	0.07	0.04	0.06	0.01	0.05	0.81	270
HH ethnicity (Tigray)	0.14	0.09	0.18	0.04	0.06	0.07	0.24	0.12	0.03	0.09	0.77	129
HH ethnicity (Others)	0.19	0.14	0.23	0.10	0.12	0.11	0.18	0.15	0.06	0.10	0.62	412

NOTE: All the subamples were created based upon 1994a values, unless otherwise specified. Balanced panel of 1174 households.

Source: Author's calculations from ERHS.

Table 2-5 Difference in prevalence of chronic poverty

Region, zone	Village	Headcount ratio	chronic poor (%)	mean real cons per capita	kiremt long term	Coef of var (kiremt)	Belg long term mean	Coef of var (belg)	Ethnicity (HHI)	Religion (HHI)	mean no. of rounds /w FFW	median no. of rounds /w FFW	Obs
Oromia, East Shoa	Sirbana Goditi	0.15	0.03	115.29	411	26.56	134	27.86	0.62	0.96	0	0	469
	Debre Berhan Milki	0.23	0.04	120.60	387	29.33	94	52.68	0.94	1.00	0	0	399
Amhara, North Shoa	Debre Berhan Bokafia	0.21	0.00	102.03	387	29.33	94	52.69	0.85	0.90	0	0	350
	Debre Berhan Kormargefia	0.22	0.03	92.16	387	29.36	94	52.73	0.79	0.95	0	0	217
	Debre Berhan Karafino	0.24	0.04	120.79	387	29.38	94	52.77	1.00	0.85	0	0	168
Oromia, East Hararche	Adele Keke	0.25	0.04	90.89	327	10.37	249	26.96	0.96	0.88	0.5432099	0	567
Amhara, North Shoa	Shumshea	0.21	0.03	101.74	466	30.77	76	129.77	1.00	0.97	1.141414	1	693
Amhara, East Gojam	Yetmen	0.32	0.10	78.36	573	19.22	128	48.74	1.00	1.00	0	0	336
Oromia, West Arsi	Trirufe	0.39	0.23	83.63	314	23.98	340	18.72	0.36	0.34	0.1772152	0	553
SNNP, Geamogofa	Doma	0.50	0.33	69.07	155	35.07	369	17.93	0.58	0.50	1.254902	1	357
Tigray, East Tigray	Haressaw	0.50	0.36	65.79	249	40.07	74	71.96	1.00	0.81	2.521739	3	483
SNNP Kembata Tembaro	Azedebao	0.56	0.38	61.52	292	21.50	392	23.39	0.79	0.88	0.6323529	1	476
SNNP, Gedio	Adado	0.57	0.45	57.52	181	41.15	397	21.32	0.90	0.48	0.0105263	0	665
Oromia, Arsi	Korodegaga	0.56	0.46	56.02	346	27.35	132	55.75	1.00	0.93	0.8024691	1	581
Amhara, North Shoa	Dinki	0.59	0.47	58.82	352	30.42	107	48.43	0.38	0.52	0.4166667	0	504
Tigray, East Tigray	Geblen	0.66	0.63	52.33	240	42.27	64	67.27	0.61	0.65	1.614035	1	399
SNNP, Guraghe	Imdibir	0.69	0.60	45.50	461	19.31	329	20.15	1.00	0.38	1.103448	1	406
SNNP, Wollayta	Gara Godo	0.76	0.73	41.87	324	18.31	445	24.70	0.83	0.48	1.294118	1	595

Note: Summary statistics are reported based upon balanced observations on consumptions available for all seven rounds.

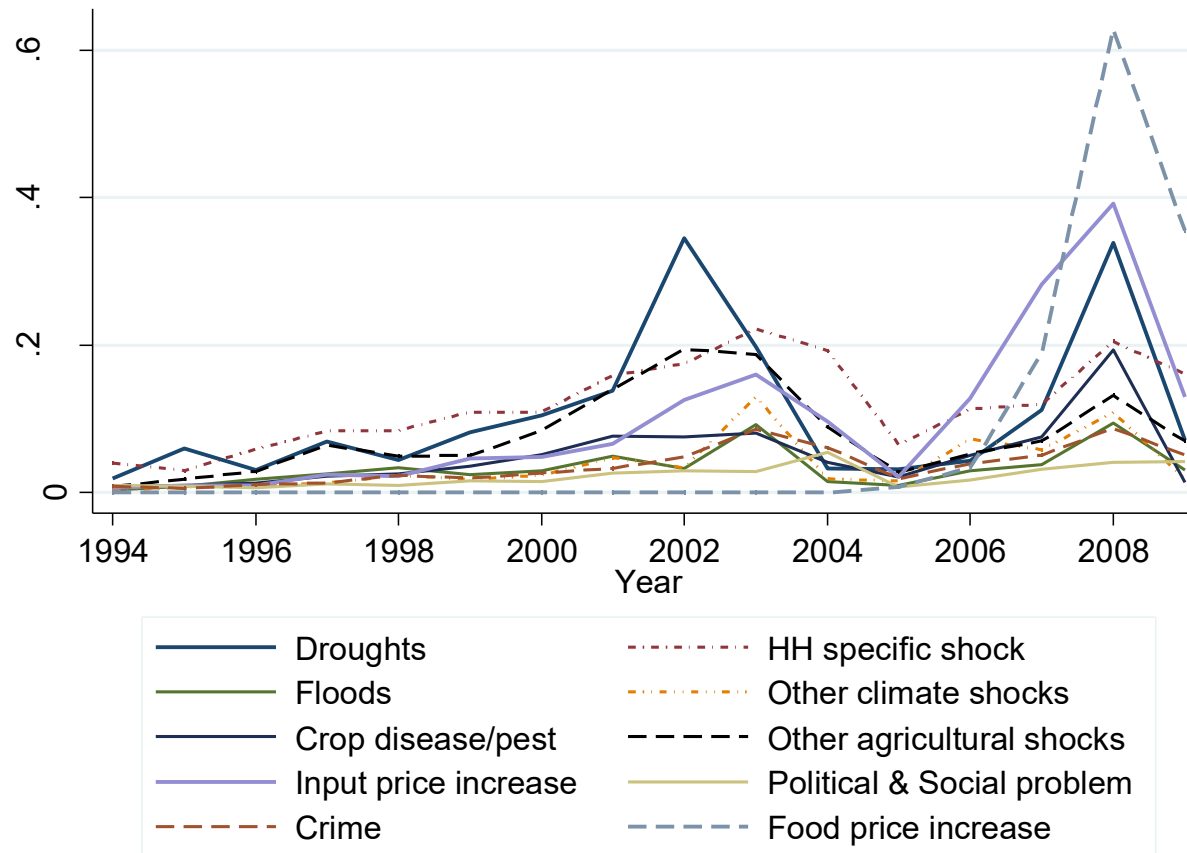
Source: Author's calculations from ERHS.

Table 2-6 Surveyed Locations & Timings

Survey round (Time of interview)													
Region	Village	Farming system	Availability of double cropping	Peak labour time	Main Harvest	1989	Round 1 1994	Round 2 1994-95	Round 3 1995	Round 4 1997	Round 5 1999	Round 6 2004	Round 7 2009
Tigray	Haresaw	Northern highland	Unreliable belg & meher	Mar-May, Oct-Nov	Oct- Nov		Jun-Jul	Jan	Mar	Jun	Aug	Apr	Apr-May
Tigray	Geblen	Northern highland	Meher only	Mar-May, Oct-Nov	Oct-Nov		Jun-Jul	Jan	Mar	Jun	Sept	May	Nov-Aug
N. Shoa	Dinki	Central highland	Unreliable belg & meher	Jun-Sept, Dec	Dec	Mar-Apr	Mar-Apr	Nov	Jan	Oct, Nov	Aug	May, Jun	Jun-Jul
N.Shoa	Debre Berhan	Central highland	Unreliable belg & meher	Jun-Jul, Nov-Dec	Nov-Dec	Mar-Apr	Mar-Apr	Oct	Mar	Jun-Aug	Jul	Apr, May	Apr-May
Gojjam	Yetmen	Central highland	Unreliable belg & meher	Jun-Jul, Nov-Dec, Jan-Feb	Nov- Dec		Mar-Apr	Oct	Mar	Sept, Oct	Jun	May, Jun	May-Jun
S.Wollo	Shumsha	Central highland	Unreliable belg & meher	Apr-Jun, Oct-Dec, Jan-Feb	Oct-Dec		Jun-Jul	Dec-Jan	May	Oct, Nov	Sept	Apr, May	Apr-May
Shoa	Sirbana Godeti	Central highland	Unreliable belg & meher	Apr-Jul, Nov-Jan, Feb	Nov-Dec		Mar-Apr	Nov	Mar	Jun, Jul	Jun	Apr, May	Apr-May
Hararghe	Adele Keke	Sorghum plough/ hoe	Unreliable belg & meher	Mar-Apr, Nov-Dec	Nov-Dec	Nov-Dec	May-Jun	Oct	Apr	Oct, Nov	Jun	Apr, May	Apr-Jul
Arssi	Koro-degaga	Grain plough	Meher only	Jul-Nov, Oct-Nov	Oct-Nov	Nov-Dec	May-Jun	Nov-Dec	May- Jun	Jun, Jul	Aug	May	May-Jun
S.Shoa	Turfe Kechemane	Grain plough	Belg & meher	Dec, Jun-Jul	Dec	Dec	Mar-Apr	Sept-Oct	Mar- Apr	Sept, Oct	Jun	May, Jun	May-Jun
Shoa (Gurage)	Imdibir	Enset	Belg & meher	Oct-Dec, Jan-Feb	Oct-Dec		Mar-Apr	Oct	Mar	Jun, Jul	Jun	Apr, May	May
Shoa (Kembata)	Aze Deboa	Enset	Belg & meher	May-Jun, Oct-Nov	Oct-Nov		Mar-Apr	Sept-Oct	Mar	Sept, Oct	Jun	Jul	Jul
Sidamo (Dilla)	Addado	Enset	Belg & meher	Dec-Jan, Feb	Dec-Jan		Mar-Apr	Jan	Apr	Jun, Jul	Sept	Apr, May	Apr-May
Sidamo (Wolayta)	Gara Godo	Enset	Belg & meher	Sept-Oct, Nov-Dec	Aug-Dec	Mar	Mar-May	Oct	May	Jun, Jul	Jun	Apr, May	Apr-May
Gama Gofa	Doma	Enset	Belg & meher	Jun-Jul, Oct-Dec	Sept-Dec	May-Jun	Apr-May	Dec-Jan	May-Jun	Nov	Sept	May, Jun	May-Jun

Source: Community Survey ERHS, Dercon & Krishnan (2000), Dercon & Hoddinott (2011)

Figure 2-3 Types and frequencies of shocks from 1994-2009



Source: Author's calculation based on recall data collected in 2004 & 2009.

Table 2-7 Correlate of chronic poverty

	(1)	(2)	(3)
	Probit w/village effect dF/dx	Probit w/ethnic & religion indexes dF/dx	Probit w/ethnic & religion dummies dF/dx
Dependency ratio	0.000641*** (4.380)	0.000585*** (3.960)	0.000634*** (4.306)
Household size	0.0598*** (9.630)	0.0613*** (10.547)	0.0545*** (9.089)
Female head (0/1)	0.0753** (2.047)	0.0185 (0.541)	0.0277 (0.779)
No. HH members w/ formal EDU	-0.0533*** (-5.574)	-0.0342*** (-3.860)	-0.0351*** (-3.794)
Livestock holdings in LSU	-0.0187*** (-2.749)	-0.0323*** (-4.365)	-0.0218*** (-3.092)
Ox holding (0/1)	0.00594 (0.105)	-0.165*** (-5.195)	-0.112*** (-2.898)
Ln land (ha)	-0.207*** (-4.765)	-0.213*** (-6.315)	-0.170*** (-4.341)
Ln kiremt rain (mm)	-0.326* (-1.766)	0.0379 (1.066)	-0.106 (-1.109)
Ln belg rain (mm)	-0.0925 (-1.402)	-0.0238 (-1.135)	-0.0661 (-1.564)
Distance to the nearest town		0.00898*** (3.342)	0.0121** (2.431)
Ethnicity (ref: Amhara)			
Oromo			-0.183*** (-3.451)
Tigrawai			-0.0115 (-0.149)
Gurage			0.565*** (6.667)
Other			0.0920 (0.918)
Gedeo			0.000231 (0.002)
Gammo			0.179 (1.452)

Continued

Kembata		0.174	
		(1.630)	
Wolaita		0.394***	
		(3.402)	
Argoba		0.163	
		(1.035)	
Religion (ref: Orthodox Christian)			
Catholic		0.0782	
		(0.991)	
Muslim		0.298***	
		(4.947)	
Other Christian		0.489*	
		(1.695)	
Protestant		0.0800	
		(1.384)	
Traditional		0.122	
		(0.680)	
Other		0.0170	
		(0.133)	
Ethnicity & religion indexes			
HHI, ethnicity	0.0582		
	(0.855)		
HHI, religion	-0.326***		
	(-5.290)		
Ethnic minority (0/1)	-0.00362		
	(-0.085)		
Religious minority (0/1)	0.0757**		
	(2.116)		
Village fixed effect	yes	omitted	omitted
N	1336	1341	1340
pseudo R-sq	0.335	0.224	0.281

NOTE: Absolute values of z stats in parentheses. * significant at 10% level. ** significant at 5% level. *** significant at 1% level. Columns show marginal effects from probit regression with dependent variable whether chronically poor. Explanatory variables from the first round are used.

Source: Author's calculations from ERHS.

Table 2-8 Summary statistics

	Non-chronically poor		Chronically poor		Mean diff.	p-value
	Obs.	Mean	Obs.	Mean		
Annual cons growth p.c.	3971	-0.027	1656	-0.014	-0.013	0.337
Lag of consumption in birr	3971	95.431	1656	38.675	56.756	0.000
Dependency ratio	3971	120.900	1656	133.374	-12.474	0.000
Household size	3971	5.854	1656	6.944	-1.090	0.000
Female head (0/1)	3971	0.219	1656	0.241	-0.022	0.062
No. HH members with formal education	3971	1.959	1656	1.818	0.141	0.010
Livestock holding	3971	3.987	1656	2.349	1.638	0.000
Oxholding (0/1)	3971	0.523	1656	0.379	0.145	0.000
Ln land holding	3971	0.882	1656	0.619	0.264	0.000
% of HHs with FFW access at t-1	3971	0.117	1656	0.151	-0.034	0.000
Kiremt percent deviation	3971	99.080	1656	97.809	1.271	0.187
Belg percent deviation	3971	85.466	1656	88.372	-2.905	0.041
Lagged belg percent deviation	3971	93.202	1656	96.112	-2.910	0.030
Lagged kiremt percent deviation	3971	107.366	1656	108.098	-0.732	0.455
Idiosyncratic crop shock (0/1)	3971	0.710	1656	0.712	-0.002	0.855
Distance to the nearest town	3971	9.130	1656	11.122	-1.992	0.000
Fasting (0/1)	3971	0.037	1656	0.062	-0.026	0.000
Lebour peak (0/1)	3971	0.247	1656	0.418	-0.170	0.000

Source: Author's calculations from ERHS.

Table 2-9 Consumption growth estimates

	Dependent var: Annualized growth in consumption per capita		
	(1)	(2)	(3) /w Chronic poverty interaction effects
Lag of log consumption	-0.539*** (0.000)	-0.529*** (0.000)	-0.529*** (0.000)
Dependency ratio	-0.018** (1.000)	-0.018*** (0.800)	-0.018** (1.000)
Household size	-0.049*** (0.000)	-0.051*** (0.000)	-0.050*** (0.000)
Female head (0/1)	-0.0306 (0.162)	-0.0468** (0.036)	-0.0479** (0.032)
No. HH members with formal education	-0.000756 (0.868)	0.000165 (0.971)	0.0000109 (0.998)
Livestock holding	0.00576** (0.016)	0.00607*** (0.010)	0.00627*** (0.008)
Ox holding (0/1)	0.00858 (0.600)	0.0223 (0.163)	0.0232 (0.147)
Ln land holding	0.0358* (0.086)	0.00874 (0.666)	0.00537 (0.792)
Chronic poor (0/1)			
% of HHs with FFW access at t-1	-0.0475 (0.777)	-0.0926*** (0.000)	-0.0776*** (0.005)
Rainfall shock (kiremt)	-0.00619 (0.379)	0.00105 (0.139)	0.000593 (0.442)
Lagged rainfall shock (kiremt)	-0.00388 (0.423)	-0.00142** (0.014)	-0.00190*** (0.009)
Rainfall shock (belg)	-0.00125 (0.492)	0.00132*** (0.000)	0.00107*** (0.005)
Lagged rainfall shock (belg)	0.00132 (0.442)	-0.00134*** (0.000)	-0.00131*** (0.000)
Distance to nearest town		-0.0420*** (0.006)	-0.0459*** (0.009)

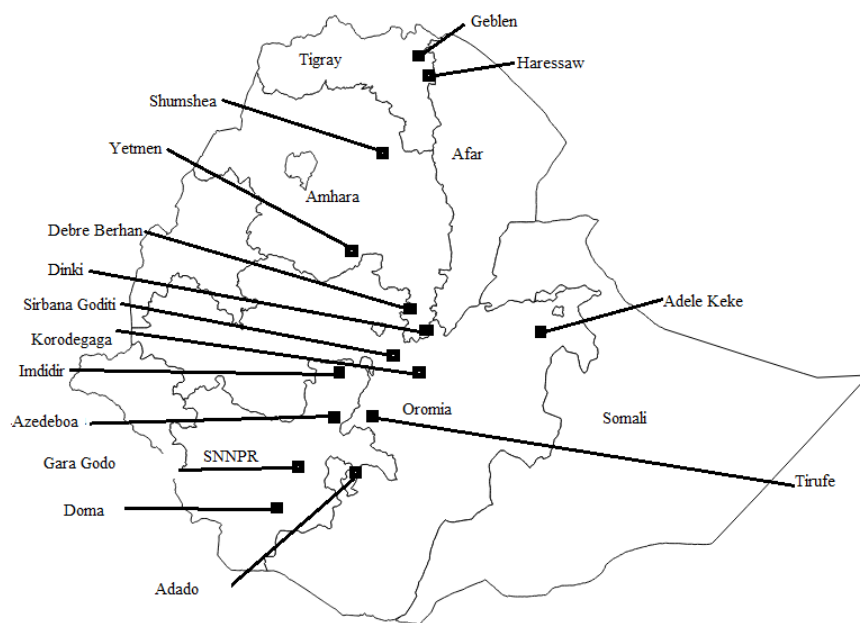
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Idiosyncratic crop shock (0/1)	0.0359*** (0.009)	0.0298** (0.022)	0.0461*** (0.003)
<i>Interaction term with chronically poor</i>			
% of HHs with FFW access at t-1			-0.0349 (0.378)
Rainfall shock (kiremt)			0.000623 (0.430)
Lagged rainfall shock (kiremt)			0.00112 (0.301)
Rainfall shock (belg)			0.000653 (0.192)
Lagged rainfall shock (belg)			0.000250 (0.694)
Distance to nearest town			-0.00994 (0.773)
Idiosyncratic crop shock (0/1)			-0.0567** (0.043)
<i>Seasonality effects</i>			
Fasting		-0.0658*** (0.000)	-0.0663*** (0.000)
Fasting*Orthodox Christian village		-0.0720*** (0.002)	-0.0734*** (0.002)
Peak labour		0.0673*** (0.000)	0.0679*** (0.000)
Constant	2.228*** (0.000)	2.383*** (0.000)	2.401*** (0.000)
Survey month fixed effects	yes		
Village-round fixed effects	yes		
Round fixed effects	omitted	yes	yes
Village fixed effects		omitted	omitted
N	5627	5627	5627
adj. R-sq	0.392	0.352	0.352

Source: Author's calculations from ERHS.

