MASTER THESIS

The persistence of shocks in absence of credit and insurance:

Studying welfare dynamics in Northern Uganda between 2004 and 2008

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Cover picture by Rob Kuijpers: Buluzi village, Kitgum district, October 2011.

Abstract

Recent literature shows that weather related shocks (e.g. droughts, heavy rainfall, and hurricanes) may well be an important cause of structural poverty. Using panel data from Northern Uganda, this thesis expands the current knowledge base by investigating the persistent effects of a wider range of shocks on different types of households in an asset dynamics framework. While the educated, urban based and wealthier households appear to be completely insensitive for any type of shock; 2008 asset levels of poor, uneducated and rurally located households are negatively affected by harvest losses, epidemics and weather related shocks that occurred multiple years ago. Results also show that uneducated households living in rural communities accumulate assets much slower and reach a lower equilibrium than educated households living in urban areas. These results suggest that an insecure environment, which produces a continuous series of adverse events, can keep a household from reaching their equilibrium and can present a structural constraint on development.

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1. Introduction

Uncertainty, risks and shocks are part of everyone's daily life. In the developed world the impact of risks and shocks on people's welfare is minimized by the presence of labor markets promptly offering alternative sources of income, credit markets allowing households to smooth consumption and insurance and social safety nets preventing households from severely falling into poverty. Unfortunately, the rural poor in many parts of the developing world tend to have limited access to these types of risk management mechanisms (Alderman and Paxson 1992; Besley 1995). Therefore, when mitigating risks they often rely on themselves, by diversifying income (e.g. Barrett et al. 2001), accumulating assets (e.g. Deaton 1992; Zimmerman and Carter 2003) or by sharing risk (e.g. Fafchamps and Lund 2003). Unfortunately, these mechanisms are often either risky (e.g. Verpoorten 2009), costly (e.g. Dercon 1996) or not accessible for everyone (e.g. Schindler and Giesbert 2010). This suggests that risk impacts the welfare of the rural poor *ex-ante*; before it is even materialized in the form of a shock.

The *ex-post* impact of risk is then the actual shock: an adverse event that reduces the household's asset base, income and/or consumption (Dercon and Hoddinott 2005). Examples of shocks are droughts, price fluctuations, disease or dead of a household member or harvest losses due to pests or wild animals. These types of events can lead to increased volatility of consumption and can send households temporarily into poverty (Dercon and Krishnan 2000). However, recent literature suggests that shocks can also have a persistent (e.g. Dercon 2004) or even a permanent impact on household welfare (Carter et al. 2007), suggesting that shocks might well be one of the fundamental reasons why some households find themselves in structural poverty.

Unfortunately, there is yet too little theoretical understanding and empirical support on the effects of shocks to adequately inform policy about potential solutions that could improve the current situation in which many poor households in rural areas are finding themselves. This is especially regrettable, considering that current theoretical insights suggests that effective one-time interventions could lead to long-term welfare improvements (Naschold 2012).

This thesis aims to further increase the knowledge-base on shocks and welfare dynamics by investigating the persistence and structural effects of shocks in Northern Uganda, building on existing theoretical and empirical literature in at least four different ways. First, it will present a theoretical model that will define 'shock persistence'. Second, it will investigate the asset dynamics in the region, as this for a large part will determine the potential (structural) effects of shocks. Third, it will quantify the persistent effects of shocks on asset accumulation and, finally, explore the role of heterogeneity in both welfare dynamics and the long term effects of shocks.

This translates in the following research question:

What is the effect of covariate asset and income shocks on household asset accumulation in Northern Uganda?

Before we can answer this research question, a set of sub research questions has to be answered.

Theoretical research questions:

1. *When can the effect of a shock on household welfare be considered 'persistent'?*
2. *How can a shock have a structural effect on household welfare?*

Empirical research questions:

3. *Did shocks that occurred between 2004 and 2008 in Northern Uganda have a persistent impact on household asset accumulation?*
4. *Could shocks occurring in Northern Uganda have a structural impact on household welfare?*

The Northern Ugandan Survey (NUS), conducted by the Ugandan Bureau of Statistics (UBoS) in 2004 and 2008, will serve as the main source of data in answering these questions. Northern Uganda in this time span is an exceptionally suitable area for our purposes since it offers an harsh environment where shocks are common and where financial services are inaccessible for most of the people (Mpuga 2010).