Appendix

Appendix 2-1 Location of surveyed villages



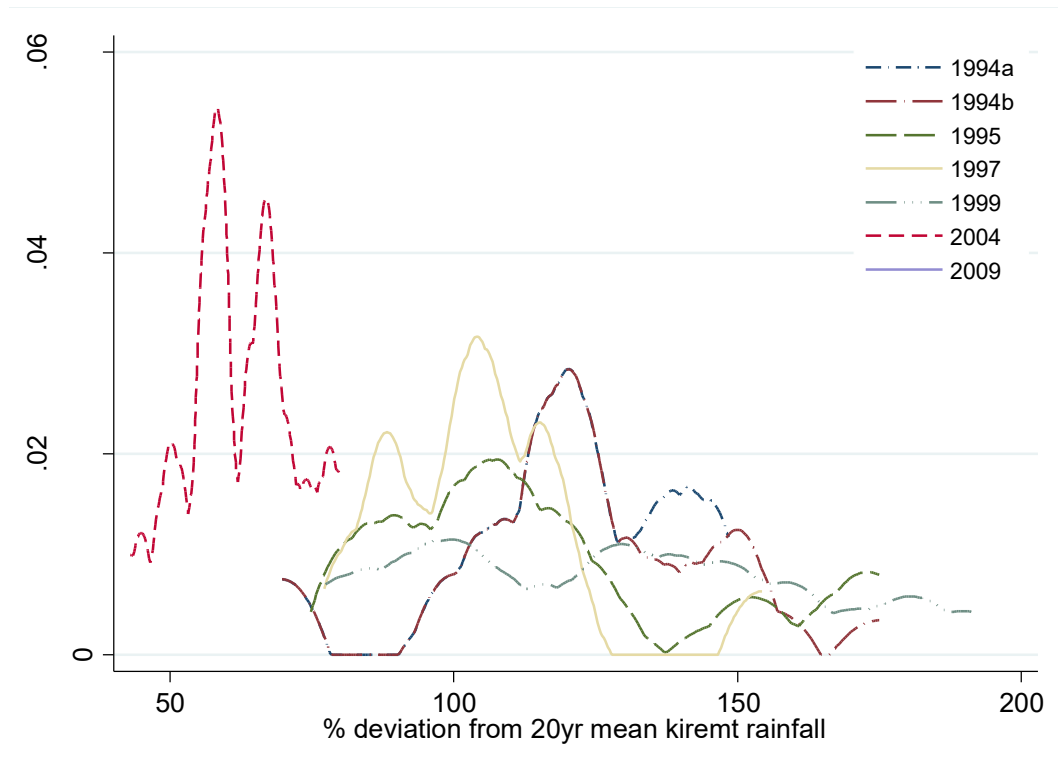
Source: ERHS document.

Appendix 2-2 Disasters recorded from 1990-2009 with 10,000+ affected population

Year	Disaster type	Total deaths	Total affected
1990	Flood		350,000
1993	Flood	2	34,800
1994	Flood	4	43,014
1995	Flood	27	93,875
1996	Flood	40	115,000
1997	Drought		986,200
1997	Flood	326	65,022
1999	Drought		4,900,000
1999	Flood	48	147,255
2000	Flood	69	30,000
2001	Flood	5	39,500
2003	Drought		12,600,000
2003	Flood	119	110,000
2005	Drought		2,600,000
2005	Flood	211	242,418
2006	Epidemic	351	32,848
2006	Flood	951	434,146
2007	Flood	17	245,386
2008	Drought		6,400,000
2008	Flood	45	116,440
2009	Drought		6,200,000
2009	Epidemic	135	13,652

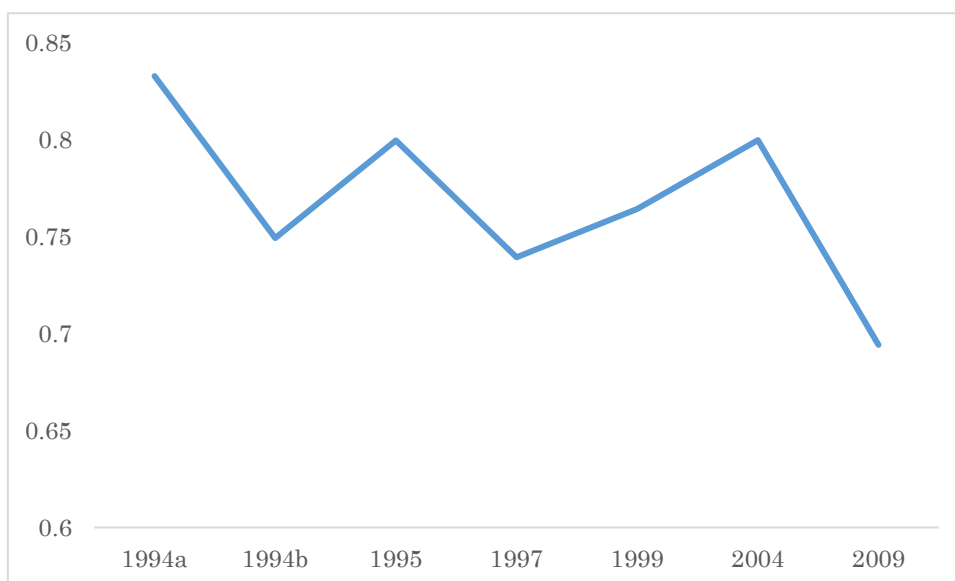
Source: The Emergency Events Database at
www.em-dat.net -Université Catholique de Louvain
– Belgium.

Appendix 2-3 Kiremt rainfall percent deviation from long term mean



Source: Author's calculations from USGS database.

Appendix 2-4 σ -convergence



Source: Author's calculations from ERHS.

Appendix 2-5 Fasting and Ramadan schedules during ERHS surveys

The following fasts are obligatory for Orthodox Christians:

The fasts fixed every year (except for Leap years)

1. The fast of the Prophets (Tsome Nevayat) preceding Christmas.
40 days from 25th November to 6th January (15th Hedar to 28th Tahsas in Ethiopian Calendar (E.C.)) The Eve of Epiphany
1 day on 18th January (10th Ter (E.C.))
2. The Assumption of the Virgin Mariam (Tsome Filseta)
16 days from 7th August to 21st August (1st Nehassie to 16th Nehassie (E.C.))
3. All Wednesdays and Fridays, (except the 55 days after Easter, and also if the feasts of Christmas and Epiphany fall on these days)

The fasts which move with Easter every year

4. The fast for Hudadi (Abiye Tsome, or Lent)
55 days before Easter:
March 7 to May 1 1994 (28th Yekatit to 23 Miaziah 1986 (E.C.))
February 27 to April 22 1995 (20th Yekatit to 14 Miaziah 1987 (E.C.))
March 3 to April 26 1997 (24th Yekatit to 18 Miaziah 1989 (E.C.))
February 15 to April 10, 1999 (8th Yekatit to 2nd Miaziah 1991 (E.C.))
February 16 to April 10, 2004 (8th Yekatit to 2nd Miaziah 1996 (E.C.))
February 23 to April 18, 2009 (16th Yekatit to 10th Miaziah 2001 (E.C.))
5. The fast of Nineveh/Nenawe, commemorating the preaching of Jonah.
Three days on Monday, Tuesday and Wednesday of the third week before Lent
6. The fast of the Apostles (Tsome Hawariat)
10-40 days. It begins on the Monday after Pentecost and continues until July 12:
June 20 to July 12, 1994 (13th Sanni to 5th Hamle 1986 (E.C.))
June 12 to July 12, 1995 (5th Sanni to 5th Hamle 1987 (E.C.))

June 16 to July 12, 1997 (9th Sanni to 5th Hamle 1989 (E.C.))

May 31 to July 12, 1999 (23rd Genbot to 5th Hamle 1991 (E.C.))

May 31 to July 12, 2004 (23rd Genbot to 5th Hamle 1996 (E.C.))

June 8 to July 12, 2009 (1st Sanni to 5th Hamle 2001 (E.C.))

Ramadan schedule during ERHS surveys (Only round 2 coincided with Ramadan.)

The start of Ramadan moves with new moon appearances.

30 days before the Eid al-Fitr holiday

February 12 to March 13, 1994 (5th Yekatit to 4th Makawit 1986 (E.C.))

February 1 to March 2, 1995 (24th Tarr to 23rd Yekatit 1987 (E.C.))

January 10 to February 8, 1997 (2nd Tarr to 1st Yekatit 1989 (E.C.))

December 9 to January 7, 1999 (29th Hadar 1992 to 28th Tahsas 1992 (E.C.))

October 15 to November 13, 2004 (5th Tekemr to 4th Hadar 1997 (E.C.))

August 22 to September 20, 2009 (16th Nashi to 10th Maskarram 2002 (E.C.))

Appendix 2-6 Consumption growth estimates (evenly spaced panels only)

Evenly spaced panel only (Dependent var: Annualized growth in consumption per capit)		
	(7)	(8)
		W/ Interaction
Lag of log consumption	-0.296*** (0.000)	-0.304*** (0.000)
Dependency ratio	-0.0000370 (0.273)	-0.0000326 (0.349)
Household size	-0.0206*** (0.000)	-0.0198*** (0.000)
Female head (0/1)	-0.0205* (0.100)	-0.0249* (0.052)
No. HH members with formal education	0.00161 (0.443)	0.00233 (0.278)
Livestock holding	0.00238** (0.042)	0.00366*** (0.002)
Ox holding (0/1)	0.0193** (0.036)	0.0115 (0.224)
Ln land holding	0.0175* (0.089)	0.00581 (0.580)
chronic poor (0/1)		
% of HHs with FFW access at t-1	0.115*** (0.000)	0.113*** (0.000)
Rainfall shock (kiremt)	0.00589*** (0.000)	-0.00400*** (0.000)
Lagged rainfall shock (kiremt)	-0.00109** (0.029)	-0.000304 (0.366)
Rainfall shock (belg)	0.000243 (0.486)	-0.00120*** (0.000)
Lagged rainfall shock (belg)	-0.00153*** (0.000)	0.000416** (0.042)
Distance to nearest town	-0.000861 (0.666)	-0.00641*** (0.000)

Continued

Idiosyncratic crop shock (0/1)	0.0173*** (0.007)	0.0267*** (0.000)
Interaction term with chronically poor % of HHs with FFW access at t-1		-0.0649* (0.088)
Rainfall shock (kiremt)		0.0000387 (0.959)
Lagged rainfall shock (kiremt)		-0.000529 (0.249)
Rainfall shock (belg)		0.000930** (0.015)
Lagged rainfall shock (belg)		0.0000236 (0.960)
Distance to nearest town		0.000710 (0.719)
Idiosyncratic crop shock (0/1)		-0.0150 (0.292)
Fasting	0.00549 (0.967)	0.0562 (0.664)
Peak labour	0.0385 (0.287)	-0.00159 (0.861)
Constant	1.158*** (0.000)	1.564*** (0.000)
Survey month fixed effect	yes	
Village-round fixed effect	yes	
Round fixed effect		yes
paid	omitted	omitted
N	2212	2212
R-sq	0.857	0.844
adj. R-sq	0.668	0.640

Source: Author's calculations from ERHS.

3 Liquidity constraints and risk sharing in rural Ethiopia

3.1 Introduction

When an insurance market is missing, destocking assets, savings (inter-temporal smoothing) and risk sharing among households (inter-state smoothing) are the only ways left for affected households to *ex-post* smooth consumption. In Ethiopia, financial institutions were not widely available for the rural population. Instead, unique risk-sharing mechanisms have been developed. The most common instruments of risk sharing are gift-giving, loan- and livestock-lending (*dabare* and *amesa*) that are used for *ex-post* consumption-smoothing purposes.²¹ On the other hand, during the 2000s, the availability of formal sector credit has been improved. In particular, the role of microcredits has increased in rural Ethiopia. Under the consumption smoothing theory, liquidity constraint is a major constraint against consumption smoothing, and thus availability of formal sector credits may relax liquidity constraints and improve consumption smoothing of households in the face of adverse income shocks. I would like to investigate whether those institutional lendings smooth out the consumption fluctuations that resulted from adverse income shocks.

In the 1990s-2000s, the role of formal sector institutions (e.g., micro credit institutions/NGOs, agricultural cooperatives) expanded. As those institutions are relatively resilient to agricultural shocks (but not to say completely independent), the risk they can insure may differ from those risks that conventional informal risk-sharing networks can insure. Hence, I investigate the effects of three primary sources of credit:

²¹ *Dabare* is a loan of cattle for restocking for households that are experiencing negative shocks. *Amesa* is a shorter-term loan of a milking animal for those households to supplement food. *Busa gonofa* a gift giving from the rich to the needy, is observed for redistributive purposes among the rich and the poor.

social networks, the formal sector and commercial/interlinkage lenders, on consumption smoothing with regard to the existence of idiosyncratic and aggregate adverse shocks. Since the primary motivation for informal risk sharing comes from mutual insurance, households that could accumulate wealth efficiently and reduce income variances might no longer need informal risk sharing and leave the risk-sharing network. In contrast, households with more accumulated wealth might play the role of an insurer and absorb more adverse shocks experienced in a village where altruistic pressure is present.

The possibility that villagers share their risks has been investigated widely. Townsend (1994) found that income fluctuations are alleviated by aggregate income pooled within villagers and only partially influence consumption. Udry (1994) found that repayment and interest payments are subject to the shock experienced by both lenders and borrowers, and even borrowers paid back more to lenders when lenders experienced adverse income shocks. Takashino, Maharjan, and Fukui (2014) examined whether the insurance function of formal and informal borrowing differs in the face of different types of risks. They found that informal borrowing without any interest was responsive to harvest failure and livestock theft, but informal borrowing with interest was responsive to marriage payment. However, there is no empirical study which investigates the extent of consumption smoothing achieved through commercial and social network credit borrowing in Ethiopia.

3.2 Literature review

In many developing countries, financial markets are fragmented among formal lenders and informal lenders: those who cannot observe private information and those who can. Due to this fragmentation, optimal credit allocation is not achieved and this problem is called the problem of *fragmented credit markets* (Bardhan & Udry, 1999). Innovative formal instruments have recently been developed to address conventional private information problems. For example, index insurance that sets a threshold for an exogenous weather shock lowers the transaction costs for the insurer to investigate the

damage. The potential mediating effects of these new innovative instruments to exogenous shocks and their crowding-out effects on informal risk sharing are currently widely investigated through randomized control trials.

For instance, Berg, Blake, and Morsink (2017), and Takahashi, Barrett, and Ikegami (2017) found that the index-based livestock insurance does not crowd out risk sharing. Berg et al. (2017) explained that the basis risk, the residue loss uninsured by index insurance, may be an incentive to remain in informal risk-sharing networks. Dercon and Krishnan (2002) also found that the workfare payment complemented risk sharing, alleviating the adverse effect of shocks experienced by non-recipient households.

In addition, informal risk sharing may not be truly altruistic, as Santos and Barrett (2011), and Carter and Castillo (2005) found that persistently poor households are excluded from the risk-sharing network in southern Ethiopia and Honduras. Carter et al. (2007) observed that the poor benefit more from the capital market than the rich when they face a hurricane. Hence, better access to the credit market may enable the poor to insure the risk and achieve better consumption smoothing.

On the other hand, there are some instances where these formal insurance instruments crowd out informal risk sharing, and the capacity of the poor to smooth their consumptions deteriorates. Dizon, Gong, and Jones (2015) found that self-insurance through microsaving is a substitute for risk sharing among vulnerable women in Kenya, reducing the probability of informal risk sharing by 12 per cent. In addition, the laboratory experiment by Berg et al. (2017) shows that indemnity insurance whose payout covers the whole damage was a substitute for risk sharing. The instruments that eliminate the risk of idiosyncratic shock have the potential to crowd out the informal risk-sharing network. Microsaving is an effective saving instrument for rural households that otherwise face difficulty in accumulating wealth due to high altruistic pressure, but those who accumulate enough wealth to self-insure themselves may no longer need a risk-sharing arrangement and their social networks may deteriorate.

Institutionalized lending may alleviate aggregate shocks that are not efficiently insured by risk sharing, and complement the loophole of informal risk sharing. Due to this difference, in this study, I would like to investigate whether the extent of institutionalized and social network lending differ in consumption smoothing in rural Ethiopia. Both idiosyncratic and aggregate shocks interact with these three sources of credit and will be investigated as to whether they were alleviated through these two credit sources.

3.3 Data description

For this study, I use the rural household panel data, Ethiopian Rural Household Surveys (ERHS) collected from 1994-2009. In our sample, from 36 to 61 per cent of households had access to credit during the seven survey rounds (Table 3-1). Except for 1995 when the number of borrowers dropped sharply, credit access seems to have increased steadily. This trend suggests that credit constraints in rural Ethiopia were relaxed during the 1990s-2000s, and rural Ethiopian households were more likely to smooth consumption efficiently.

[Insert Table 3-1 here]

The decomposition of the sources of credit is shown in Figure 3-1. *Formal sector lenders* include banks, the Ministry of Agriculture, service cooperatives, credit associations, and NGO/microfinance institutions. *Social networks* include friends/relatives, *iddir* (viz., funeral associations), and *equb* (viz., ROSCA). *Informal commercial/interlinkage lenders* include money lenders, employers and traders. Whilst credits from social networks were dominant throughout the periods, credit borrowing from formal institutions, especially governmental organizations and agricultural cooperatives, has gradually caught up since 1997, which coincided with two new

arrangements taking place in rural credit provision. First, in 1996/97, agricultural input credit began to be provided through extension agents replacing direct provision through the Agricultural and Industrial Development Bank (AIDB) (Gebremedhin, Hoekstra, & Tegegne, 2006).²² Secondly, the cooperative activities that were largely downsized in the early 1990s, were revitalized through the Cooperative Societies Proclamation No.147/1998 (Kodama, 2007), and farmers' cooperatives became another major provider of agricultural credits. Only 8 per cent of sample households obtained credit from formal institutions in 1994a, whilst the proportion gradually increased to 24 per cent in 2009. During the 2000s, the advent of microfinance institutions also contributed to the rise of formal sector credit borrowing. Since its appearance in the survey of 1999,²³ the role of microfinance expanded during the 2000s (Table 3-2). Loans from NGOs and microcredits are mainly used to buy livestock or to buy other agricultural inputs.

[Insert

²² Later known as the Development Bank of Ethiopia and the Commercial Bank of Ethiopia, these banks provided input credits through intermediaries (i.e., service cooperatives, peasant associations and farmers' groups). Due to a high default rate, a new arrangement was made between regional governments and the banks in 1996/97, under which the regional governments became responsible for recovering all the loans through their extension agents (Gebremedhin et al., 2006).

²³ The Microfinance proclamation was passed in 1996, and microcredits started playing a role in the financing of agricultural input in rural areas (Ayele, 2015; Gebremedhin et al., 2006).

Figure 3-1 here]

[Insert Table 3-2 here]

Money lenders (*arata*) had originally been landowners of large private farms, who became traders or specialized moneylender after the socialist government confiscated their lands (Aredo, 1993). Each household's relationship with money lenders varied from no business relationship (59 per cent), collateral owner (14 per cent), labour sharing (10 per cent), oxen sharing (4 per cent), crop buyer (4 per cent), and others.²⁴ Credits from money lenders, traders and employers might be interlinked with contract farming, and other transactions are mostly not based upon reciprocal relations and will be separated from social network lending in this paper.

In the sample of 15 Ethiopian villages, about 84 per cent of the households were members of at least one *iddir*, except for those in the Tigray region (as of 1999). *Iddir* is a funeral association that pays out cash and in-kind transfers at the time of the death of an *iddir* member or a member of the family of an *iddir* member. When the member of an *iddir* dies, his or her family will receive a payout equivalent to approximately USD 20: equivalent to 40 per cent of monthly consumption expenditure in rural Ethiopia (Dercon, De Weerdt, Bold, & Pankhurst, 2006). Also when an *iddir* member's family member dies, a reduced payout is also paid to the member. A household can be a member of several *iddirs*, e.g., average households in Sirbana Godeti have two to three *iddir* memberships. In addition to the funeral insurance, many *iddirs* provide loans for their member households on the occasion of adverse shocks (e.g., destruction of a house, illness, fire, the death of cattle, bad harvest) or life-time events such as a wedding. *Iddir* is a well-organized system that requires regular contributions from the members and has written rules and accounting books for monthly contributions. If the loan is not repaid on time,

²⁴ The relationship information is derived from 1994a data.

an *iddir* can bring the case to a local court. *Iddirs* are often open for any households within the same locality, regardless of religion or socio-economic status. The probit estimation of Dercon et al., (2006) of the membership of an *iddir* suggests that membership of *iddirs* is not related to socio-economic differences (i.e., consumption level and land holdings).

Other traditional forms of savings associations (*equb*) are present in rural Ethiopia, and 14-17 per cent of the surveyed households participated in *equb*. Like *iddir*, *equb* still played an essential part in lives in rural Ethiopia throughout the 15 years of the survey periods, and no downward trends are observed. In *equb*, “participants agree to pay periodically a small sum into a common pool so that each, in rotation, can receive one large sum” (Aredo, 1993). Unlike *iddir*, an *equb* payout does not always act as insurance against idiosyncratic shocks, since the payout is determined by the outcome of a lottery. However, savers can buy a lot at a certain price before the determined payout release, if they face an urgent cash need. Hence, those who can pay the lots can alleviate the effects of adverse shock. Periodical payments under peer pressure impose self-discipline on the savers, and *equb* works as an effective saving institution in rural Ethiopia (Aredo, 1993).

Dabare livestock lending to household affected by idiosyncratic shocks are also widely observed in pastoral regions (Santos & Barret 2011). However, the survey covered only sedentary farming areas, and the questionnaire on in-kind credit asked only the amount of crop borrowed²⁵ but not livestock. Hence, in this paper, credit refers only to cash and crop lending among sedentary farmers.

Most credits are taken for consumption and operational purposes, rather than investment. Table 3-2 presents the decompositions of reasons for borrowing for all the seven rounds. The top three most common reasons for borrowing have been: “to buy food or nonfood items,” followed by “to buy agricultural inputs” and “to pay for health

²⁵ Some livestock lending is observed but detailed livestock types rented out are not available and cash values are not calculated.

expenses” for all the seven rounds. Hence, the primary motivation behind credit borrowing seem to smooth consumption in rural Ethiopia. Credit lending plays an essential role in rural Ethiopia where the form of precautionary saving is limited to asset accumulation (i.e., livestock and grain stocks). Although credit access improved during the 1990s-2000s, only 6 per cent of surveyed households had a bank account as of 2009.²⁶

Descriptive statistics decomposed by credit borrowers and non-borrowers and by regions are presented in Table 3-3. In the sample of all the regions, borrowers have significantly smaller real per capita consumption, larger household size, fewer livestock- and land- holdings. However, once borrower and non-borrower samples are decomposed by regions, the mean differences of those explanatory variables are less significant for Oromia and the SNNP, where more than 50 per cent of our sample households reside. Mean consumption level differences among borrowers and non-borrowers are partly explained by regional differences: the largest differences exist in Tigray and Amhara where not only consumption credit but credit borrowing in general is relatively uncommon (only 40 per cent of households borrow any type of credit). In the other two regions, where 58.9-59.0 per cent of households borrow some type of credit, there is no significant difference in mean consumption levels between borrowers and non-borrowers.

[Insert Table 3-3 here]

Access to commercial lending and social network lending between consumption quantiles was also compared (Figure 3-2). No clear distinction between those quantiles is observed. In general, the poorest households borrow more credit from social network lending, whilst a modest proportion of the richest (approximately 30 per cent) also borrow consumption credit from social network lending.

²⁶ In a country that experiences high inflation, saving cash is not a good option for precautionary saving. The saved cash may lose a large proportion of its value in the future.

[Insert Figure 3-2 here]

3.4 Empirical strategy

I focus on intertemporal behavior in the face of risk, and investigate whether the existence of community and household-based lending mechanisms work as consumption smoothing against the adverse effects of income risk. As a basis for this analysis, I use standard risk-sharing tests (Townsend 1994), which are not concerned with *how* this full insurance occurs, and whether full insurance occurred through "formalized" market mechanisms or via "informal" sources (e.g., mutual support within families or villages). To address this problem, formalized *institutional* lending, informal lending with potential *interlinkage* contracts and informal *social network* lending are interacted with idiosyncratic shocks, and will be explicitly investigated in this study.

Following the empirical strategy of Ravallion and Chaudhuri (1997), and Townsend (1994), per capita consumption is estimated under the CRRA utility as follows:

$$\ln c_{it} = b + \sum_{vt} \delta_{vt} D_{vt} + \zeta \ln y_{it} + \gamma \mathbf{X}'_{it} + u_{ivt} . \quad (1)$$

First difference or fixed effect estimators remove the unobserved fixed pareto weights. Since consumption and income are subject to endogeneity bias due to measurement errors and simultaneity (Ravallion and Chaudhuri 1997), household income ($\ln y_{it}$) is replaced by idiosyncratic shocks (IS_{ivt}), following Dercon and Krishnan (2005), Fafchamps and Lund (2003), and Kurosaki (2015). If there are measurement errors that are positively correlated to both consumption and income, Townsend's original risk-sharing model's income coefficients face downward attenuation bias (Deaton, 1997). Hence, the use of exogenous shocks rather than household income is better, in order to assess the excess sensitivity of consumption to idiosyncratic shock (Dercon & Krishnan 2005). Household composition and the gender of the household head variables ($\mathbf{X}_{ivt}$) are used to control time-varying taste shifters.

Aggregate shocks are controlled by village-round fixed effects (D_{tv}) or woreda-level rainfalls ($Rain_{vt}$), as follows:

$$lnc_{it} = b + \sum_{tv} \delta_{tv} D_{tv} + \zeta IS_{it} + \gamma X'_{it} + u_{it} , \text{ or} \quad (2)$$

$$lnc_{it} = b + \delta Rain_{vt} + \zeta IS_{it} + \gamma X'_{it} + u_{it} . \quad (3)$$

All the aggregate shocks at the village level were captured by D_{tv} in equation (2). Shortage of rain is the major risk prevalent in rural Ethiopia, and rainfall-related aggregate shocks are explicitly captured by $Rain_{vt}$ in equation (3). Since negative rainfall shock is expected to have a larger effect on consumption, I allow δ_1 to differ according to the sign of the rainfall shocks: when $\delta < 0$ (or $\zeta < 0$), household i fails to smooth consumption in the face of aggregate (or idiosyncratic) shocks.

Under the risk-sharing theory, only idiosyncratic shocks can be mediated through village-level risk sharing. Hence, under perfect risk sharing, $\zeta = 0$, while the positive and significant coefficients of rainfall shock are expected. Equation (2) only shows whether perfect risk sharing exists or not and does not tell us whether each village-level coping mechanism alleviates the adverse effects of idiosyncratic shocks. In this paper, I investigate the heterogeneous effects of three types of credit (social network (SN_{it}), commercial/ interlinkage lending (IN_{it}), and formal sector lending (FN_{it})) and include their interactions with idiosyncratic shocks as:

$$lnc_{it} = b + \delta Rain_{vt} + \zeta_0 IS_{it} + \zeta_1 IS_{it} * SN_{it} + \zeta_2 IS_{it} * FN_{it} + \zeta_3 IS_{it} * IN_{it} \quad (4)$$

$$+ \gamma X_{it} + u_{it} .$$

When risk sharing through social network lending is present, I expect $\zeta_1 > 0$. If consumption smoothing through formal sector (or commercial/ interlinkage) lending is present, I expect $\zeta_2 > 0$ (or $\zeta_3 > 0$). ζ_1 , ζ_2 and ζ_3 reflect to what extent those credit lendings alleviate excess smoothness of consumption. If consumption credit borrowing is determined by characteristics that do not change over time, then estimating (3) by fixed effects removes the source of inconsistency.

To separately investigate whether the *villages* with better credit access are more resilient against idiosyncratic shocks and the *households* with better access to credit are more resilient against idiosyncratic shocks, I included both village-mean formal sector lending and household-level formal sector lending together, as follows:

$$\begin{aligned} \ln c_{it} = & b + \delta \text{Rain}_{vt} + \zeta_0 IS_{it} + \zeta_1 IS_{it} * SN_{it} + \zeta_2 IS_{it} * IN_{it} + \zeta_3 IS_{it} * VIN_{vt} \quad (5) \\ & + \gamma X_{ivt} + u_{it} . \end{aligned}$$

This specification investigates whether the non-borrowers in the village with better financial access are more resilient to idiosyncratic shocks than the non-borrowers in the village with less favorable financial access. Village-level formal sector lending (VIN_{vt}) is defined as the average access to institutional lending, excluding household i . If the interaction between household-level credit access and idiosyncratic shocks is positively significant but the interactions between village mean accessibility to credit and idiosyncratic shocks are negatively significant, the borrower benefits from the credit access in the face of idiosyncratic shocks, but non-borrowers in the villages are less resilient to idiosyncratic shocks.

As idiosyncratic shocks (IS_{it}), I included the number of ill- and deceased adult members per year. Self-reported illness may suffer from self-reporting bias when perceptions and responses are correlated with wealth and education (e.g., richer people tend to report health problems more). This should not be a problem when we drop household fixed effects. Also, when controlling for fixed effects, any recall bias correlated to unobservable household characteristics is eliminated.

3.5 Results

Table 3-4 presents the fixed effect estimate of equations (2)-(5), with standard errors clustered at household level. I begin with a test of the perfect risk-sharing model, with all aggregate resources summarized as time-varying village-level dummies. Table 3-4 Column 1 suggests that the perfect risk-sharing model is rejected, since idiosyncratic

shock (i.e., death of an economic active member) negatively affects consumption levels after controlling for time-varying community fixed effects at 10 per cent significance level. In later specifications, idiosyncratic shocks (i.e., number of deceased or ill economic active members (older than 15 and younger than 65 per year)) have consistently negative effects on consumption. Column 1 suggests that having one deceased adult member per year decreases per capita consumption by 7 per cent.

[Insert Table 3-4 here]

Column 2 presents estimates where rainfall shocks are controlled as aggregate shocks in place of village-round fixed effects. The overall results suggest that the consumption of rural Ethiopian farmers is vulnerable to aggregate rainfall shocks. The rainfall shocks have consistently negative coefficients on household consumption, e.g., a 30 per cent decrease in *kiremt* rainfall correlates with 4 per cent losses in real per capita consumption. This suggests a household's inability to insulate consumption from rainfall shock. Aggregate shocks are better explained by village-round fixed effects than by rainfall shocks, comparing within R^2 of Columns 1 and 2.

Although the negative and significant idiosyncratic shocks imply the absence of perfect risk sharing, we cannot conclude that there is no partial risk sharing. To explicitly investigate the effects of credit lending as a risk sharing and consumption smoothing role, I add idiosyncratic shocks and their interaction terms with the availability of consumption credit. The consumption credit variable is a dummy variable that takes 1 if the household borrows for consumption purposes (i.e., to buy food/goods, pay for health expenses, pay for educational expenses, pay rent/taxes and pay debts) and 0 if the household does not borrow for consumption purposes. Columns 3 and 4 include the interaction with the access to consumption credit. The positive coefficients of interaction between death and consumption loan show that a household death shock was partially alleviated through a

consumption loan. Having one adult death decreases the per capita consumption by 14 per cent, but access to consumption credit alleviated the death shock more than the loss induced by the deaths. Wald tests for the hypothesis that the coefficients of death- and illness-shock interactions with consumption credit are simultaneously equal to zero were rejected at the 5 per cent level in Column 3.

Next, I broke down the accessibility to consumption credit to the accessibility to social network lending, institutional lending and commercial/interlinkage lending (Columns 5 and 6). Loans among social networks as well as institutional lending, have positive and significant coefficients for interactions with death shock, but the interactions of commercial/interlinkage loans with idiosyncratic shocks are not significant, suggesting that commercial/interlinkage loans are not responsive to death and illness shocks. A Wald test for the hypothesis that the coefficients of death- and illness-shock interactions with social network consumption credit are simultaneously equal to zero was rejected at the 5 per cent level (Column 5), confirming that social network lending plays a mediating role when rural Ethiopian households encounter idiosyncratic shocks.

Then, I investigate whether village-level financial liquidity affects the extent of consumption smoothing, even for non-borrowers. I include a household-level credit access dummy, as well as village-level credit accessibility, to differentiate the direct effect of borrowing and the indirect effect of financial liquidity inside the village (Column 9). Direct institutional borrowing effects are positive when they interacted with death and illness idiosyncratic shocks, although they are not significant. The interaction term of village-level institutional lending accessibility and illness shocks is negative and significant at 1 per cent significance level. This result suggests that the villagers with a less liquidity-constrained environment suffer more from lack of full insurance than those with more severe liquid constraints, as if in localities with institutional lending, an illness shock is no longer insured.

There is a possibility that formal sector loan alleviates aggregate agricultural shocks,

since their risk is not directly affected by rainfall shocks, and formal sector lenders may be able to release credit for households that face rainfall shock. Column 7 includes the interaction with rainfall shocks²⁷ and access to consumption credit. Consumption credit is responsive to *kiremt* rainfall shocks, almost negating the negative effect of *kiremt* rainfall shocks. Rural households periodically experience shortage of *kiremt* rainfall, and their community may have a responsive insurance mechanism against this shock. When we separate consumption credit into social network- and institutional lending (Column 8), institutional lending interactions with rainfall shocks become negative and social network lending interaction remains positive. Negative coefficients of interaction terms between negative rainfall and institutional lending may be not only because those credits are not responsive to rainfall shocks, but because the households have to pay their debts even when they are under rainfall shocks. In the case of social network lending, social network lending alleviated the effect of *kiremt* rainfall shock: if 16 per cent of village households had access to social network lending, the negative effect of *kiremt* rainfall shock will be negated. Those villagers may help each other when rainfall shocks occur, and the decrease in consumption through rainfall shocks can be alleviated, although only seven out of 18 villages have this level of prevalence in social network lending. In sum, institutional credits are not efficient consumption-smoothing tools against aggregate rainfall shocks. This suggests that institutional lending does not complement the shortcomings of social network lending so far.

²⁷ In chapter 1, I investigated the correlation between variation (i.e., the long-term coefficient of variation) and level (i.e., long term means) of *kiremt* and *belg* rainfalls, and found that *belg* rain (both in level and variation) was not correlated to consumption poverty. Thus, in this empirical analysis, I include only *kiremt* rainfall shocks in the interactions.

3.6 Conclusion

In this paper, consumption smoothing effects of three different credits on idiosyncratic and aggregate shocks are investigated. I found that rural Ethiopian households fail to smooth consumption, and their current consumption is heavily affected by idiosyncratic shocks (e.g., illness and death), as well as aggregate rainfall shocks. However, I found the adverse effects of death shocks are partially alleviated through social network lending, as well as institutional lending. Conventional commercial/interlinkage lending, on the other hand, is not responsive to death shocks, and does not alleviate the adverse effects of death of economic active members. I also investigated whether the households within less financially constrained village are more likely to smooth consumption in the face of idiosyncratic shocks. Village-level accessibility to institutional lending has negative effects on consumption smoothing when it interacts with illness shocks. Aggregate rainfall shocks are not alleviated through institutional lending, which implies that even with the increasing role of institutional lending in rural Ethiopia, institutional lending does not complement the aggregate shocks that risk-sharing lending cannot effectively address. Since rainfall shocks have large negative effects on consumption, there is some room for improvement through providing social protection for better consumption smoothing.

Figures & Tables

Table 3-1. Access to credit, balanced panel

	1994a		1994b		1995		1997		1999		2004		2009	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
No	575	50.22	543	47.42	722	63.06	541	47.25	539	47.07	534	46.64	436	38.08
Yes	570	49.78	602	52.58	423	36.94	604	52.75	606	52.93	611	53.36	709	61.92
Total	1,145	100	1,145	100	1,145	100	1,145	100	1,145	100	1,145	100	1,145	100

Source: Author's calculations from ERHS.

Table 3-2. The reasons for credit borrowing by credit sources

1994a									
Reason for loan	Commercial/ Interlinkage	Social network			Institutional lending			Other	Total
	Moneylender	Friend/ relative	Iddir	Equb	Bank	NGO	Formal institutions*		
<u>Daily Expenses</u>									
To buy food/goods	53	216	6	1	0	1	1	15	293
To pay for health expenses	7	45	5	0	0	0	1	1	59
To pay rent/taxes	1	8	0	0	0	0	0	0	9
To pay for education	0	3	0	0	0	0	0	0	3
<u>Cost for farm inputs</u>									
To buy farm or other implements	3	19	0	0	0	5	3	7	37
To buy inputs such as seeds/fertilizer	12	57	6	0	1	13	60	10	159
To buy livestock	11	20	1	0	3	7	7	3	52
To pay for hired labour	3	5	2	0	0	0	0	1	11
For transporation	2	7	1	0	0	1	0	1	12
To buy fodder/hay	0	2	0	0	0	0	0	0	2
<u>Investment</u>									
To start an off-farm business	4	15	1	0	0	0	0	0	20
To pay for building material	11	25	2	0	0	1	0	1	40
<u>Ceremonial expenses</u>									
For wedding	4	26	2	0	0	0	0	2	34
For funeral	11	28	4	1	0	0	0	0	44
For other ceremonial expenses	2	7	2	0	0	0	0	0	11
<u>Other</u>									
To repay debts	4	4	0	0	0	0	0	0	8
Other	9	52	1	0	0	0	0	1	63
Total	137	539	33	2	4	28	72	42	857

1994b									
Reason for loan	Commercial/I nterlinkage	Social network			Institutional lending			Other	Total
	Moneylender	Friend/ relative	Iddir	Equb	Bank	NGOs	Formal institutions *		
<u>Daily Expenses</u>									
To buy food/goods	57	278	17	7	0	4	6	10	379
To pay for health expenses	7	50	18	1	0	0	1	2	79
To pay rent/taxes	1	4	1	0	0	0	0	0	6
To pay for education	0	6	1	0	0	0	0	0	7
<u>Cost for farm inputs</u>									
To buy farm or other implements	12	48	4	2	0	4	1	2	73
To buy inputs such as seeds/fertilizer	28	99	4	1	1	5	0	4	142
To buy livestock	1	16	0	2	2	1	2	2	26
To pay for hired labour	3	15	1	0	0	0	1	0	20
For transporation	2	16	1	1	1	0	0	0	21
To buy fodder/hay	0	2	1	0	0	0	0	0	3
<u>Investment</u>									
To start an off-farm business	4	12	5	1	0	0	4	2	28
To pay for building material	1	17	1	1	0	0	0	0	20
<u>Ceremonial expenses</u>									
For wedding	5	8	2	0	0	0	0	0	15
For funeral	3	12	9	2	0	0	3	1	30
For other ceremonial expenses	2	14	2	0	0	0	0	0	18
<u>Other</u>									
To repay debts	0	5	1	0	0	0	0	0	6
Other	3	15	1	0	1	0	1	0	21
Total	129	617	69	18	5	14	19	23	894