The remainder of this thesis is organized as follows. Section 2 reviews the risk and asset dynamics literature and presents a model to understand shock persistence. Section 3 describes the data, presents background information on the region and takes care for the attrition in the data. Section 4 introduces the methodology in which an asset index is constructed and an empirical strategy is developed to uncover the asset dynamics in the region and to identify whether shocks do in fact have persistent effects. Section 5 then presents the results, while section 6 concludes this thesis.

2. Theoretical Framework

Risk is defined as the possibility of adversity or loss (Harwood 1999). In the context of rural areas in developing countries, Pan (2009) identifies four types of risk: *environmental hazard* (e.g. droughts, floods and pests); *disease or death* of people and livestock; *business shocks* (e.g. input and output price fluctuations); and *policy shocks* (e.g. land reforms, changes in tax policy, conflict and war). A shock is the realization of risk and is defined as "an adverse event that is costly to individuals and households in terms of lost income, reduced consumption, or the sale or destruction of assets" (Dercon and Hoddinott 2005). Following this definition we can distinguish between an asset shock, which directly reduces household asset holdings (e.g. by theft); and an income shock, which lowers income (e.g. in the case of harvest losses). Another distinction that can be made is between idiosyncratic shocks that only affect the individual or the household (e.g. the death of a household member) and covariate shocks, which are experienced by a whole community, region or country (e.g. droughts or price fluctuations).

Risks and shocks, are by definition, welfare reducing. The net-effect on welfare is however, mediated by household risk management and coping strategies. Unfortunately, people in the developing world often do not have access to formal insurance or credit and have to rely on a range of alternative mechanisms instead (Alderman and Paxson 1992; Deaton 1992; Besley 1995). This makes determining the welfare-effects of risk in developing countries more complex. What follows is an attempt to capture the different channels through which risk can have a welfare-reducing effect.

2.1 The transitory effect of risk

The impact of risk on welfare can be either transitory or persistent. Transitory risk effects usually come in the form of shocks that temporarily lower income, due to the inability of the household to avert the event (Pan, 2009). In this respect, risk leads to volatility in income or consumption and movements in and out of poverty (Dercon and Krishnan 2000).

2.2 The persistent effects of ex-ante risk

The persistent effect of risk on household welfare can be incurred both *ex-ante*, during the phase of uncertainty and *ex-post*, immediately after the shock occurred. Elbers et al. (2007) estimate that in Zimbabwe the presence of risk over a 50 year period leads to a reduction in household capital stock of 46%, compared to a simulated case with complete risk absence. Moreover, they find that over two thirds of the reduction can be attributed to ex-ante effects. In general, ex-ante risk decreases welfare through the costs of risk-management, or in other words; through the cost of income smoothing (Morduch 1995; Pan 2009). Risk management in absence of insurance markets, predominately entails crop or activity diversification. Unfortunately, these diversification strategies come with a price as they often present a tradeoff between the volatility and expected value of income (Morduch 1995; Dercon 1996).

2.3 The persistence of shocks in a single-equilibrium asset dynamics model

The persistence of the shock itself is determined by its direct and indirect influence on asset holdings and the household recovery preferences (Carter et al. 2007). A shock-induced reduction in assets, consequently, leads to a reduction in the household's income generating ability and, hence, its investment capacity. In the absence of credit markets, the household can only recover and get back to their original asset growth path by gradually saving and investing part of their income. This is what makes a shock potentially persistent.

Corresponding with the livelihood framework, assets are seen as determinants of income and can come in the form of natural, physical, social, financial and human capital (Ellis 2001). In this respect, we do not distinguish between buffer and productive assets, since this distinction appears to be rather arbitrary. Livestock, for instance, is commonly used as storage of wealth, but can at the same time produce labor and food (such as milk and eggs) and act as a mode of transport. Furthermore, buffer assets can be easily sold to smooth consumption in the case of an income shock, but can also be used as a way to save for lumpy investments. This way they can be transformed into productive assets in the future.

A shock can reduce asset holdings *directly*, by destruction or (i.e. less income leads to less investments) or *indirectly*, via the coping strategy implemented by the household. This normally happens in the event of an income shock, when the household can smooth consumption, by shifting labor to off-farm activities, acquiring (formal or informal) credit, drawing down savings or selling assets (Pan 2009). When the household chooses to cope by selling assets or drawing down savings, it reduces its asset base and, ultimately, chooses to smooth consumption *now* in exchange for a lower stream of income in the future until it is recovered from the shock. The household can be considered *fully* recovered when their asset-level catches up with the asset-level predicted in case no shock had occurred, but only *partially* recovered when their asset level arrives at the pre-shock level.