Continued

1995

Reason for loan	Commercial/ Interlinkage	Social network			Institutional lending			Other	Total
	Moneylender	Friend/ relative	Iddir	Equb	Bank	NGO	Formal institutions*		
<u>Daily Expenses</u>									
To buy food/goods	16	169	15	1	0	3	16	5	225
To pay for health expense	6	45	12	0	0	1	7	0	71
To pay rent/taxes	2	15	2	0	0	0	1	1	21
To pay for education	0	0	0	0	0	0	0	0	0
<u>Cost for farm inputs</u>									
To buy farm or other implements	9	31	3	0	0	0	3	0	46
To buy inputs such as seeds/fertilizer	5	42	1	0	0	0	1	1	50
To buy livestock	1	18	2	0	0	0	0	1	22
To pay for hired labour	0	6	1	0	0	0	0	1	8
For transporation	1	12	1	0	0	0	0	0	14
To buy fodder/hay	0	2	0	0	0	0	0	0	2
<u>Investment</u>									
To start an off-farm business	4	12	1	0	8	0	0	1	26
To pay for building material	1	31	4	0	0	0	2	0	38
<u>Ceremonial expenses</u>									
Funeral	2	12	2	0	0	0	2	0	18
For other ceremonial expenses	0	2	1	0	0	0	0	1	4
<u>Other</u>									
To repay debts	0	3	0	0	0	0	0	0	3
Other	2	39	4	0	0	0	0	1	46
Total	49	439	49	1	8	4	32	12	594

1997

Reason for loan	Commercial/I nterlinkage	Social network			Institutional lending			Other	Total
	Moneylender	Friend/ relative	Iddir	Equb	Bank	NGO	Formal institutions*		
<u>Daily Expenses</u>									
To buy food/goods	60	276	25	19	3	3	1	23	410
To pay for health expenses	8	53	23	1	0	0	1	2	88
To pay rent/taxes	1	9	6	0	0	0	0	0	16
To pay for education	0	5	1	1	0	0	0	0	7
<u>Cost for farm inputs</u>									
To buy farm or other implements	4	21	0	1	0	7	1	2	36
To buy inputs such as seeds/fertilizer	15	65	10	0	21	10	86	24	231
To buy livestock	4	17	0	0	3	27	0	2	53
To pay for hired labour	1	6	6	0	0	0	1	0	14
For transporation	0	11	2	0	0	0	0	0	13
<u>Investment</u>									
To start an off-farm business	3	12	6	1	0	4	2	4	32
To pay for building material	3	28	6	3	1	0	1	0	42
<u>Ceremonial expenses</u>									
For wedding	1	32	6	0	0	0	0	1	40
For funeral	3	26	7	2	0	0	0	0	38
For other ceremonial expenses	0	7	1	0	0	0	1	0	9
<u>Other</u>									
Other	1	24	3	1	0	1	6	7	43
Total	104	592	102	29	28	52	100	65	1072

Continued

1999

Reason for loan	Commercial/I	Social network			Institutional lending			Other	Total
	nterlinkage								
	Moneylender	Friend/relative	Iddir	Equb	Bank	NGO	Formal institutions*		

<u>Daily Expenses</u>									
To buy food/goods	93	307	44	8	8	17	0	15	492
To pay for health expenses	16	70	24	1	0	0	0	3	114
To pay rent/taxes	4	12	1	2	0	0	0	0	19
To pay for education	0	6	1	3	0	0	0	1	11
<u>Cost for farm inputs</u>									
To buy farm or other implements	20	26	4	2	3	5	0	5	65
To buy inputs such as seeds/fertilizer	18	56	8	5	21	8	1	9	126
To buy livestock	2	11	1	1	8	11	0	6	40
To pay for hired labour	1	5	0	0	0	0	0	0	6
For transportaion	4	6	1	0	0	0	0	0	11
<u>Investment</u>									
To start an off-farm business	5	16	2	1	1	7	0	5	37
To pay for building material	8	42	2	1	0	2	1	0	56
<u>Ceremonial expenses</u>									
For wedding	4	18	2	0	0	0	0	0	24
For funeral	5	24	9	0	1	0	0	0	39
For other ceremonial expenses	1	15	0	0	0	1	0	0	17
<u>Other</u>									
To repay debts	0	2	1	1	0	0	0	0	4
Other	1	21	2	0	0	1	0	0	25
Total	182	637	102	25	42	52	2	44	1086

2004

Reason for loan	Commercial/I nterlinkage	Social network		Institutional lending				Other	Total
	Moneylende r	Friend/ relative	Iddir	Equb	Bank	Micro financ e/NGO	Formal institutions*		
<u>Daily Expenses</u>									
To buy food/goods	23	123	13	2	0	6	6	4	177
To pay for health expenses	9	57	28	5	0	0	1	2	102
To pay rent/taxes	2	20	5	0	0	0	1	0	28
To pay for education	3	13	5	1	0	0	2	2	26
<u>Cost for farm inputs</u>									
To buy farm or other implements	3	22	5	0	0	17	10	1	58
To buy inputs such as seeds/fertilizer	5	55	14	0	1	31	168	37	311
To buy livestock	3	9	2	1	5	32	17	2	71
To pay for hired labour	2	6	8	4	1	0	0	0	21
For transportaion	0	10	3	0	0	0	0	0	13
<u>Investment</u>									
To start an off-farm business	1	8	4	0	0	3	2	1	19
To pay for building material	5	23	6	1	0	2	0	1	38
<u>Ceremonial expenses</u>									
For wedding	3	16	1	0	0	0	0	1	21
For funeral	2	23	8	0	0	0	0	1	34
<u>Other</u>									
To repay debts	3	5	0	1	0	3	0	0	12
other	1	25	6	0	0	3	7	1	43
Total	65	415	108	15	7	97	214	53	974

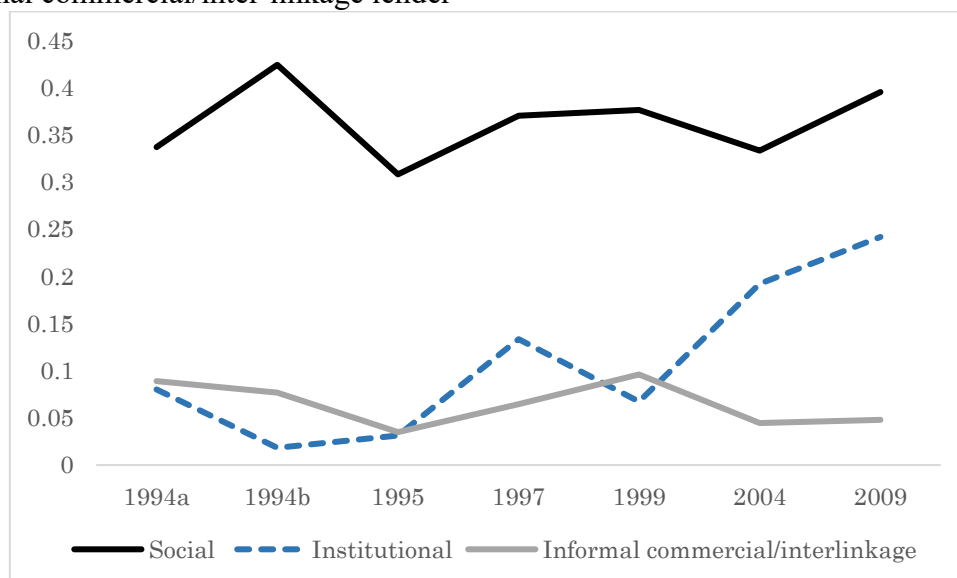
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Reason for loan	Commercial/ Interlinkage	Social network			Institutional lending			Other	Total
	Moneylender	Friend/ relative	Iddir	Equib	Bank	Micro	Formal		
						finance / NGOs	institutions*		
<u>Daily Expenses</u>									
To buy food/goods	56	343	42	12	0	18	14	8	493
(For electric power**)	0	3	0	0	0	0	49	2	54
To pay for health expenses	9	65	35	2	0	3	3	3	120
To pay rent/taxes	0	13	2	1	0	2	4	0	22
To pay for education	1	16	7	0	0	3	0	1	28
<u>Cost for farm inputs</u>									
To buy farm or other implements	1	14	10	3	0	9	4	1	42
To buy inputs such as seeds fertilizer	6	60	16	2	0	44	203	3	334
To buy livestock	1	23	2	4	1	56	20	5	112
To pay for hired labour	1	15	5	1	1	2	0	0	25
For transportaion	2	14	3	0	0	1	1	1	22
To buy fodder/hay	0	2	0	0	0	0	0	0	2
<u>Investment</u>									
To start an off-farm business	1	21	5	4	0	13	6	6	56
To pay for building material	5	31	6	2	0	5	5	4	58
<u>Ceremonial expenses</u>									
For wedding	2	5	1	0	0	1	1	2	12
For funeral	2	14	6	0	0	2	2	0	26
For other ceremonial expenses	0	13	1	0	0	4	4	1	23
<u>Other</u>									
To repay debts	0	13	1	1	0	1	1	1	18
Other	1	21	0	1	0	3	8	1	35
Total	88	686	142	33	2	167	325	39	1482

Note: The observations are credit levels. A household can have multiple credits from different lenders.

Source: Author's calculations from ERHS.

Figure 3-1 Proportion of credit lending from institutional lender, social network and informal commercial/inter-linkage lender



Note: Author's calculation from Table 1.

Table 3-3 Basic statistics decomposed by consumption credit borrowers and non-borrowers (all regions)

All regions	Mean difference	t-value	Non-borrower Obs	Borrower Mean	Borrower Obs	Mean
Real p.c. consumption (monthly)	9.49	5.52	5054	74.74	1927	65.25
No of adult deaths	-0.01	-1.75	5054	0.03	1927	0.03
No of adult illness	-0.04	-1.99	5054	0.28	1927	0.32
Dependency ratio	0.65	0.25	5054	123.96	1927	123.31
Household size	-0.20	-2.78	5054	6.13	1927	6.33
Female head	-0.01	-0.78	5054	0.22	1927	0.23
No of educated household members	-0.08	-1.54	5054	1.79	1927	1.87
Livestock holding size	0.98	9.53	5054	3.43	1927	2.45
Log land holding size	0.07	5.30	5054	0.79	1927	0.72

Tigray	Mean difference	t-value	Non-borrower Obs	Borrower Mean	Borrower Obs	Mean
Real p.c. consumption (monthly)	15.54	3.37	640	60.45	159	44.91
No of adult deaths	0.00	-0.19	640	0.01	159	0.01
No of adult illness	0.04	0.46	640	0.29	159	0.25
Dependency ratio	-10.94	-1.23	640	131.84	159	142.79
Household size	-0.66	-3.00	640	5.34	159	6.00
Female head	-0.02	-0.42	640	0.43	159	0.45
No of educated household members	-0.60	-5.13	640	0.97	159	1.57
Livestock holding size	-0.39	-2.49	640	1.76	159	2.15
Log land holding size	0.00	0.02	640	0.35	159	0.35

Amhhara	Mean difference	t-value	Non-borrower Obs	Borrower Mean	Borrower Obs	Mean
Real p.c. consumption (monthly)	15.02	4.01	1741	91.90	448	76.88
No of adult deaths	0.01	1.54	1741	0.02	448	0.01
No of adult illness	-0.05	-1.67	1741	0.18	448	0.23
Dependency ratio	0.07	0.01	1741	123.93	448	123.86
Household size	0.20	1.72	1741	5.50	448	5.31
Female head	-0.06	-2.64	1741	0.19	448	0.25
No of educated household members	0.43	4.64	1741	1.70	448	1.27
Livestock holding size	2.08	7.92	1741	5.38	448	3.30
Log land holding size	0.14	5.53	1741	1.07	448	0.93

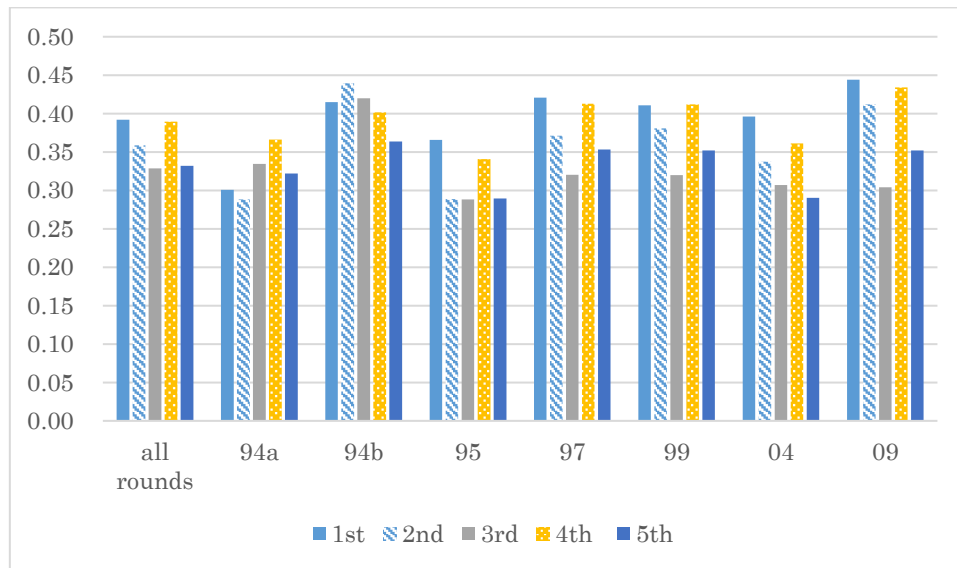
Oromia	Mean difference	t-value	Non-borrower Obs	Borrower Mean	Borrower Obs	Mean
Real p.c. consumption (monthly)	2.04	0.61	1318	81.78	608	79.74
No of adult deaths	-0.03	-3.45	1318	0.03	608	0.06
No of adult illness	-0.05	-1.11	1318	0.33	608	0.38
Dependency ratio	-0.34	-0.07	1318	123.44	608	123.78
Household size	-0.06	-0.46	1318	6.55	608	6.61
Female head	-0.01	-0.58	1318	0.25	608	0.26
No of educated household members	0.09	0.89	1318	2.05	608	1.96
Livestock holding size	0.86	5.39	1318	3.57	608	2.71
Log land holding size	0.08	3.66	1318	0.97	608	0.89

Continued

SNNP	Mean difference	t-value	Non-borrower		Borrower	
			Obs	Mean	Obs	Mean
Real p.c. consumption (monthly)	2.49	1.09	1355	52.60	712	50.11
No of adult deaths	0.00	0.41	1355	0.04	712	0.03
No of adult illness	0.00	0.11	1355	0.35	712	0.35
Dependency ratio	2.58	0.59	1355	120.80	712	118.22
Household size	0.09	0.63	1355	6.89	712	6.80
Female head	-0.01	-0.62	1355	0.13	712	0.14
No of educated household members	-0.19	-2.07	1355	2.03	712	2.23
Livestock holding size	-0.20	-1.83	1355	1.57	712	1.77
Log land holding size	-0.05	-2.94	1355	0.48	712	0.54

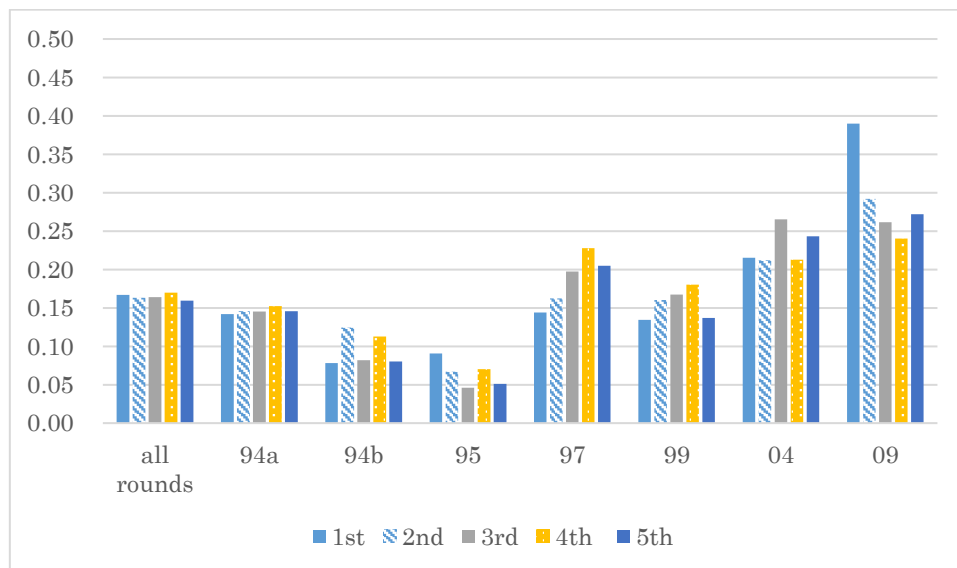
Source: Author's calculations from ERHS.

Figure 3-2 Access to social network lending by consumption quantiles



Source: Author's calculations from ERHS.

Figure 3-3 Access to institutional lending by consumption quantiles



Source: Author's calculations from ERHS.

Table 3-4 Testing risk sharing and consumption smoothing through credits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Shock									
Lagged kiremt rain percent deviation (negative rainfall shock)		-0.140** (0.0666)		-0.137** (0.0667)		-0.137** (0.0665)	-0.228*** (0.0760)	-0.242** (0.114)	
Lagged kiremt rain percent deviation (positive rainfall shock)		0.153*** (0.0272)		0.154*** (0.0272)		0.153*** (0.0271)	0.155*** (0.0272)	0.184*** (0.0284)	
Lagged belg rainfall percent deviation (negative rainfall shock)		-0.103** (0.0467)		-0.102** (0.0467)		-0.0990** (0.0465)	-0.105** (0.0468)	-0.124*** (0.0471)	
Lagged belg rainfall percent deviation (positive rainfall shock)		0.0966*** (0.0279)		0.0962*** (0.0279)		0.0993*** (0.0279)	0.0982*** (0.0279)	0.0846*** (0.0282)	
no of died member per year	-0.0733* (0.0437)	-0.0453 (0.0492)	-0.141*** (0.0494)	-0.107** (0.0522)	-0.140*** (0.0493)	-0.108** (0.0522)	-0.0428 (0.0493)	-0.0471 (0.0486)	-0.167*** (0.0484)
no of illness per year	-0.00177 (0.00931)	-0.0216** (0.00943)	-0.00161 (0.0108)	-0.0258** (0.0109)	-0.00236 (0.0107)	-0.0264** (0.0108)	-0.0211** (0.00945)	-0.0245*** (0.00947)	0.00718 (0.0107)
Lending types									
Credit for consumption access (0/1)	0.00911 (0.0165)	-0.00548 (0.0177)	0.000590 (0.0182)	-0.0184 (0.0194)			-0.0341* (0.0201)		
Social network lending for consumption purpose (0/1)					0.0154 (0.0191)	-0.00906 (0.0208)			0.0147 (0.0190)
Institutional lending for consumption purpose (0/1)					-0.0248 (0.0528)	-0.0622 (0.0502)			-0.0855 (0.158)
Comercial/ interlinkage lending for consumption purpose (0/1)					-0.0180 (0.0438)	-0.0312 (0.0474)			-0.0177 (0.0438)
Village level social network lending for consumption purpose								-0.326*** (0.115)	
Village level institutional lending for consumption purpose								-0.0483 (0.132)	-3.758 (14.46)
Interaction terms									
Credit for consumption access#no of died member per year			0.253** (0.100)	0.235** (0.117)					
Credit for consumption access#no of illness per year			0.000690 (0.0175)	0.0168 (0.0195)					
Social network lending for consumption purpose#no of adult deaths per year					0.240** (0.105)	0.203 (0.123)			0.247** (0.104)
Social network lending for consumption purpose#no of adult illness per year					-0.00107 (0.0181)	0.0105 (0.0199)			0.00238 (0.0183)
Institutional lending for consumption purpose#no of adult deaths per year					0.787** (0.399)	0.870** (0.379)			0.513 (0.444)
Institutional lending for consumption purpose#no of adult illness per year					-0.0252 (0.0798)	0.0604 (0.0862)			0.0656 (0.0881)
Comercial/ interlinkage lending for consumption purpose (0/1)#no of adult deaths per year					-0.0654 (0.206)	0.181 (0.283)			-0.0784 (0.205)
Comercial/ interlinkage lending for consumption purpose (0/1)#no of adult illness per year					0.0369 (0.0362)	0.0529 (0.0487)			0.0408 (0.0357)

Continued

Village level institutional lending for consumption purpose #no of adult deaths per year									3.823 (2.847)
Village level institutional lending for consumption purpose #no of adult illness per year									-0.883*** (0.312)
Credit for consumption access#lagged kiremt negative rainfall						0.263** (0.104)			
Credit for consumption access#lagged belg negative rainfall									
Village level institutional lending for consumption purpose #lagged kiremt negative rainfall								-11.44*** (2.144)	
Village level social network lending for consumption purpose#lagged kiremt negative rainfall								1.572*** (0.397)	
dependency ratio	-0.048*** (0.009)	-0.031*** (0.009)	-0.049*** (0.009)	-0.031*** (0.009)	-0.049*** (0.009)	-0.032*** (0.009)	-0.301*** (0.0912)	-0.307*** (0.009)	-0.0494*** (0.009)
Household size	-0.118*** (0.00535)	-0.114*** (0.00566)	-0.118*** (0.00535)	-0.114*** (0.00567)	-0.118*** (0.00536)	-0.114*** (0.00568)	-0.114*** (0.00568)	-0.115*** (0.00571)	-0.118*** (0.00535)
Female household head	-0.125*** (0.0330)	-0.157*** (0.0369)	-0.128*** (0.0330)	-0.159*** (0.0370)	-0.125*** (0.0330)	-0.156*** (0.0370)	-0.156*** (0.0369)	-0.150*** (0.0372)	-0.126*** (0.0330)
No of educated household members	0.0222*** (0.00593)	-0.00366 (0.00582)	0.0219*** (0.00592)	-0.00381 (0.00582)	0.0224*** (0.00591)	-0.00345 (0.00583)	-0.00358 (0.00584)	0.000 (0.00587)	0.0222*** (0.00592)
Livestock holdings size	0.0157*** (0.00575)	0.0125** (0.00522)	0.0157*** (0.00575)	0.0125** (0.00522)	0.0156*** (0.00574)	0.0124** (0.00520)	0.0125** (0.00522)	0.0133** (0.00531)	0.0156*** (0.00574)
log land holding size	0.113*** (0.0309)	0.0521* (0.0314)	0.113*** (0.0309)	0.0525* (0.0314)	0.115*** (0.0309)	0.0534* (0.0315)	0.0531* (0.0314)	0.0596* (0.0314)	0.114*** (0.0310)
Constant	4.539*** (0.0473)	4.701*** (0.0467)	4.500*** (0.0472)	4.703*** (0.0467)	4.471*** (0.0476)	4.701*** (0.0467)	4.709*** (0.0470)	4.743*** (0.0492)	4.671*** (0.750)
All the credit variables and interactions=0			2.28 (0.078)	1.56 (0.198)			3.34 (0.036)		
All the social network credit variables and interactions=0					2.39 (0.067)	0.99 (0.397)			2.58 (0.052)
All the institutional credit variables and interactions=0					1.34 (0.261)	2.05 (0.105)			0.68 (0.564)
All the comercial/ institutional credit variables and interactions=0					0.39 (0.758)	0.55 (0.645)			0.50 (0.685)
All the village level social network credit access variables and interactions=0								6.16 (0.000)	
All the village level institutional credit access variables and interactions=0								14.69 (0.000)	3.24 (0.021)
village*round fixed effects	yes		yes		yes				yes
Observations	8,333	8,333	8,333	8,333	8,339	8,339	8,333	8,339	8,339
within R-squared	0.285	0.107	0.286	0.107	0.287	0.107	0.107	0.114	0.288
Number of hhid_uniq	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494
Note:									
1. Clustered standard errors in parentheses in fixed effect estimations.									
2. P-values in parenthesis in Wald test results.									
3. *** significant at the 10 per cent level, ** significant at the 5 per cent level, *** significant at the 1 per cent level.									

Source: Author's calculations from ERHS.

4 Heterogeneous livestock holding responses to climatic disasters: Case study from rural Ethiopia

4.1 Introduction

The impacts of climatic disasters on the welfare of rural households are substantial and can be persistently detrimental, especially where a range of insurance mechanisms are absent. Droughts and floods are the two common disasters widely observed in the Horn of Africa, where annual rainfall variation has been intensifying at an increasing rate. During the period of 1990–2015, 46 natural disasters were reported in Ethiopia, according to the emergency events database (EM-DAT)²⁸, among which floods and droughts were the most frequently observed disasters, accounting for 63 per cent of all disasters during that period. The scale of impact of those two disasters is also the largest; approximately 129 thousand people per flood and 5.4 million people per drought were affected populations. In addition, a heavy reliance on rain-fed farming and a lack of flood-control interventions make Ethiopian farmers vulnerable to rainfall fluctuation.

Since the poor tend to have limited access to formal financial markets, buffer-stock saving and informal insurance mechanisms are the alternative coping strategies left to insulate the consumption from adverse income shocks. However, informal insurance mechanisms commonly used by villagers are not reliable for protecting against aggregate shocks when the peer villagers are also adversely affected by the shock. Self-insurance through destocking assets may result in a reduced level of future consumption if the households are unable to restore their meagre productive assets. Hence, the extent of self-insurance through the sale of assets may be different depending upon the level of initial

²⁸ For a disaster to be registered with EM-DAT database, at least one of the following criteria must be fulfilled: ten or more deaths, 100 or more affected population, declaration of state of emergency, call for international assistance.

endowment of liquid assets and an individual's liquid asset portfolio (i.e., cash, grain stocks and livestock).

A significant body of microeconomic research examines how households cope with aggregate and idiosyncratic shocks and the long-term consequences of those shocks. However, comparative studies on different types of disasters are largely limited to macroeconomic cross-country research (e.g., Sawada, Rima & Kotera, 2011; Skidmore & Toya, 2002), and most of the microeconomic research examines either droughts (Carter & Lybbert, 2012; Dercon, 2004; Fafchamps, Udry & Czukas, 1998; Hoddinott, 2006; Kazianga & Udry, 2006; Thiede, 2014) or heavy rain-related events (Kurosaki, 2015a; Miura, Kanno & Sakurai, 2012). Three exceptions in the effort to examine the welfare costs of different disasters are worth noting (e.g., Carter, Little, Mogues & Negatu, 2007; Dassanayake, Mohapatra, Luckert & Adamowicz, 2018; Kurosaki, 2015b). Kurosaki (2015b) compared the impacts of above-normal rainfall and below-normal rainfall disasters on consumptions of rural households in Pakistan. Dassanayake et al. (2018) compared the impact of dry-spell and wet-spell on the choice of type of coping strategies adopted by households. Carter et al. (2007) investigated the impact of Honduras's hurricane and Ethiopia's drought on the productive asset holdings. However, none of them compared the impacts of different disasters on productive asset holdings.

A drought is an event that occurs after several bad rain seasons. The duration of a drought is longer than the duration of other climatic disasters, and the size of the affected population is often the largest, even though a drought does not immediately damage public infrastructures (i.e., road and communication networks) and household productive and non-productive assets. Over-precipitation and subsequent floods may immediately affect the lives of households, damaging public infrastructure and household assets. On the other hand, as Carter et al. (2007) assumes, a drought may endogenously determine the household livestock accumulation strategies through the other coping strategies already taken by the households. Due to these differences in the disaster's suddenness and

duration of impact, affected households may react to each disaster differently.

Ethiopia has been suffering recurrent climatic disasters for many years. Among others, droughts have often led to the greatest famines in Ethiopia and have left long-lasting impacts on economic growth. One of the survey collection years, 2010–2011, was the driest year on record, and the drought crisis affected 13 million people in the Horn of Africa (IASC, 2012). In Ethiopia, this drought mainly affected the eastern part of the country, where poor precipitation for two consecutive ploughing seasons, *meher* rain (June–September 2010), and *belg* rain (February–May 2011)²⁹ left approximately 4.6 million people in need of humanitarian aid in 2011. The drought in 2010–2011 was an extreme case of climatic disasters observed during our survey period. To a lesser extent, above-normal rainfall and subsequent disasters were observed in 2010 and 2013 in our sample areas. The gathered data are therefore particularly appropriate to test whether livestock were de-accumulated in the face of these below-normal and above-normal rainfall shocks.

This paper attempts to fill in these gaps in the literature by investigating the following questions: What are the effects of above-normal and below-normal rainfall shocks on household livestock holdings? As previous empirical analysis predicts, do asset-poor households smooth consumption by selling their livestock in the face of aggregate rainfall shocks regardless of whether the aggregate shocks are below-normal or above-normal rainfall events?

Drawing upon the panel data collected both in the middle of a drought and an

²⁹ There are two agricultural seasons in most parts of crop harvesting areas in Ethiopia: *meher* and *belg*. *Meher* is the main rainy season, and the area cultivated and the amount of crop produced in the *meher* season accounts for 92.1 per cent of the total cultivated area and 96.9 per cent of the total crop production (Taffesse, Dorosh, & Asrat 2012).

unusually heavy rainfall event, the heterogeneity in livestock accumulation dynamics among different asset-holding levels has been examined. The rainfall data used for this purpose was collected and distributed for the Ethiopian Early Warning System by the U.S. National Oceanic and Atmospheric Administration (NOAA). As discussed later, in Section 4, the accuracy of the data enables us to identify village-level rainfalls. First, the relative welfare impacts of two different rainfall shocks on livestock-holding dynamics are estimated utilising a dynamic panel data model. It is then investigated whether the change in livestock holdings came from the sale of livestock or from mere loss due to the disasters. Analysis of livestock accumulation with different asset-status subsamples reveals that the effects of above-normal and below-normal rainfall on livestock holdings differ depending on initial asset status. The households that had enough cattle power for ploughing before the drought of 2011 de-accumulated their small livestock holdings in the face of below-normal rainfall by increasing their sales, but those households without enough cattle for ploughing did not reduce their livestock holdings significantly in the face of below-normal rainfall. In contrast, the asset poor de-accumulated their small livestock in the face of above-normal rainfall, although the net sale of small livestock was not responsive to the above-normal rainfall. In sum, asset-accumulation dynamics varied not only by the difference in initial asset endowment but also by the differences in scale and duration of the natural shocks.

The next section discusses how livestock sales are analyzed in the literature of consumption and asset smoothing. The rural Ethiopian setting and the data used in this study are described in Sections 3 and 4. Section 5 presents an empirical model of livestock holdings dynamics and investigates the effects of above-normal and below-normal rainfalls. The main analysis of the response of household livestock holdings to rainfall shocks is presented in Section 6. The final section concludes the paper.

4.2 Literature Review

Under severe credit constraints and the existence of frequent aggregate rainfall shocks, poor households in developing countries are often caught in hardship where they have to self-insure themselves through destocking their assets. Upon the occasion of idiosyncratic shocks, informal insurance arrangements amongst the peer villagers function well in rural villages, where the risk of information asymmetry is minimized. However, in the case of aggregate shocks, the adverse impacts extend to a large proportion of the affected villages and, hence, such informal insurance systems are not effective. Livestock have long been believed to serve as a buffer stock against adverse income shocks in Sub-Saharan Africa, where other coping mechanisms do not work sufficiently. However, a large body of empirical studies suggest that households in developing areas do not always destock their livestock at the time of negative income shocks (Fafchamps et al., 1998). Zimmerman & Carter (2003) showed a theoretical possibility that the asset poor deliberately protect their productive assets (i.e., ‘asset smoothing’) as part of their optimal inter-temporal consumption strategy. Due to the existence of a fixed cost for the adoption of high-productivity technology (i.e., the use of a two-ox plough), poor households in the vicinity of the minimum subsistence asset level may try to retain their productive assets by sacrificing current consumption. The asset level around which the optimal intertemporal consumption strategy bifurcates is often referred to as the dynamic asset poverty threshold, or Micawber Threshold. Above this dynamic asset poverty threshold, a household accumulates assets and settles in a stable, high-level equilibrium, whereas being below the threshold would mean that a household degrades their assets and falls into another stable, low-level equilibrium, a poverty trap (Carter & Barrett, 2006). Thus, the asset poor whose livestock holdings are around the threshold may not destock their productive assets and may let the consumption level fluctuate.

Empirical evidence that explores the asset poverty threshold supports the differences in the use of livestock as a buffer stock among the asset poor and the asset rich (Carter &

Lybbert, 2012). Hoddinott (2006) found that during the time of drought, half of the asset-rich households sold their oxen, but only 15 per cent of asset-poor households did so in Zimbabwe. Kazianga & Udry (2006) tested several possible mechanisms behind inactive livestock sales extending the same ICRISAT panel data used in the study of Fafchamps et al. (1998). They found a strong evidence that risk sharing mechanism does not smooth out consumptions of those who are already close to subsistence level, and even so these poor households refrain selling young livestock for their herd production strategy during a serious drought. In the case of their sample of Bukina rural households, also price decline during the drought time also was not a major reason of the reluctance of livestock destocking. In addition to the initial level of livestock holdings, the availability of social networks and non-farm employment also affects livestock management strategies differently among the asset poor and the asset rich (Mogues, 2004; Carter et al. 2007; McPeak & Barrett, 2001).

Changes in different types of assets accompany different transaction costs, so that a difference in asset portfolios can also cause heterogeneity in the use of livestock as a buffer stock. Assets such as cash, grain stock, and small livestock are easier to liquidate without high transaction costs. Comparing the relative impact of rainfall shocks on different types of livestock, Fafchamps et al. (1998) found that small livestock were more favourably sold than cattle during the time of famine in Burkina Faso in the 1980s. Mogues (2011) found similar outcomes in the case of drought in Ethiopia, where grain stock and small livestock were more de-accumulated than cattle. Cattle are essential draught animals for farmers, and so farm households will hold on to their cattle to avoid losing the essential number of draught animals for ploughing.

Both below- and above-normal rainfall shocks are often treated as one category of aggregate shock influencing a large proportion of affected villages, although household coping mechanisms may differ due to differences in duration and the scale of the disaster. To my knowledge, very few papers have compared the differences in impacts of droughts

and floods. Using the contingent behaviour method, Dassanayake et al. (2018) found that household coping strategies widely differ between dry and wet- spells. Kurosaki (2015b) used the panel data from rural Pakistan and compared the impact of floods and droughts on consumption growth, and found that household consumption was more responsive to floods than it was to droughts in rural Pakistan. In this study, I extended Kurosaki (2015b)'s approach to investigate the accumulation path of livestock assets of the asset poor and the asset rich during times of large rainfall fluctuations.

Kurosaki (2015b) and Mogue (2011) used a damage scale evaluated by villagers as exogenous shock variables, but this kind of scale can be affected by other socioeconomic attributes correlated with livestock-holding decision making. Dealing with this problem, I controlled for the village-level exogenous rainfall shocks by using detailed satellite rainfall imagery.

4.3 Rural Ethiopia Setting

Ethiopia has the largest number of livestock in Africa (Van Campenhout & Dercon, 2012). In lowland Ethiopia, pastoralists and agro-pastoralists subsist mainly on livestock rearing with large herds,³⁰ while farmers in the highlands conduct crop–livestock mixed farming with a more moderate number of livestock. Given this distinguishing feature between these two types of livelihood, livelihood strategies are likely to be considerably different. Thus, this study focuses on rural households living in non-pastoral regions³¹.

³⁰ It is estimated that they require 4.5 Tropical Livestock Units (TLUs) per capita to survive while herding (McPeak & Barrett, 2001).

³¹ Within non-pastoral regions, the southern *enset* cultivation areas (i.e., SNNR) traditionally have practiced hoe and digging-stick cultivation and relatively smaller proportion of population practice cereal cultivation using ox draught power.

Among the animals, oxen are essential draught power for land preparation in rural Ethiopia, where farmers use local ploughs, *maresha*, with a pair of oxen. Studies of the International Livestock Research Institute (ILRI)³² found that the lack of draught power induces early ploughing, less cultivated land, and less cereal cropping (Astatke & Saleem, 1993). To supplement draught animals, a common arrangement made between households without enough cattle is to borrow (*mekanajo*) or rent (*minda*) oxen³³ from other households in exchange for labour or grain (Gryseels, Astatke, Anderson & Assemenew, 1984). However, these arrangements do not fully substitute for the ownership of ox draught power, forcing those households without enough draught power to cultivate smaller plots of land than the other households. This agricultural practice, which is heavily reliant on cattle draught power, provides a ‘threshold’ in the vicinity of which the households are reluctant to sell their limited livestock resources. Hence, the possession of more than two cattle is utilised as a proxy for the asset poverty threshold. This treatment is also seen in Hoddinott (2006) and Miura, Kanno & Sakurai (2012).

In Ethiopia, all land is owned by the state and is allocated to each farmer through peasant associations. Land use rights are granted only for the residents of the locality, and people that leave the locality for a long time lose their rights (USAID, 2011). The short-term land lease is allowed only between local farm households, and the land rights are not allowed to be used as collateral. This restrictive land regulation in the absence of individual ownership of land inhibits the migration since migrants find it difficult to

³² ILRI was formerly known as International Livestock Centre for Africa (ILCA).

³³ A household with only one ox borrows another ox from another household with only one ox without any charge, although a household without any ox has to rent oxen from other households in exchange for some proportion of their harvest or human labour for weeding to the renter (Omiti, Parton, Ehui, & Sinden, 2000).

acquire land (Kwak & Smith, 2013) and to retain their land use rights in their homelands (USAID, 2011). In rural Ethiopia, access to financial institutions is still limited. In this environment, many households rely on livestock for their wealth accumulation.³⁴

4.4 Data and Methods

The Ethiopian Socioeconomic Survey (ESS) was implemented during 2011's drought period and in 2013 as a part of the World Bank Living Standards Measurement Studies³⁵. The first ESS was conducted in 290 rural and 43 small town enumeration areas (EAs), covering all regional states except for the capital, Addis Ababa, although the second wave of the ESS was expanded to include urban areas. The first and second waves collected information on 3,969 households and 5,262 households respectively. Of the initial 3,969 households, the second wave successfully re-interviewed 3,776 households with a 5 per cent attrition rate. The data are representative at the national level, but this study only focuses on rural samples. From the total balanced rural panel, the observations were excluded from two pastoral regions, Afar and Somali, where the ox-plough production

³⁴ Both post-planting and post-harvest data are available in the ESS. This study uses post-planting land size data to control for farm land size. Harvested land may be smaller than planted land for idiosyncratic agricultural shocks (e.g., crop disease) and might not reflect the actual size of land owned by households.

³⁵ The ESS were collected by the Central Statistical Agency of Ethiopia. Ethiopia in collaboration with the World Bank Living Standard Measurement Study-Integrated Surveys on Agriculture Team. Data are publicly accessible. Dataset Ref: ETH_2011_ERSS_v02_M & ETH_2013_ESS_v02_M, Retrieved from http://microdata.worldbank.org/index.php/catalog/2053/related_materials. Downloaded on April 2015.

system is not prevalent, which leaves 2,444 balanced households. Observations with missing data for any of the variables described below were dropped from the analysis, which left a balanced panel of 1,381 households. Among them, 96.32 per cent of households are crop and livestock farmers that conduct livestock raising and cropping. Each wave of the survey contains recall questions on livestock flows from the previous year, from which the level of livestock holdings in the previous years (i.e., 2010 for the 2011 round and 2012 for the 2013 round) can be obtained.