To get better insight into what it takes to recover from a shock, we consider the following endogenous asset growth model, inspired by Solow (1956):

(1) $$y_{i,t} = f(a_{i,t})$$

$$s.t. \quad f'(a) > 0 \; and \; f''(a) < 0$$

(2) $$a_{i,t+1} - a_{i,t} = I_{i,t} - \delta a_{i,t}$$

$$s.t. \quad \delta = constant \; and \; \delta \in (0,1)$$

(3) $$I_{i,t} = s y_{i,t}$$

$$s.t. \quad s = constant \; and \; s \in (0,1)$$

(4) $$y_{i,t} = s y_{i,t} + c_{i,t}$$

where per capita income y_{it} of household i in period t is a function of per capita asset holdings a_{it}, which is increasing with diminishing returns; asset accumulation, $a_{i,t+1}$ - $a_{i,t}$, is determined by the amount invested I_{it}, minus the depreciation of current assets $\delta a_{i,t}$ and δ is a constant. Investment is in turn determined by the savings rate, s, and the level of household income[1]. Income not saved or invested is consumed, $c_{i,t}$. For simplicity, the savings rate is assumed constant and determined by household time preferences, which for now are assumed constant as well[2]. It is important to notice that this model only applies to households with no access to credit and therefore have to rely on savings to accumulate assets. Graphically the model is identical to the Solow model as illustrated in figure 1.
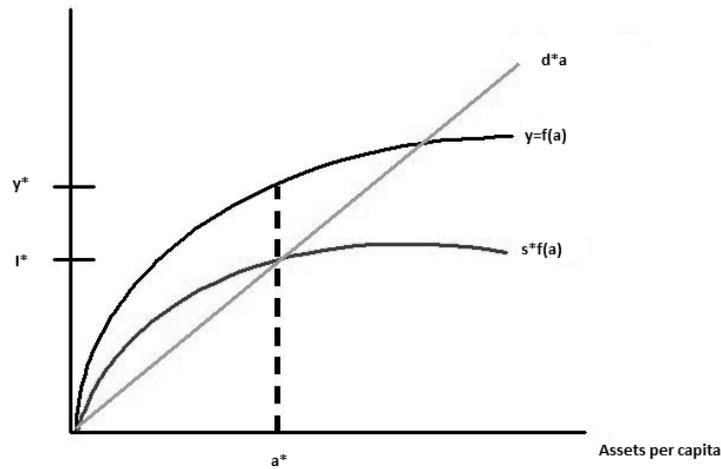
Figure 1: Solow model for individual household

The household will continue to accumulate assets, year after year, until investment equals the value of the depreciated assets in that period, which means that the equilibrium asset level, a*, is reached. In this steady state the household will invest I* and consume y*-I*.

Combining equations (1) up till (4) yields the dynamic asset equation:

(5) $$a_{i,t+1} = (1 - \delta)a_{i,t} + f(a_{i,t}) * s$$

where future assets, $a_{i,t+1}$, are dependent on current assets, $a_{i,t}$. Figure 2 illustrates the described asset dynamics.

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[1] The savings rate is the percentage of income that is saved. Here we assume, in line with neo-classical macro-economic theory that savings equals investment.

[2] The literature indicates that the savings rate will rise with household income (see Schmidt-Hebbel, K., S. B. Webb, et al. (1992). "Household saving in developing countries: first cross-country evidence." The World Bank Economic Review **6**(3): 529-547.) and also intuitively it is true that the rich can be more patient and set a bigger chunk of their income aside for savings, while the poor can afford fewer saving as they need almost all of their income to fulfill their basic consumption needs. However, the conclusions that will follow would not be different with an increasing savings rate, only more complicated.
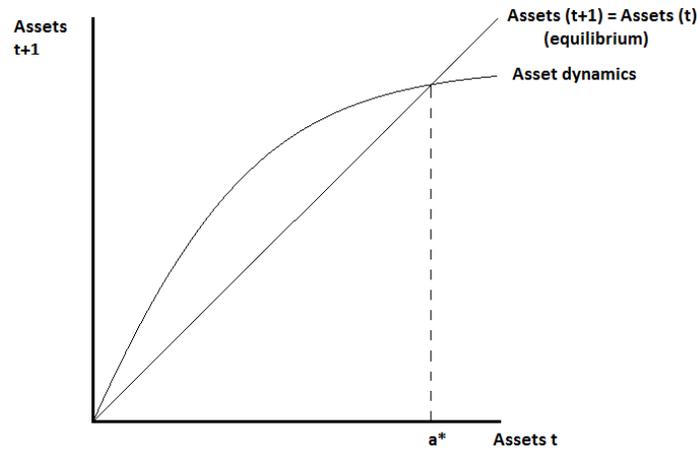
Figure 2: Hypothetical convergent asset dynamics

The asset dynamics line represents equation (5) and indicates the asset level in the next period, given the asset level in the current period for a household with production function f(a) under stable conditions regarding preferences (e.g. the savings rate), technology, positive shocks (e.g. a cash transfer or inheritance) or negative shocks (e.g. illness of a household member). Point a* represents the asset equilibrium in which no growth is possible. This point corresponds exactly to the same point in figure 1, where investment equals savings[3], and represents the level of welfare a household can reach given current economic opportunities and returns to their assets (Naschold 2012).

In figure 3 below the same asset dynamics are plotted over time to explore what a sharp decrease in asset holdings (an asset shock) would mean for the household.
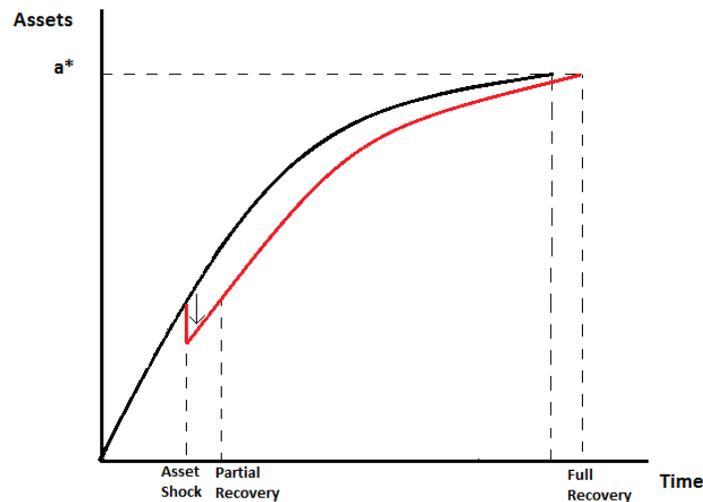
Figure 3: Hypothetical asset shock

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[3] A similar convergent pattern of the asset dynamics line would have been found when we would have used the Ramsey growth model as a starting point instead of the Solow model. In the Ramsey model, the household would reach the equilibrium and stops accumulating when it does not want give up any more current consumption in exchange for future consumption.

The black line displays the stable asset growth path of a household. When an asset shock occurs, its asset level drops and the household has to diverge from its stable growth path and instead follow the red line. Note that the red line has exactly the same shape as the black line, but is shifted to the right. This is only the case if it is assumed that the household can continue producing using the same technology $f(a_{i,t})$ and does not change their savings rate, s. Relatively soon after the shock, the household find itself at the pre-shock asset level and can be considered "partially" recovered. According to our definitions, the household will however not be fully recovered until it reaches the equilibrium asset level. Until then the shock has a persistent effect on welfare.

The alternative asset-accumulation path in the case of an *income shock* is illustrated in figure 4.
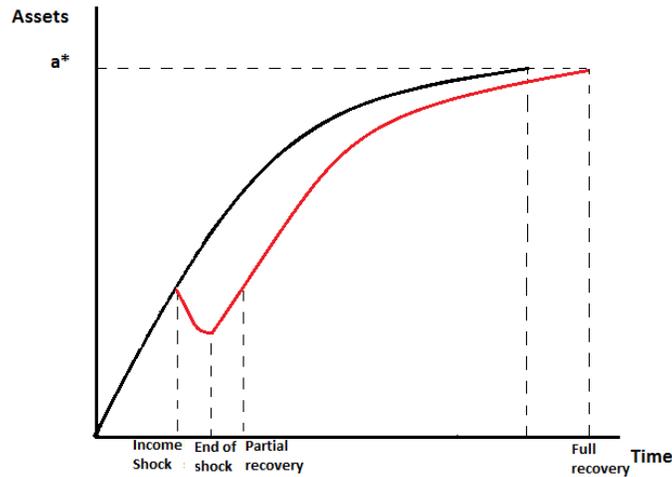
Figure 4: Hypothetical income shock

In this case the depletion of assets is more gradual over time. Assets are sold to smooth consumption until sufficient income is obtained from the household's activities. This could be the case at the start of a new harvesting season, for example. From then on, the households will start accumulating assets along the same path, they previously diverged from. Again, the household will relatively quickly reach the pre-shock asset-level, but they will not complete recovery until they reach the equilibrium.