Rainfall data were constructed from decadal (10-day) rainfall estimates of the U.S. National Oceanic and Atmospheric Administration (NOAA),³⁶ which provides rainfall estimates with an accuracy of 8 km by 8 km pixel size from 1900 until now. Using EA-level latitudes and longitudes,³⁷ EA-level 10-day total rainfall was extracted from the images, and the annual rainfall for 2010, 2011, 2012, and 2013 was calculated. Unlike conventional rainfall data obtained by rain stations, EA-level satellite rainfall data can reduce the measurement errors that arise from the geographical distances between the stations and the EAs. Two measurements of rainfall shocks have been used in this paper: percent deviations from long-term mean annual rainfall and positive and negative percent deviation from the long-term mean. Rainfall percent deviation³⁸ is measured by the

³⁶ The NOAA has provided climate information for the Ethiopian Early Warning System since 1991. The data that support the findings of this study are openly available in USGS FEWS NET Data Portal at <https://earlywarning.usgs.gov/fews/product/119>.

³⁷ To maintain confidentiality, the ESS adds some errors to EA-level coordinates. For instance, small town EA level coordinates contain 0–2 km of errors, and rural EA-level coordinates contain 0–5 km of errors. Those errors are limited at the zone level so that the modified coordinates still fall within the correct zones, allowing the user to obtain zone-level locational information.

³⁸ Both absolute and percent deviation are widely utilised rainfall measurements. Estimates were explored with both specifications, and no differences were found.

annual rainfall divided by the mean annual rainfall from 2000–2010 minus one (i.e., $(\text{rainfall}/\text{mean}) - 1$). Positive and negative rainfall shocks were distinguished since theory would predict possibly differential effects.

Figure 4-1 presents kernel density distributions of the annual rainfall percent deviation from 2010 to 2013 in the sample EAs. The sample Ethiopian farmers experienced floods and droughts in almost every year, except in 2012. The year 2009 was the second driest year on record since 1971, while 2010 witnessed heavy, above-normal rainfalls that resulted in flash floods in five regions (Afar, Amhara, Gambella, Oromia, and Tigray) due to La Niña episodes (UNOCHA, 2016). The year 2011 observed below-normal rainfall at the height of the drought. Then, in 2013, above-normal rainfalls were observed that eventually caused the floods that affected a large part of the Somali region and two districts of the Oromia region in May, affecting a total of 32,391 people (UNOCHA, 2013). As the dashed distribution curve in Figure 4-1 is mostly to the left of zero, about 93 per cent of non-pastoral households experienced below-normal total rainfall in 2011. On the other hand, 79 per cent of the households experienced above-normal total rainfall in 2013. On average, the sample households experienced 115.55 per cent more rainfall than the ten-year mean in 2013. This suggests that 2011 and 2013 witnessed two extremely different rainfall events, one with under-precipitation and the other with over-precipitation.

[Insert Figure 4-1 here]

To examine the livestock accumulation path over the survey periods across different

asset-holding levels, mean and median livestock holdings in TLUs³⁹ were plotted over the survey periods by two subsamples of the asset poor and the asset rich, whose asset statuses are determined by their 2010 cattle holdings (Figure 4-2). As we can observe in the figure, the asset poor with fewer than two cattle in 2010 accumulated their total livestock holdings over time and had over three TLUs by 2013. In contrast, the asset rich de-accumulated their livestock over time. Both the asset rich increased and the asset poor reduced TLUs drastically during the 2011–2012 span. Since the effect of drought on household welfare has a time lag, the affected households are most likely to cope with the subsequent shocks during the hunger seasons starting from late 2011 to early 2012,⁴⁰ which is consistent with the de-accumulation/accumulation dynamics observed in Figure 4-2. Mean and median small livestock holdings in TLUs were plotted over the survey periods by two subsamples of the asset poor and the asset rich in Figure 4-4. Wider variances exist in small livestock holdings than in total livestock holdings, although the medians of small livestock holdings have similar dynamic paths to those of total livestock holdings.

³⁹ Total aggregate livestock holdings have been aggregated using Tropical Livestock Units (TLUs). TLU weights are calculated by typical livestock weight and their calorie consumption per unit of time. Following conversion factors for Ethiopia used by Mogue (2011), a camel was weighed as 1.43 TLU, a cattle as 1 TLU, a horse, a mule and a donkey as 0.5 TLU, a goat and sheep as 0.1 TLU, and a chicken as 0.05 TLU.

⁴⁰ Livestock holding data was collected from November to December in 2011 and 2013. As planting relies on subsequent rainy seasons, the consequence of failure of *meher* rain (June to September 2010) and *belg* rain (February to May 2011) were observed in the next harvest and eventually affected household welfare in the next hunger seasons from the late half of 2011 (June to September) in the *meher* rain zone to early 2012 (April to June) in the *belg* rain zone.

[Insert Figure 4-2 here]

[Insert Figure 4-3 here]

[Insert Figure 4-4 here]

To investigate the effect of current livestock holdings on future holdings before imposing a parametric assumption, a nonparametric regression was conducted where the independent variable is household i 's livestock holdings at the $t-s$ period (y_{it-s}) and the dependent variable is livestock holdings at t period (y_{it}). Figure 4-5 shows the result of a locally weighted scatterplot smoothing estimator (LOWESS) of cattle and small livestock holdings in TLUs for households living in rural areas of the studied regions, where $t = 2011, 2012$, and 2013 and $s = 1$. The solid, dashed, and dot curves represent the annual evolution of livestock holdings at the different points in time. For each time gap, curves intersect the 45-degree line only once; the households whose livestock holdings are below the intersection have positive wealth accumulation, while the households whose livestock holdings are above the intersection gradually reduce their livestock assets over time, approaching the single equilibrium level. The most severe asset de-accumulation amongst the households with above-intersection livestock holdings occurred from 2011 to 2012, immediately following the drought. The observed pattern reflects convergence trends. The growth rate of livestock accumulation is higher for the asset poor, which suggests improving livestock-holding inequality, consistent with the observation of Van Campenhout & Dercon (2012) in their survey from 1993 to 2004. Comparing small animal and cattle holdings, it is clear that small livestock holdings have slightly flatter curves than aggregate livestock, which suggests that rural poor farmers accumulate small livestock relatively more easily than large animals.

[Insert Figure 4-5 here]

In Table 4-1, summary statistics are presented on shocks, mitigating factors, and demographic variables of surveyed households. Sampled households were divided into 1,049 asset-rich households and 282 asset-poor households, whose asset statuses were determined by initial livestock holdings. Possession of more than two cattle is considered essential for ploughing in Ethiopia and is also considered a critical asset threshold in other sub-Saharan African countries (Hoddinott, 2006; Miura et al., 2012). Average asset-poor households cultivated significantly smaller plots of land compared to those of asset-rich households, likely reflecting their limited draught power available for ploughing. Both asset-rich and asset-poor households owned their farm lands, suggesting that draught power rather than land ownership determine the cultivated land size. Asset-rich households tend to have a larger household size, although they have a smaller dependency ratio. Shock-mitigating factors, such as access to loans, access to public transfers (i.e., money, in-kind, or food transferred from government, NGOs, or international organisations) and profitability from non-farm jobs are shown in village means excluding household *i*. The accessibility to loan exhibit no difference between the asset poor and the asset rich, although accessibility to public transfer is slightly larger for asset-poor households. Another important mitigating factor, non-farm profits are higher for the asset poor, but the difference is significant only in 2011. Both asset rich and asset-poor households earned more nonfarm income in a drought year, 2011, but the asset poor earned thrice more than the asset rich did. The asset poor might have engaged in nonfarm work to smooth their consumption with limited self-insurance abilities. This observation is consistent with the study of Porter (2012) where she found rural Ethiopian households supplement the crop-income loss through nonfarm earning in the face of rainfall shocks. At individual level, the engagement in a non-farm activity is observed more often in asset-poor households in both years.

[Insert Table 4-1 here]

The extent of livestock-holding growth from 2010 to 2013 differs among the different asset levels. Although asset-rich households experienced only small growth (4 per cent) in three years, asset-poor households experienced large positive asset growth (118 per cent) from the before-drought period (2010) to the after-drought period (2013). In sum, we can see convergence trends in livestock accumulation over time in descriptive statistics, consistent with Figure 4-2. Amongst this growth in livestock holdings, cattle holdings saw the largest increase amongst the surveyed asset-poor households. Mean cattle holdings of the asset poor increased from 0.50 TLU in 2010 (49 per cent of total livestock holdings) to 1.66 TLU in 2013 (75 per cent of total livestock holdings). On the other hand, cattle holdings of the asset rich barely changed: 4.85 TLU (84 per cent) in 2010 up to 4.99 TLU (83 per cent) in 2013. Cattle constitute a major proportion of livestock holdings, reflecting the relative importance of cattle as draught animals.

4.5 Empirical Strategy

The non-parametric regressions in Figure 4-5 only explain the bivariate relations between current and past livestock holdings without controlling for the effects of rainfall as well as demographic and socioeconomic variables. Drawing upon the empirical strategies used by Kurosaki (2015a) and Mogues (2011), I first estimated the standard dynamic panel data model, as shown below:

$$TLU_{i,t} = \beta_0 + TLU_{i,t-1}\beta_1 + \mathbf{X}'_{i,t}\beta_2 + \mathbf{M}'_{i,t}\beta_3 + Z_{i,t}A_i\beta_4 + Z_{i,t}\beta_5 + \epsilon_{i,t}, \quad (1)$$

with $\epsilon_{i,t} = \mu_i + v_{i,t}$,

where μ_i is time-invariant unobservable household factors and $v_{i,t}$ is a white noise error term. $TLU_{i,t}$ is the number of livestock that household i holds in time t . The previous year's livestock-holding level, $TLU_{i,t-1}$, is included, following the conventional growth model. The variable $Z_{i,t}$ represents the rainfall measurements defined above. Asset status A_i is a binary dummy that takes one (1) if the household had

more than two cattle in 2010 (i.e., the asset rich); otherwise, it takes zero (0). To investigate how rainfall shocks influence livestock holdings among the asset rich and the asset poor, the interactions of rainfall shocks and initial asset status are included. $\mathbf{X}'_{i,t}$ is a vector of demographic and socioeconomic characteristics of household i at point t . I controlled following major shock-mediating factors that we typically observe in rural Ethiopia: public transfers, non-farm job engagement and loan lending. $\mathbf{M}'_{i,t}$ is a vector of the mediating factors of household i at point t : the proportion of villagers receiving public transfers,⁴¹ village average profit from non-farm job and village average accessibility to loans. All the three mediating factors are calculated as village means excluding household i . Household characteristics such as household size and dependency ratio are included in $\mathbf{X}'_{i,t}$ to control life-cycle effects. The other variables in $\mathbf{X}'_{i,t}$ include cultivated land size (ha), the proportion of certified land, land tenancy status, irrigation ratio in the village, and the number of vaccinated livestock as the determinants of livestock holdings. Access to irrigation facilities will also alleviate crop damage from drought. As weakened livestock is more vulnerable to infectious diseases during times of drought, vaccination is critical to prevent animal loss from infectious diseases. Due to the rise of land conflict from land scarcity, each regional government has implemented land certification for agricultural land since the early 2000s. The impact of land certification on livestock herding is not yet clear, but we can anticipate that the privatisation of land-use right can affect the availability of pasture for livestock herding and can negatively affect livestock holdings.

The main concern of this paper is parameters β_4 and β_5 , which show the average impact of rainfall shocks on the household livestock growth of each asset group. The

⁴¹ The number of households that received aid during the last 12 months, excluding the household i divided by the number of households in the village minus one

parameter β_4 indicates whether asset-rich households face larger or smaller declines in livestock holdings compared to asset-poor households if their EAs are hit by rainfall shocks.⁴² If asset-rich households de-accumulate more of their livestock in the face of negative rainfall shocks and percent deviation ($Z_{i,t}$) takes a negative value, then it is expected for $\beta_4 > 0$. The parameter $0 < \beta_1 < 1$ shows a conditional convergent trend⁴³ in livestock accumulation, although $\beta_1 > 1$ suggests a divergence trend.

Time-invariant household heterogeneity (μ_i) (i.e., household abilities of livestock rearing) is most likely to affect both current and lagged livestock holdings and to cause the omitted variable bias. To handle the unobserved time-invariant heterogeneity, the common procedure of the dynamic panel model with fixed T starts with the first difference transformation. Instead, in this study, the two-period difference of equation (1) was utilised as the vectors of $\mathbf{X}'_{i,t}$ and $\mathbf{M}'_{i,t}$ are available only for t and $t - 2$ periods. This can be expressed as:

$$\begin{aligned} TLU_{i,t} - TLU_{i,t-2} &= (TLU_{i,t-1} - TLU_{i,t-3})\beta_1 + (\mathbf{X}'_{i,t} - \mathbf{X}'_{i,t-2})\beta_2 + (\mathbf{M}'_{i,t} \\ &- \mathbf{M}'_{i,t-2})\beta_3 + (Z_{i,t}A_i - Z_{i,t-2}A_i)\beta_4 + (Z_{i,t} - Z_{i,t-2})\beta_5 \\ &+ (v_{i,t} - v_{i,t-2}), \end{aligned} \quad (2)$$

where time-invariant heterogeneity (μ_i) and constant term (β_0) are removed after a difference transformation. However, there is still the possibility that the two-period difference of $TLU_{i,t-1}$ is correlated to the two-period difference of error term $v_{i,t}$. This

⁴² The interaction terms of initial attribute and aggregate shocks are often utilised in macroeconomic analysis on the impact of natural disasters on economic growth, as in Noy (2009). Application to microeconomic analysis is seen in Kurosaki (2015b).

⁴³ Following Jones (2002), this paper uses the term “conditional convergence” here since each household is likely to have a different steady state due to the heterogeneity of household characteristics.

problem includes dynamic panel data models and is called Nickell bias. Anderson & Hsiao (1981) proposed the use of an instrument for a lagged dependent variable. In our model, TLU_{t-3} , or the first difference of $TLU_{i,t-3}$, can be used as an instrument because they have a strong correlation with $(TLU_{i,t-1} - TLU_{i,t-3})$ while displaying no correlation with $(v_{i,t} - v_{i,t-2})$. Arellano (1989)'s numerical analysis compared the two possible instruments and found that the estimator using the level instrument has smaller asymptotic standard errors with fixed T sample. Accordingly, $TLU_{i,t-3}$ is used as an instrument in this study.

Table 4-2 presents the results of estimations of the model (1). The lagged livestock holdings on the right-hand side are treated as an endogenous variable and are instrumented by the Anderson-Hsiao instrument variable (i.e., $TLU_{i,t-3}$). Agricultural variables, such as access to irrigation and livestock vaccination practices, are controlled to condition the resilience of agricultural practice. By definition, a parameter of rainfall percent deviation from the long-term mean takes a negative value in the case of below-normal rainfall. Rainfall shock and its interaction with asset status have their expected positive effects on aggregate livestock and cattle holdings, although they are not significant. On the other hand, the asset status interaction terms are positive and significant for small livestock holdings, suggesting that the asset rich destock small livestock in the face of below-normal rainfall shocks more often than the asset poor. The size of the area of land has a positive and significant effect on aggregate livestock and cattle holdings, but it is not significant for small livestock. The loan access variable has significantly negative coefficients on small livestock holdings but has significantly positive coefficients on cattle holdings. If farm households rely first on small livestock for their divisible traits relative to cattle, this opposite sign of small animal to that of cattle holdings are not counterintuitive. Households with better access to loan institutions might have stronger abilities in intertemporal resource allocation; they may have low precautionary demand for small livestock but may accumulate essential draught animal

faster. The result of a heteroscedasticity test (Pagan Hall general test) suggests the presence of heteroscedasticity in the estimations of small livestock holdings, and thus heteroscedasticity-robust statistics for small livestock estimations are presented here. The weak identification tests under homoscedasticity and heteroscedasticity assumptions confirm the instrument relevance between the dependent variable and the lagged dependent variables. The coefficients of the lagged dependent variable lying between zero and one confirm the conditional convergence, which is consistent with the results from LOWESS.

[Insert Table 4-2 here]

[Insert Table 4-3 here]

The rainfall shocks were separated into positive (above-normal) and negative (below-normal) rainfall shocks,⁴⁴ and the estimates of those effects on livestock holdings are shown in Table 4-3. Negative and positive rainfalls are strongly correlated to each other by definition, so that the model containing both rainfall variables suffers from multicollinearity. In view of this difficulty, this study limits one interaction term of either positive or negative rainfall per estimation. Both negative and positive rainfall shocks have negative coefficients on aggregate and small livestock holdings, although only negative rainfall shock has a significant effect on small livestock holdings.

Table 3 Column (5) suggests that the asset rich decrease their small livestock more than the asset poor do when they face a negative rainfall shock. This effect is significant at the 5 per cent level and suggests that asset-rich households would decrease by 0.08

⁴⁴ Positive rainfall shock takes $\frac{(\text{Annual rainfall})}{\text{long-term annual rainfall mean}} - 1$, when *Annual rainfall* > *long-term annual* and otherwise takes 0. Negative rainfall shock takes $\left| \frac{(\text{Annual rainfall})}{\text{long-term annual rainfall mean}} - 1 \right|$ and otherwise takes 0.

TLU for small livestock if they have the average rainfall of 2011. Columns (3) and (6) estimate the effect of above-normal rainfall shocks on livestock holdings. Above-normal rainfall shocks do not have significant effects on aggregate livestock holdings amongst the asset poor (Column 3), but it does have negative and significant heterogeneous effects on small livestock holdings (Column 6).

The mechanism behind the opposite direction of behaviours amongst asset-rich and asset-poor households in the face of below- and above-normal rainfall is unclear. There are two potential reasons: Households may lose their livestock as a direct result of a rainfall shock (i.e., infectious disease and lack of feed), or they may choose to sell their livestock to protect their consumption. Hence, we need to carefully investigate whether heterogeneous livestock accumulation paths among the asset rich and asset poor are a part of the household coping strategy or a mere result of rainfall shocks.

4.6 Effects of Rainfall on Net Sale

To investigate the mechanism behind these bifurcated asset-accumulation dynamics, it is necessary to examine a flow variable of livestock accumulation: net sale (i.e., sold TLU – purchased TLU) in this section. Since transactions of livestock, especially cattle, are discrete events and the median net sale is zero, this study employed random effects ordered probit model under the assumption that the true model is nonlinear, where net sales are categorized into three groups (3 = positive net sales, 2 = zero net sales, and 1 = negative net sales). The threshold parameters are statistically significantly different from each other, and thus the three categories of net sales do not need to be combined into two. The result is presented in Table 4-4. Net-sale variables are only available for two periods, and I added the death and birth ratio of livestock among each livestock holdings to control the changes in livestock holdings status due to deaths and births of livestock. To check the model misspecification problem under the assumption of nonlinearity, fixed effects and random effects estimators were also obtained and are presented in Table 4-5. The LM

tests on the random effects versus the pooled regression are significant and support the use of random effects estimators. The robust Hausman test argues in favour of the random effects model relative to the fixed effects model for net sale estimates of small livestock. To conserve space, either random-effects or fixed-effects estimators supported by the robust Hausman test are reported.

Although it was not well reflected on a stock variable (i.e., livestock holdings), below-normal rainfall shocks have negative significant effects on a flow variable (i.e., netsale), after controlling deaths and births of livestock. Consistent with the estimates of livestock dynamics in Table 4-3, the interaction of asset status and below-normal rainfall deviations has positive and significant effect on small livestock netsale at the 1 per cent level, suggesting that asset-rich households sell more small livestock in the face of below-normal rainfall than asset-poor households do. In addition, the directions of interaction term parameters are opposite to those of below-normal rainfall shocks, suggesting that the asset poor and the asset rich respond differently to below-normal rainfall; the asset poor are more likely to refrain from selling those livestock in the face of below-normal rainfall shock (Table 4-4 and Table 4-5). Above-normal rainfall has an insignificant effect on the net sale of small livestock in Table 4-4. For the small livestock net sale estimate, this non-significant result is contrary to the finding of the estimates of small livestock holdings dynamics in Table 4-3, where above-normal rainfall has negative effects on small livestock holdings. The non-responsiveness of the small livestock net sale of asset-poor households might indicate that the deduction of small livestock holdings of asset-poor households is not the result of the increased net sale induced by above-normal rainfall⁴⁵. Asset-poor households may have lost their small livestock in the face of above-normal rainfall shocks due to their inability to protect livestock from floods and water-

⁴⁵ Wide range of infectious disease has been increasingly observed after heavy rain (Epstein, 2001).

borne infections. Also, the death ratio is negatively significant on the net sale of small livestock in ordered probit and random effect estimates, suggesting that net sale of small livestock is susceptible to death of those livestock.