The persistence of the shock also depends on the household's recovery preferences (Carter et al. 2007). The household can prefer to increase investments, by increasing their savings rate and giving up a larger part of their current consumption. If they do so and maintain a higher savings rate than when no shock would have occurred, they can potentially recover significantly quicker.

There is yet very little evidence on the persistence of shocks. Lokshin and Ravallion (2002) focused on the persistence of income shocks in Hungary and Russia where they found, by simulation, that households who in steady state need three years to recover about 80% of their income and need about 9 years to fully recover from an income contraction of 50%. Dercon (2004) looks at the persistent effects on consumption instead and finds that rainfall shocks in both current and preceding years affect current

consumption growth in Ethiopia. Dercon and Hoddinott (2005) found that illness, drought and output price shocks experienced between 1999 and 2001 in Ethiopia, had a significant effect on the consumption levels in 2004. Davies (2010) found that in rural Malawi both drought and illness have a short term effect on consumption, but could not identify a persistent impact. To our best knowledge, the only study that attempts to measure the persistence of shocks on household asset level so far is Quisumbing and Baulch (2009). However, the long term effects of shocks found by these authors were inconsistent over different specifications and groups of households and often had counterintuitive signs.

2.4 The permanent effects of shocks in a multiple equilibrium dynamic asset model.

In a very risky environment, where it is common to see one shock followed by another, adverse events can keep a household from reaching its equilibrium state. In this case, the individual shock has a *persistent* impact, while the distribution of shocks in that region might generate a continuous series of adverse events that have a mutual structural effect on household welfare. However, also an individual shock can have a permanent effect on welfare. Carter et al. (2007), Quisumbing and Baulch (2009) and Schindler and Giesbert (2010) are the first studies exploring whether a shock-induced asset reduction can be permanent. To be able to understand their empirical strategies, the asset dynamics model illustrated by figure 2 is reintroduced, and connected with the literature on multiple-equilibrium poverty traps.

The model underlying figure 2 describes a growth path with diminishing returns on assets. Households, in this model, are converging to a single equilibrium. When the asset level in this equilibrium yields income below the poverty line, it can be concluded that the household finds itself trapped in poverty (for recent evidence see Quisumbing and Baulch 2009; Naschold 2012). However, numerous theories suggest the existence of local convexities in asset-growth dynamics, which shapes the argument for the existence of multiple equilibriums (Carter and Barrett 2006; 2012). Local convexities, in this respect, are increasing marginal returns on assets for a particular range of asset holdings. Carter and Barret (2006) and Naschold (2012) name a few of the possible mechanisms that can lead to local increasing marginal returns, including[4]:

- Limited access to credit and insurance lead households to diversify production into low-risk, low-return activities. Poor households therefore might have lower marginal returns on assets than richer households (Carter and Barrett 2006).
- Only the most productive workers get employed. Worker productivity depends on nutrition, which in turn depends on consumption (Dasgupta 1997). The ones who are employed and can afford to consume enough to be productive, converge to a higher equilibrium, while the unemployed, who have not enough income to nourish themselves properly, converge to a lower equilibrium.
- Poor households might retain their children from going to school, as their labor is needed to sustain minimum consumption. This can trap the household in

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[4] This is by no means an exhaustive list. See Barret and Carter (2012) for a more elaborate discussion.

intergenerational poverty, since the household's children do not possess the qualifications to utilize future high return opportunities (Basu 1999; Emerson and Souza 2003).

▪ Higher return production activities might require large start up investments, that poor households cannot afford (Carter and Barrett 2006).

The resulting asset dynamics are illustrated in figure 5.
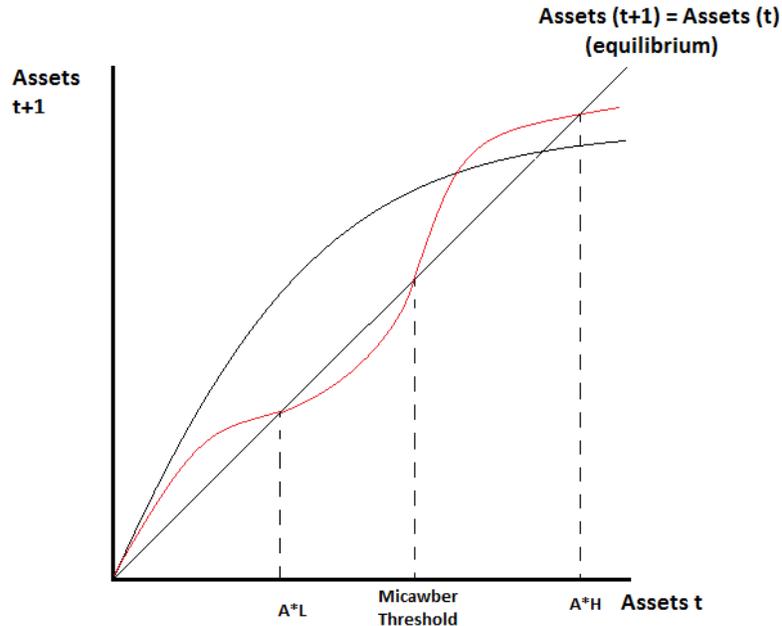
Figure 5: Hypothetical S-shaped asset dynamics

The concave black line is the same as in figure 2 and leads to a single equilibrium, while the red line is inserted to illustrate the alternative hypothesis of the existence of multiple equilibriums. This particular hypothetical asset dynamics line, leads to two stable equilibriums, one lower, A^*_L, and one higher, A^*_H and one unstable equilibrium, which is positioned in the middle. This point is called the "Micawber threshold", or alternatively, when the lowest equilibrium lies below the poverty line: the "dynamic asset poverty threshold". If a household is positioned below this threshold, it is converging to the lower equilibrium and when it is positioned above the threshold it is converging to the higher equilibrium. One way for a poor household to reach the higher equilibrium, is to receive a 'big push' in the form of credit, or a transfer. But as mentioned earlier, in many parts of the developing world, access to credit is limited. Conversely, a household that is converging to the higher equilibrium can be pushed downward by an adverse asset-reducing event, which drives the household below the Micawber threshold, where it will converge to the lower equilibrium instead.

Shocks can be a cause of structural poverty in a region that exhibits multiple dynamic equilibriums, where at least one of the equilibriums falls below the poverty line. In this type of regions, policy in the form of cash or asset transfers and safety nets can in turn lift households out of poverty and keep them there (Naschold 2012).

The literature presents mixed results regarding the existence of multiple equilibriums. Initially, several studies found positive results, especially in Sub-Saharan Africa and in groups with straightforward underlying dynamics, such as among pastoralists, for whom livestock is the single most important asset (e.g. Adato et al. 2004; Lybbert et al. 2004; Barrett et al. 2006; Carter et al. 2007). Recently, several studies report different types of asset dynamics. Naschold (2012), for example, finds only a single equilibrium in rural semi-arid India, but do conclude that the poor stay poor due to very slow asset accumulation. Similarly, Schindler and Giesbert (2010) found a single equilibrium in Mozambique, which was positioned just barely above the poverty line. Finally, McKay and Perge (2011) have performed both parametric and non parametric tests on seven data sets collected in five countries (Uganda, Tanzania, South Africa, Vietnam and Bolivia) and found no local increasing returns. Unfortunately, they fail to further investigate on single- equilibrium poverty traps. They conclude that the reason for not finding multiple equilibriums in "more complex" economies is that households have more flexibility in allocating their assets and can be more effective in coping with shocks

Carter et al. (2007), Quisumbing and Baulch (2010) and Schindler and Giesbert (2010) are the only authors attempting to investigate the effect of shocks in a multi equilibrium environment. Unfortunately, only Carter et al. (2007) found evidence for multiple equilibriums and could conclude that shocks, in both Honduras and Ethiopia, can indeed have a permanent effect. Schindler and Giesbert and Quisumbing and Baulch did not find any evidence for multiple equilibriums and could not continue to investigate the structural effects of shocks.

3. Data

The Northern Ugandan Survey (NUS), conducted by the Ugandan Bureau of Statistics (UBoS) in 2004 and 2008, will serve as the main source of data in this thesis. Northern Uganda in this time-span offers a unique environment that will allow us to examine the effects of numerous types of shocks, including rebel attacks and cattle rustling, in absence of well functioning credit markets.