[Insert Table 4-4 here]

Although the other coefficients are not the main focus of the paper, village-level mean access to public transfer (except for household *i*) consistently has positive and significant coefficients on all the livestock net sales, suggesting that if other things are equal, the availability of public transfer is associated with an increase in the net sale of livestock. One possible reason is that villagers with access to public transfer may be better able to allocate their resources intertemporally and sell their livestock more frequently in the face of natural disaster⁴⁶, but further investigations are required.

[Insert Table 4-5.here]

4.7 Conclusion

Using two-period panel data of rural Ethiopia, this article discusses heterogeneity in livestock accumulation among different asset-holding levels. An analysis of livestock accumulation comparing different asset-status subsamples reveals that the effect of below- and above-normal rainfall on livestock holdings differs among initial asset statuses. The households with enough cattle power for ploughing (i.e., the asset rich) de-

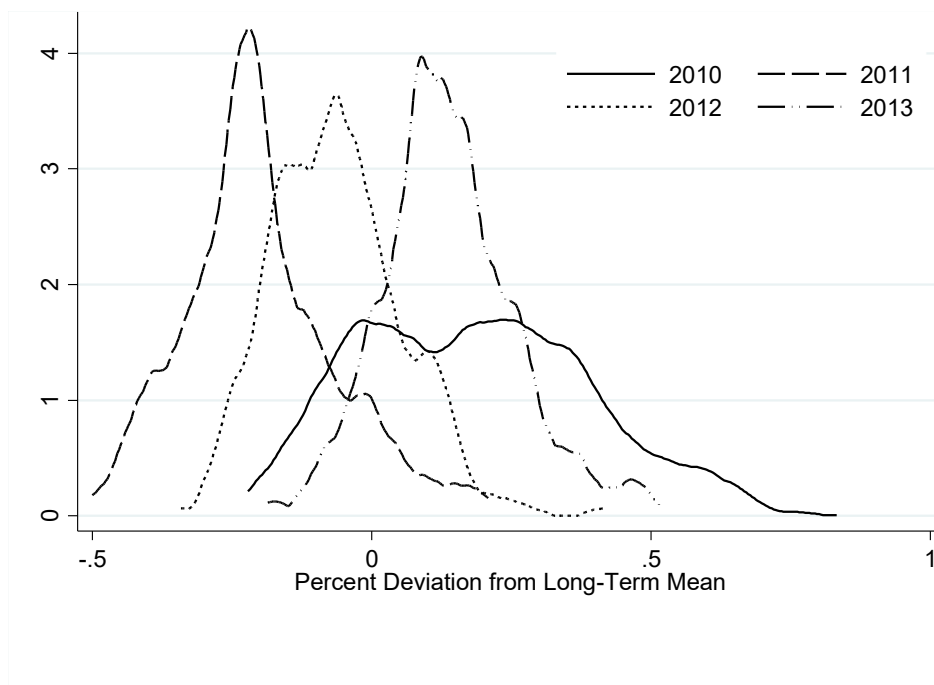
⁴⁶ Some may argue that the public transfer is targeted to the asset poor, and thus those who wish to remain receiving public transfer have motivation to reduce their livestock and sell out those. However, public transfer is insignificant in the previous estimates on all types of livestock holdings, confirming those households just increase their transactions but not decrease livestock holdings.

accumulate their small livestock holdings in the face of below-normal rainfall. In contrast, those households that do not have enough cattle for ploughing (i.e., the asset poor) de-accumulate their small livestock in the face of above-normal rainfall. The asset rich seem to de-accumulate their small livestock through the sale of the livestock, but the asset poor's declining possession of small livestock in the face of above-normal rainfall merely seems like a result of loss through rainfall-related disasters. Although both under- and above-normal rainfall are aggregate shocks that may adversely affect villagers' lives, the differences in the suddenness and duration of below- and above-normal rainfall, coupled with socioeconomic heterogeneities, bring about further bifurcated reactions from asset-rich and asset-poor households.

The heterogeneity of the asset-accumulation path across different asset statuses is confirmed and is the result of the heterogeneous coping strategy of the asset rich (i.e., consumption smoothing) and the asset poor (i.e., asset smoothing) during the drought period.

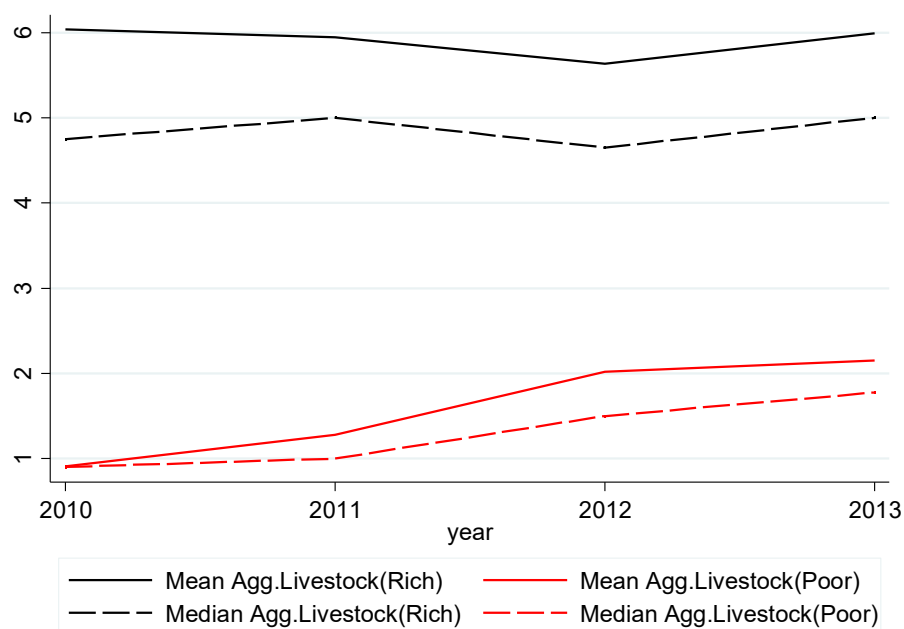
Figures & Tables

Figure 4-1 Kernel density distribution of rainfall deviation in highland Ethiopia



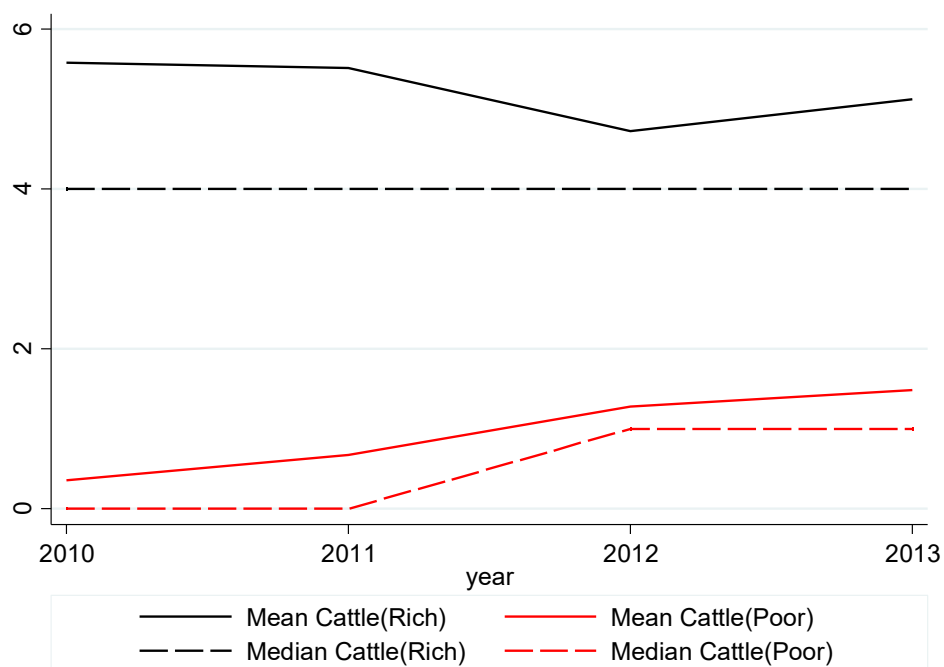
Source: Author's calculations from NOAA.

Figure 4-2 Mean and median aggregate livestock holding (TLU) by asset status



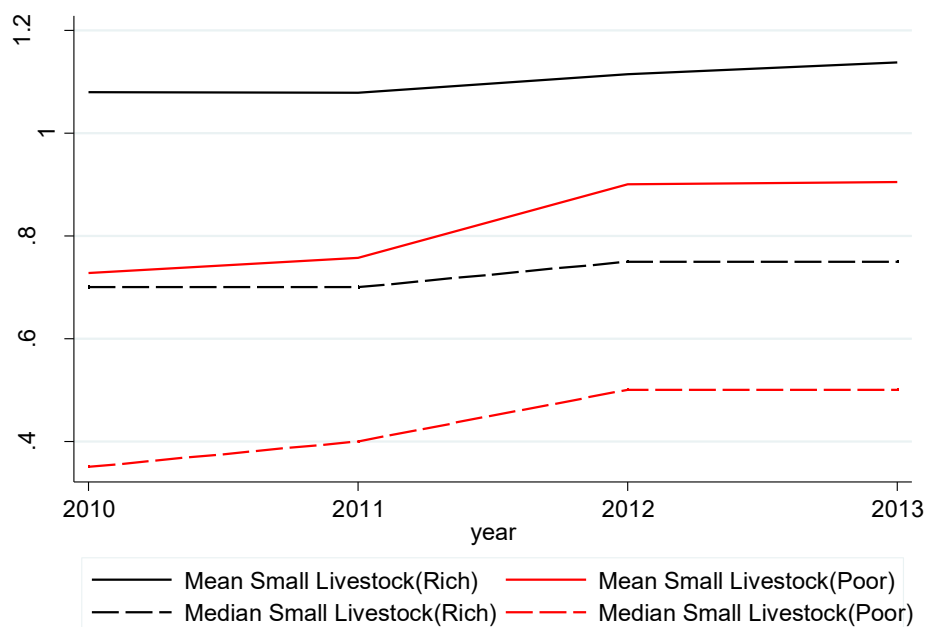
Source: Author's calculations from ESS.

Figure 4-3 Mean and median cattle livestock holding (TLU) by asset status



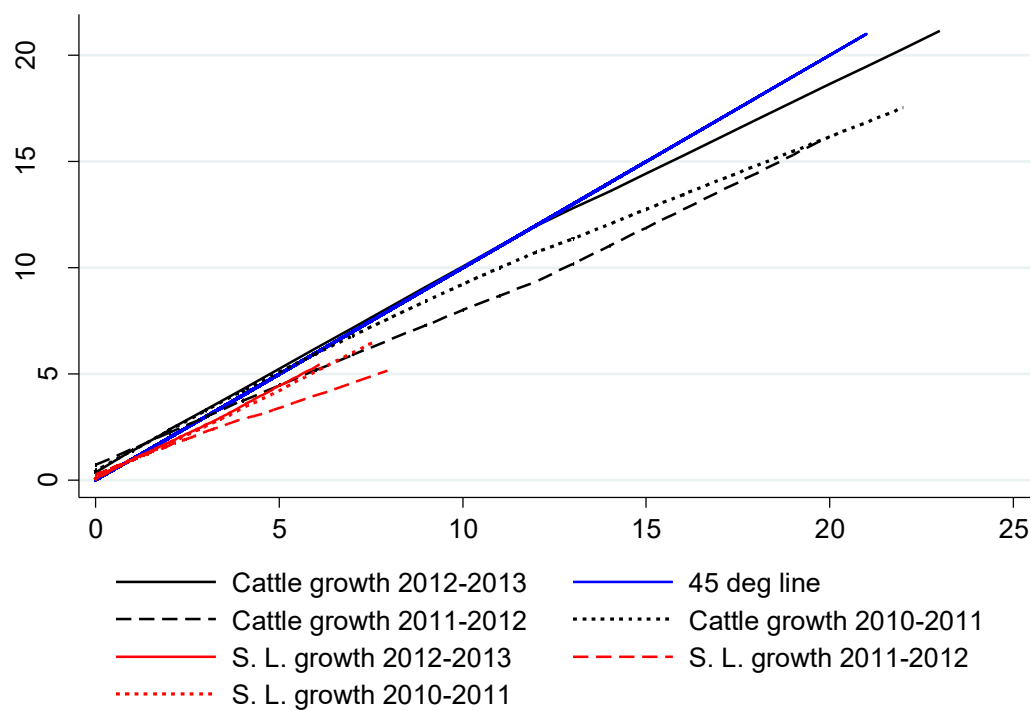
Source: Author's calculations from ESS.

Figure 4-4 Mean and median small livestock holding (TLU) by asset status



Source: Author's calculations from ESS.

Figure 4-5 Nonparametric estimation of dynamic livestock asset path (cattle & small livestock)



Source: Author's calculations from ESS.

Table 4-1 Characteristics of the asset poor and the asset rich

	Obs of asset-poor	Mean of asset poor	Obs of asset rich	Mean of asset rich	Mean difference	p-value
TLU_t	284	2.217	1049	6.023	-3.805	0.000
TLU_t-1	284	2.085	1049	5.683	-3.598	0.000
TLU_t-2	284	1.589	1049	5.912	-4.323	0.000
TLU_t-3	284	1.017	1049	5.773	-4.756	0.000
Cattle_t	284	1.660	1049	4.990	-3.330	0.000
Cattle_t-1	284	1.475	1049	4.676	-3.201	0.000
Cattle_t-2	284	1.032	1049	4.992	-3.960	0.000
Cattle_t-3	284	0.504	1049	4.850	-4.347	0.000
Percent deviation from historical annual rainfall mean	284	0.119	1049	0.148	-0.029	0.019
Percent deviation from historical annual rainfall mean_t-2	284	-0.207	1049	-0.213	0.006	0.005
Household size	284	4.979	1049	5.920	-0.941	0.000
Household size_t-2	284	5.067	1049	5.982	-0.915	0.000
Dependency ratio	284	132.069	1049	127.437	4.631	0.021
Dependency ratio_t-2	284	146.531	1049	130.617	15.913	0.096
Village mean nonfarm profit (ETB)	284	131.925	1049	106.728	25.196	0.637
Village mean nonfarm profit (ETB)_t- 2	284	621.104	1049	163.336	457.768	0.046
Planted land size (ha)	284	1.092	1049	1.850	-0.758	0.000
Planted land size (ha)_t-2	284	0.685	1049	1.752	-1.067	0.000
Tenancy status (1=landowner, 0=otherwise)	284	0.989	1049	0.991	-0.002	0.928
Tenancy status (1=landowner, 0=otherwise)_t-2	284	1.000	1049	1.000	0.000	N/A
Proportion of certified land	284	0.482	1049	0.593	-0.111	0.044
Proportion of certified land_t-2	284	0.434	1049	0.512	-0.078	0.068
Village mean access to loan	284	0.331	1049	0.312	0.019	0.769
Village mean access to loan_t-2	284	0.294	1049	0.282	0.012	0.763
Village mean access to public transfer	284	0.115	1049	0.100	0.015	0.002
Village mean access to public transfer_t-2	284	0.129	1049	0.132	-0.003	0.054
Village mean access to irrigation	284	0.086	1049	0.072	0.014	0.095
Village mean access to irrigation_t-2	284	0.097	1049	0.086	0.012	0.089
Proportion of vaccinated livestock	284	0.229	1049	0.319	-0.091	0.495
Proportion of vaccinated livestock_t-2	284	0.233	1049	0.267	-0.034	0.058

Source: Author's calculations from ESS.

Table 4-2. Anderson-Hsiao estimates of aggregate livestock and small livestock holdings with rainfall

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	TLU		Small animal		Cattle	
TLU_(t-1)	0.497*** (0.179)	0.496*** (0.180)				
Small animal_(t-1)			0.436*** (0.107)	0.438*** (0.106)		
Cattle_(t-1)					0.421** (0.207)	0.418** (0.210)
Rainfall shock*Asset status at t-3	0.212 (0.507)	0.201 (0.511)	0.222** (0.112)	0.234** (0.114)	-0.061 (0.751)	-0.095 (0.769)
Rainfall shock, % deviation from 10 yr annual rainfall mean	0.127 (0.585)	0.156 (0.606)	-0.101 (0.102)	-0.149 (0.107)	0.317 (0.872)	0.393 (0.918)
Squared rainfall shock		0.297 (1.439)		-0.584 (0.377)		0.695 (1.469)
<u>Mediating factors</u>						
Village mean nonfarm profit (thousand ETB)	0.015 (0.009)	0.015 (0.009)	0.002 (0.003)	0.003 (0.003)	0.031 (0.037)	0.030 (0.037)
Village mean access to loan	0.310 (0.224)	0.310 (0.224)	-0.156** (0.063)	-0.154** (0.063)	0.473* (0.249)	0.471* (0.250)
Village mean access to public transfer	-0.223 (0.233)	-0.227 (0.232)	-0.038 (0.080)	-0.031 (0.079)	-0.345 (0.216)	-0.355 (0.217)
<u>Household characteristics</u>						
Household size	0.005 (0.056)	0.006 (0.055)	0.017 (0.015)	0.015 (0.015)	-0.003 (0.065)	0.001 (0.062)
Dependency ratio	0.106 (0.264)	0.107 (0.265)	-0.041* (0.023)	-0.042* (0.023)	0.157 (0.004)	0.161 (0.004)
Planted land size (ha)	0.035*** (0.013)	0.035*** (0.013)	0.003 (0.003)	0.002 (0.003)	0.025** (0.011)	0.025** (0.011)
Tenancy status (1=landowner, 0=otherwise)	-0.443 (0.800)	-0.448 (0.800)	-0.120 (0.142)	-0.113 (0.145)	-0.682 (0.928)	-0.697 (0.932)
Proportion of certified land	0.081 (0.131)	0.082 (0.131)	-0.058 (0.041)	-0.060 (0.041)	0.044 (0.142)	0.045 (0.142)
Village mean access to irrigation	0.741** (0.367)	0.740** (0.367)	-0.005 (0.125)	-0.005 (0.126)	0.841** (0.382)	0.836** (0.380)
Proportion of vaccinated livestock	-0.312*** (0.094)	-0.312*** (0.094)				
Proportion of vaccinated small animal			-0.118 (0.103)	-0.117 (0.103)		
Proportion of vaccinated cattle					-0.399** (0.164)	-0.398** (0.164)
underidentification test (Kleibergen-Paap rk LM stat)	6.767	6.74	37.935	38.389	6.076	5.98
ch-sq(1) p-val	0.009	0.009	0.000	0.000	0.014	0.015
weak identification test (Cragg-Donald Wald F stat)	46.269	46.36	161.951	163.776	39.095	38.75
Heteroskedasticity-robust weak identification test (Kleibergen-Paap rk Wald F stat)	8.272	8.223	54.15	54.506	7.322	7.173
Pagan-Hall test for heteroskedasticity	12.072 Chi-sq (13)	12.610 Chi-sq (14)	72.311 Chi-sq (13)***	76.845 Chi-sq (14)***	9.154 Chi-sq (13)	9.458 Chi-sq (14)
Observations	1,333	1,333	1,098	1,098	1,163	1,163
Uncentered R-squared	0.572	0.571	0.385	0.387	0.529	0.527

Notes:

1. Heteroskedasticity-robust standard errors in parentheses.

2. *** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.