3.1 Northern Uganda
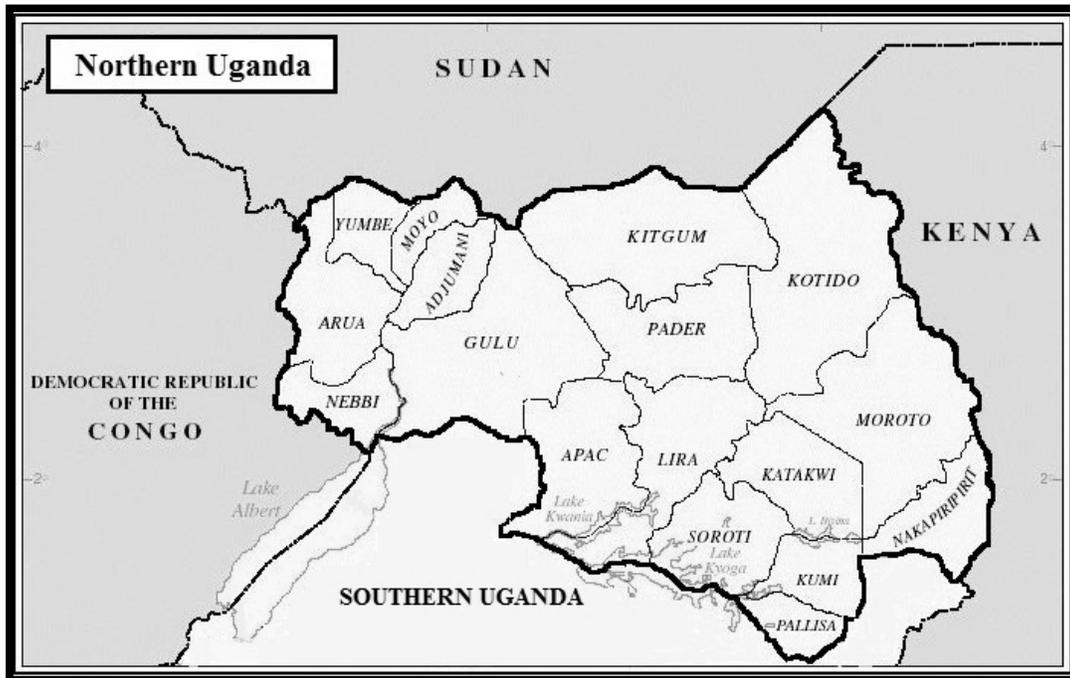
Figure 6: Map of Northern Uganda (before 2010)

Northern Uganda is separated from the Southern part of the country mainly by the Victoria Nile and Lake Kyoga. It borders the Democratic Republic of Congo to the west, Sudan to the north and Kenya to the east. The region can be divided into the following five sub regions and districts (in parentheses): *West Nile* (Adjumani, Arua, Moyo, Arua and Nebbi), *Acholi* (Gulu, Kitgum and Pader), *Lango* (Apac and Lira), *Teso* (Soroti, Katakwi, Kumi, Pallisa, Kaberamaido) and *Karamoja* (Kotido, Moroto and Nakapirpirit)[5].

Since Yoweri Museveni took power in 1986 and Uganda as a nation remained stable, civil conflict has ravaged Northern Uganda for over 20 years. The Lord's Resistance Army (the LRA), a rebel group lead by the infamous Joseph Kony, initially sought to overthrow the government in interest of the Acholi people, but soon lost support (Doom and Vlassenroot 1999). As a reaction, the LRA turned against the Acholi's and became notorious for violent village attacks in which acts of murder, abduction, sexual

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[5] This is the division in districts like it was in 2004 and 2008. As of 2010 many districts have been subdivided into smaller parts.

enslavement, mutilations, mass burning of houses and looting was common.[6] More than 1.8 million people were forced to leave their lands and livelihoods and moved to IDP camps in search for safety. The conflict ended in 2006, when the LRA fled the region and moved into Congo where they continued their horrific and brutal activities[7].

Acholi was the epicenter of the conflict, but also West Nile, Lango and Teso were affected, albeit to a lesser extent (Ssewanyana et al. 2007). The only region not affected, Karamoja, has long been plagued by its own source of insecurity, namely the tradition of cattle-rustling and the widespread availability of small fire-arms (Nannyonjo 2005). The insecurity in the Northern region resulted in a loss of productive assets, paralyzed economic activity and restricted access to social services and markets (Nannyonjo 2004). The North is consequently the poorest region in Uganda with an estimated 60.1% of the people living in poverty (UBOS 2006) and the worst scoring region on the human development indicator (0.418, compared to the national HDI of 0.488) and human poverty index (41.7, compared to the national HPI of 36.0) (UNDP 2005).

It should therefore not come as a surprise that people living in Northern Uganda have limited access to credit and other financial services, such as insurance. Only 1.6% of the Northern communities in 1999 had a bank or financial institution in its vicinity, compared to 22.7% nation-wide (Mpuga 2010). As a result, only 1.2% of the households had applied for a formal loan in 2006 (UBoS 2006). Moreover, semi-formal (e.g. from micro-finance organization, NGO's or cooperatives) and informal loans (e.g. from employers, local groups, relatives, friends or local money lenders) are neither popular, as, respectively, only 3% and 7.6% of the households ever applied for such loans, compared to 4.9% and 23.9% nation-wide (UBoS 2006).