3. Sample are drawn from Tigray, Amhara, Oromia, SNNP regions

Source: Author's calculations from ESS.

Table 4-3. Anderson-Hsiao estimates of aggregate livestock and small livestock holdings with rainfall (with positive and negative rainfall shock)

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TLU			Small animal			Cattle		
TLU_(t-1)	0.482*** (0.150)	0.506*** (0.181)	0.487*** (0.168)						
Small animal_(t-1)				0.422*** (0.107)	0.441*** (0.105)	0.433*** (0.106)			
Cattle_(t-1)							0.425** (0.170)	0.422** (0.214)	0.422** (0.193)
Negative rainfall shock	-0.397 (0.487)	0.005 (0.898)	-0.400 (0.483)	-0.307** (0.152)	0.041 (0.174)	-0.310** (0.151)	-0.270 (0.466)	-0.329 (1.276)	-0.268 (0.462)
Positive rainfall shock	0.182 (0.630)	0.148 (0.658)	0.0403 (1.072)	-0.211 (0.170)	-0.223 (0.169)	-0.543* (0.311)	0.252 (0.656)	0.257 (0.712)	0.396 (1.504)
Negative rainfall shock*Asset status at t-3		-0.506 (0.880)			-0.424** (0.177)			0.0704 (1.323)	
Positive rainfall shock*Asset status at t-3			0.163 (0.948)			0.383 (0.278)			-0.157 (1.289)
Mediating factors									
Village mean nonfarm profit (thousand ETB)	0.016* (0.008)	0.014 (0.010)	0.016* (0.009)	0.004 (0.003)	0.003 (0.003)	0.004 (0.003)	0.031 (0.037)	0.031 (0.037)	0.031 (0.037)
Village mean access to loan	0.309 (0.228)	0.312 (0.222)	0.309 (0.227)	-0.162*** (0.0626)	-0.153** (0.0626)	-0.159** (0.0623)	0.473* (0.247)	0.473* (0.248)	0.474* (0.249)
Village mean access to public transfer	-0.214 (0.230)	-0.224 (0.232)	-0.215 (0.231)	-0.031 (0.080)	-0.035 (0.079)	-0.032 (0.079)	-0.346 (0.216)	-0.345 (0.216)	-0.346 (0.216)
Household characteristics									
Household size	0.004 (0.056)	0.003 (0.055)	0.004 (0.056)	0.015 (0.015)	0.014 (0.015)	0.014 (0.015)	-0.003 (0.063)	-0.003 (0.063)	-0.003 (0.063)
Dependency ratio	0.112 (0.262)	0.101 (0.261)	0.110 (0.265)	-0.039* (0.023)	-0.042* (0.023)	-0.040* (0.023)	0.156 (0.344)	0.157 (0.365)	0.157 (0.354)
Planted land size (ha)	0.034*** (0.013)	0.035*** (0.013)	0.034*** (0.013)	0.002 (0.003)	0.002 (0.003)	0.002 (0.003)	0.025** (0.011)	0.025** (0.011)	0.025** (0.011)
Tenancy status (1=landowner, 0=otherwise)	-0.451 (0.799)	-0.428 (0.799)	-0.446 (0.803)	-0.111 (0.144)	-0.105 (0.147)	-0.110 (0.145)	-0.676 (0.905)	-0.680 (0.937)	-0.681 (0.922)
Proportion of certified land	0.079 (0.131)	0.081 (0.131)	0.079 (0.131)	-0.061 (0.041)	-0.060 (0.041)	-0.061 (0.041)	0.043 (0.142)	0.043 (0.142)	0.044 (0.141)
Village mean access to irrigation	0.741** (0.369)	0.737** (0.368)	0.742** (0.368)	-0.008 (0.127)	-0.009 (0.127)	-0.005 (0.126)	0.842** (0.383)	0.842** (0.383)	0.840** (0.381)
Proportion of vaccinated livestock	-0.311*** (0.096)	-0.313*** (0.093)	-0.312*** (0.095)						
Proportion of vaccinated small animal				-0.107 (0.104)	-0.114 (0.103)	-0.112 (0.104)			
Proportion of vaccinated cattle							-0.399** (0.160)	-0.399** (0.164)	-0.399** (0.162)
underidentification test (Kleibergen-Paap rk LM stat)	10.282	6.487	7.901	38.318	38.468	38.275	9.141	5.752	7.012
ch-sq(1) p-val	0.001	0.011	0.005	0.000	0.000	0.000	0.003	0.017	0.008
weak identification test (Cragg-Donald Wald F stat)	64.452	45.155	52.921	158.328	163.531	163.217	55.13	37.879	44.255
Heteroskedasticity-robust weak identification test (Kleibergen-Paap rk Wald F stat)	12.675	7.843	9.753	53.062	54.354	54.206	11.151	6.83	8.51
Pagan-Hall test for heteroskedasticity	13.335 Chi-sq (13)	12.332 Chi-sq (14)	12.639 Chi-sq (14)	72.618 Chi-sq (13)***	76.516 Chi-sq (14)***	75.951 Chi-sq (14)***	11.404 Chi-sq (13)	9.114 Chi-sq (14)	10.152 Chi-sq (14)
Observations	1,333	1,333	1,333	1,098	1,098	1,098	1,163	1,163	1,163
Uncentered R-squared	0.563	0.577	0.566	0.380	0.389	0.385	0.532	0.530	0.529

Notes:

1. Heteroskedasticity-robust standard errors in parentheses.

2. *** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.

3. Sample are drawn from Tigray, Amhara, Oromia, SNNP regions

Source: Author's calculations from ESS.

Table 4-4 Ordered probit estimate of net sale

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Netsale of TLU					Netsale of Small Animal				Netsale of Cattle		
TLU_(t-1)		0.046*** (0.006)		0.053*** (0.006)								
TLU death ratio	-0.019 (0.023)		-0.015 (0.023)									
TLU birth ratio	0.085*** (0.028)		0.062** (0.027)									
Small animal_(t-1)						0.460*** (0.033)		0.466*** (0.033)				
Small animal death ratio					-0.080*** (0.019)		-0.078*** (0.019)					
Small animal birth ratio					0.137*** (0.021)		0.135*** (0.021)					
Cattle_(t-1)										0.074*** (0.007)		0.083*** (0.007)
Cattle death ratio									-0.027 (0.102)		0.008 (0.101)	
Cattle birth ratio									0.743*** (0.114)		0.679*** (0.113)	
Negative rainfall shock*Asset status at t-3	2.145*** (0.322)	1.310*** (0.331)			1.105*** (0.351)	0.419 (0.359)			3.715*** (0.389)	2.653*** (0.400)		
Positive rainfall shock*Asset status at t-3			0.431 (0.409)	-0.362 (0.416)			0.383 (0.457)	-0.340 (0.463)			0.883* (0.456)	-0.036 (0.470)
Negative rainfall shock	-2.210*** (0.330)	-1.652*** (0.332)	-0.529*** (0.206)	-0.634*** (0.208)	-1.592*** (0.357)	-1.274*** (0.363)	-0.723*** (0.222)	-0.939*** (0.227)	-2.937*** (0.398)	-2.186*** (0.405)	0.223 (0.213)	0.064 (0.218)
Positive rainfall shock	-0.008 (0.249)	-0.180 (0.252)	-0.351 (0.422)	-0.101 (0.425)	0.159 (0.272)	-0.296 (0.278)	-0.161 (0.472)	-0.012 (0.478)	0.220 (0.256)	0.015 (0.261)	-0.521 (0.469)	0.037 (0.481)
Mediating factors												
Village mean nonfarm profit (thousand ETB)	-0.334*** (0.111)	-0.320*** (0.112)	-0.352*** (0.112)	-0.332*** (0.113)	-0.325*** (0.125)	-0.349*** (0.128)	-0.335*** (0.125)	-0.354*** (0.128)	-0.023 (0.118)	-0.038 (0.121)	-0.054 (0.117)	-0.061 (0.120)
Village mean access to loan	0.272*** (0.091)	0.273*** (0.091)	0.282*** (0.091)	0.272*** (0.091)	0.352*** (0.101)	0.442*** (0.103)	0.360*** (0.102)	0.444*** (0.103)	0.091 (0.095)	0.009 (0.097)	0.087 (0.094)	0.004 (0.097)
Village mean access to public transfer	0.479*** (0.102)	0.534*** (0.103)	0.470*** (0.102)	0.532*** (0.103)	0.381*** (0.111)	0.324*** (0.113)	0.379*** (0.111)	0.318*** (0.113)	0.380*** (0.104)	0.486*** (0.107)	0.354*** (0.103)	0.476*** (0.106)
Household characteristics												
Household size	0.012 (0.0112)	-0.010 (0.0116)	0.020* (0.0112)	-0.006 (0.0116)	0.008 (0.0126)	-0.038*** (0.0132)	0.012 (0.0127)	-0.035*** (0.0132)	0.011 (0.0115)	-0.014 (0.0120)	0.019* (0.0115)	-0.010 (0.0120)
Dependency ratio	0.026 (0.024)	0.023 (0.024)	0.016 (0.024)	0.016 (0.024)	0.035 (0.027)	0.044 (0.027)	0.028 (0.027)	0.041 (0.027)	-0.002 (0.025)	-0.011 (0.026)	-0.014 (0.025)	-0.021 (0.026)
Planted land size (ha)	-0.00745 (0.00569)	-0.0132** (0.00597)	-0.00541 (0.00566)	-0.0125** (0.00598)	0.007 (0.00618)	0.000 (0.00591)	0.008 (0.00623)	0.001 (0.00592)	-0.0132** (0.00570)	-0.0215*** (0.00619)	-0.0102* (0.00561)	-0.0200*** (0.00613)
Proportion of certified land	-0.0414 (0.0473)	-0.0428 (0.0477)	-0.0294 (0.0475)	-0.0333 (0.0479)	-0.0204 (0.0532)	-0.0489 (0.0541)	-0.0144 (0.0532)	-0.0450 (0.0541)	-0.0181 (0.0494)	-0.00837 (0.0507)	-0.00775 (0.0492)	0.00290 (0.0506)
Tenancy status (1=landowner, 0=otherwise)	0.275 (0.210)	0.339 (0.214)	0.242 (0.211)	0.353 (0.215)	0.360 (0.229)	0.394* (0.235)	0.336 (0.230)	0.404* (0.236)	0.101 (0.216)	0.162 (0.221)	0.0611 (0.216)	0.160 (0.221)
Village mean access to irrigation	0.0135 (0.139)	0.0579 (0.140)	0.00192 (0.139)	0.0513 (0.140)	-0.0183 (0.152)	0.145 (0.154)	-0.0251 (0.152)	0.137 (0.154)	-0.318** (0.145)	-0.293** (0.149)	-0.317** (0.144)	-0.295** (0.149)
Proportion of vaccinated livestock	0.0770* (0.0433)	0.0748* (0.0406)	0.0840* (0.0430)	0.0766* (0.0407)								
Proportion of vaccinated small animal					0.418*** (0.159)	0.284* (0.160)	0.398** (0.159)	0.278* (0.160)				
Proportion of vaccinated cattle									0.0908* (0.0487)	0.0799 (0.0496)	0.100** (0.0485)	0.0851* (0.0495)
p-value of chi_sq test	chi(15)=11 5.13***	chi(14)=17 0.35***	chi(15)=71. 25***	chi(14)=15 5.34***	chi(15)=12 5.22***	chi(14)=31 4.03***	chi(15)=11 5.98***	chi(14)=31 3.21***	chi(15)=16 2.17***	chi(14)=24 9.08***	chi(15)=69. 91***	chi(14)=20 3.76***
Category threshold 1	-0.107 (0.224)	-0.00589 (0.228)	-0.0999 (0.226)	0.0566 (0.230)	-0.0331 (0.246)	0.0162 (0.252)	-0.0378 (0.248)	0.0474 (0.254)	-0.807*** (0.233)	-0.801*** (0.237)	-0.791*** (0.233)	-0.733*** (0.237)
Category threshold 2	0.691*** (0.225)	0.806*** (0.229)	0.695*** (0.227)	0.868*** (0.232)	1.034*** (0.248)	1.135*** (0.255)	1.029*** (0.249)	1.166*** (0.257)	1.184*** (0.234)	1.255*** (0.239)	1.157*** (0.234)	1.301*** (0.239)
Observations	3,158	3,158	3,158	3,158	2,802	2,802	2,802	2,802	2,846	2,846	2,846	2,846

Notes:

1. Standard errors in parentheses.

2. *** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.

3. Sample are drawn from Tigray, Amhara, Oromia, SNNP regions

4. The dependent variables, net sales are categorical variables (3=positive net sales, 2=zero net sales, and 1=negative net sales).

Source: Author's calculations from ESS.

Table 4-5 Fixed and random effect estimate of netsale

Dependent variable	(1) Net sale of TLU(FE)	(2) Net sale of TLU(FE)	(3) Net sale of small animal (RE)	(4) Net sale of small animal (RE)	(5) Net sale of cattle (FE)	(6) Net sale of cattle (FE)
TLU death ratio	-0.016 (0.0373)	-0.015 (0.0370)				
TLU birth ratio	0.089*** (0.034)	0.082** (0.034)				
Small animal death ratio			-0.016*** (0.005)	-0.0157*** (0.005)		
Small animal birth ratio			0.0260*** (0.00491)	0.0255*** (0.00492)		
Cattle death ratio					-0.00432 (0.0996)	0.00438 (0.101)
Cattle birth ratio					0.266* (0.147)	0.241 (0.150)
Negative rainfall shock*Asset status at t-3	1.725*** (0.331)		0.242*** (0.0851)		2.234*** (0.371)	
Positive rainfall shock*Asset status at t-3		-2.055*** (0.453)		0.0155 (0.110)		-2.657*** (0.543)
Negative rainfall shock	-1.438*** (0.317)	-0.0471 (0.247)	-0.319*** (0.0807)	-0.127** (0.0609)	-1.776*** (0.356)	0.131 (0.247)
Positive rainfall shock	0.291 (0.308)	1.979*** (0.476)	0.0179 (0.0644)	0.00548 (0.117)	0.369 (0.297)	2.663*** (0.573)
<u>Mediating factors</u>						
Village mean nonfarm profit (thousand ETB)	-0.089 (0.203)	-0.094 (0.202)	-0.051 (0.0326)	-0.053 (0.033)	0.101 (0.216)	0.109 (0.215)
Village mean access to loan	-0.100 (0.123)	-0.0845 (0.123)	0.0616** (0.0274)	0.0631** (0.0273)	-0.127 (0.125)	-0.117 (0.126)
Village mean access to public transfer	0.399*** (0.122)	0.391*** (0.124)	0.0950*** (0.0304)	0.0945*** (0.0305)	0.273** (0.124)	0.253** (0.127)
<u>Household characteristics</u>						
Household size	0.0357 (0.0280)	0.0336 (0.0280)	0.00281 (0.00320)	0.00394 (0.00321)	0.0165 (0.0268)	0.0141 (0.0268)
Dependency ratio	-0.045 (0.044)	-0.053 (0.044)	0.004 (0.006)	0.002 (0.006)	-0.025 (0.044)	-0.034 (0.044)
Planted land size (ha)	-0.0282*** (0.00647)	-0.0282*** (0.00685)	0.00145 (0.000946)	0.00171* (0.000970)	-0.0264*** (0.00564)	-0.0264*** (0.00594)
Proportion of certified land	0.0139 (0.0781)	0.0192 (0.0788)	-0.0111 (0.0126)	-0.00956 (0.0126)	0.0498 (0.0777)	0.0498 (0.0788)
Tenancy status (1=landowner, 0=otherwise)	-0.149 (0.330)	-0.165 (0.331)	0.0692* (0.0409)	0.0665 (0.0411)	-0.210 (0.358)	-0.212 (0.359)
Village mean access to irrigation	-0.354 (0.233)	-0.381 (0.234)	0.0377 (0.0400)	0.0359 (0.0402)	-0.475* (0.244)	-0.505** (0.246)
Proportion of vaccinated livestock	0.144*** (0.0540)	0.144*** (0.0540)				
Proportion of vaccinated small animal			0.0791** (0.0395)	0.0756* (0.0397)		
Proportion of vaccinated cattle					0.120* (0.0672)	0.119* (0.0675)
Constant	0.147 (0.381)	0.171 (0.381)	-0.0860* (0.0453)	-0.0895* (0.0458)	0.212 (0.407)	0.234 (0.408)
Observations	3,158	3,158	2,802	2,802	2,846	2,846
Within R-squared	0.046	0.041	0.0253	0.0256	0.043	0.035
Number of hh_id2	1,834	1,834	1,712	1,712	1,685	1,685
Hausman test	Prob>chi2 =0.000	Prob>chi2 =0.000	Prob>chi2 =0.250	Prob>chi2 =0.343	Prob>chi2 =0.000	Prob>chi2 =0.000

Notes:

1. Clustered-robust standard errors in parentheses.

2. *** significant at 1 per cent level, ** significant at 5 per cent level, * significant at 10 per cent level.

3. Sample are drawn from Tigray, Amhara, Oromia, SNNP regions

4. The dependent variables, net sale are continuous variables (i.e., sold TLU-purchased TLU).

Source: Author's calculations from ESS.

5 Conclusion and Policy Implication

Throughout this thesis, static and dynamic measures of poverty were discussed, and various coping strategies taken in the midst of chronic and transient poverty were investigated. In this final section, I will connect the results from my thesis to the current Ethiopia government's poverty reduction policy and present policy outcomes.

Since the Government of Ethiopia launched its poverty reduction policy Agricultural Development Lead Industrialization (ADLI) in 1993, its poverty reduction policy continued to inherit ADLI and modified into Plan for Accelerated and Sustained Development to End Poverty (PASDEP) during 2005-2010 and Growth and Transformation Plan (GTP) during 2010-2015. As Rural Development Policies and Strategies (RDPS) in 2003 states, Ethiopia aim for sustained growth through labour intensive production methods and the centerpiece of its agricultural development policy has been extension program aimed at diffusion of modern agricultural technology.

Throughout the time span of 1994-2013 that this thesis covered, poverty reduction was stagnant in the first six year but has been accelerated after 2000. Ethiopia had reduced poverty rate from one of the highest level (i.e., 56 per cent of population lived below USD 1.25 PPP a day) in 2000 to 31 per cent in 2011, which was one of the largest poverty reduction observed in Africa (World Bank, 2015)⁴⁷. Decomposing poverty reduction by sector, Hill & Tsehaye (2015) found the largest poverty reduction was observed within the self-employed rural agricultural households. Coupled with its agricultural development policy, higher food price and relatively favourable weather conditions within this period contributed large poverty reduction among agricultural households.

However, poverty severity below the poverty line increased from 2005-2011 (see Chapter 2 & World Bank, 2015). One of the factors was high food inflation especially during 2008-2011, which bettered off net-seller agricultural households but worsened off

⁴⁷ Only Uganda has had higher annual poverty reduction during this time.

the poorest that were often not self-sufficient in food (World Bank, 2015). These poorest may be structurally poor for their inability to benefit adoption of new technology due to lack of draught power or labours and felled in poverty trap.

As an attempt to address the vulnerability to poverty, the Government of Ethiopia has implemented the Productive Safetynet Program (PSNP) since 2005 in which food-insecure woredas were predetermined to receive food or cash transfer. PSNP so far prevented well the poor from selling assets in the midst of shocks and improved their food security. However, the coverage was not enough, and many vulnerable households were left out from the protection. Conventional informal network may have played the role for addressing vulnerability. However, the poorest are often left from informal risk sharing as Chapter 3 found that illness shock was not well covered in the villages with better access to formal lending.

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