3.2 NUS survey

The 2004 Northern Ugandan Survey undertaken by UBoS was intended as a baseline study for the World Bank's NUSAF project. The survey was conducted between July and December 2004 and covered all 18 districts; comprising a total of 4 787 households and 26 500 individuals in 479 communities. A two-stage stratified random sampling procedure was applied to make the data representative both at the sub-region as well as at the district-level. In the first stage, one community or IDP camp was randomly selected in each sub-county, followed by a second stage in which ten randomly selected households within the community were interviewed. The survey captures extensive data on household demographics, asset holdings, consumption and community characteristics. Nevertheless, the most unique aspect of the survey is that it captures details on shocks occurring on the community level, such as the year of impact, the type of shock and the way the community was affected.

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[6] International Criminal Court - Warrant of arrest unsealed against five LRA commanders
ICC-CPI-20051014-110

[7] As reported in several news articles (e.g. The Guardian, May 2 2010: "Lord's resistance army massacres up to 100 in Congolese village" and Humans Rights Watch, March 28 2010: "DR Congo: Lord's resistance army rampage kills 321")

3.3 Attrition: diagnosis and treatment

The 2008 follow-up contained the same set of questions as in 2004 and aimed to retrace the same 4 786 households and interview them in the same period. Unfortunately, this did not succeed very well, as only 3583 households were re-interviewed, implying an attrition rate of 25.15%. Table 1 shows that there is much variation in attrition between districts, as Pader experienced the highest rate of attrition at 45.83%, while Palissa has the lowest rate at only 10.33%.

Table 1: Attrition rates			
District	**Repondents 2004**	**Respondents 2008**	**Attrition rate**
Adhuman	220	145	34.09%
Apac	300	253	15.67%
Arua	360	250	30.56%
Gulu	300	212	29.33%
Kaberamaido	200	171	14.50%
Katakwi	220	193	12.27%
Kitgum	240	156	35.00%
Kotido	300	233	22.33%
Kumi	240	210	12.50%
Lira	360	261	27.50%
Moroto	300	231	23.00%
Moyo	220	136	38.18%
Nakapiripirit	170	142	16.47%
Nebbi	300	224	25.33%
Pader	240	130	45.83%
Pallisa	300	269	10.33%
Soroti	320	231	27.81%
Yumbe	197	136	30.96%
Total	**4787**	**3583**	**25.15%**

A dataset is no longer representative for the original population if the respondents who drop out of a panel differ systematically from those who stay in (Baulch and Quisumbing 2010). In line with Alderman et al. (2001), a probit regression will establish whether the attrition in our case is completely random and thus ignorable or whether the attrition is selective on observables and has to be adjusted for[8].

Table 2 displays the estimates of the probit regression in which the dependent variable takes a value of 1 when the household dropped out of the sample and a value of 0 if it is successfully interviewed in both 2004 and 2008. The explanatory variables are believed to influence the outcome variables in the analyses presented in next section and/or to predict attrition. Included are the following 2004 variables: asset holdings, land holdings, household head characteristics, household size and composition and variables that describe the location and facilities in a community. The standard errors are clustered to attribute for the inclusion of both community and household variables and hence for the fact that the observations are not independent.

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[8] Selection on unobservables are ignored as this would involve comparisons with similar datasets or identifying instrumental variables (Fitzgerald et al. 1998), which is simply beyond the scope of this thesis.

Table 2: Probit regression on attrition dummy			
	Number of obs		= 4137
Log pseudolikelihood = -2.095	Pseudo R2		= 0.0791
Variable	**Coefficient**		**Robust Std. Err.**
Asset holdings in 2004	0.0452	*	0.0268
Land holdings in 2004	0.0011		0.0008
Household head age in 2004	-0.0325	***	0.0079
Household head age² in 2004	0.0002	***	0.0000
Household head years of education in 2004	0.0108	*	0.0058
Household size (in adult equivalents) in 2004	-0.1624	***	0.0215
Dependency ratio (children/household size) in 2004	-0.0369		0.1142
Gender ratio (males/household size) in 2004	-0.0086		0.0933
Did the household reside in an IDP camp in 2004?	-0.0494		0.0913
Distance to nearest bank/ financial institution in 2004	-0.0001		0.0012
Distance to nearest tarmac trunk road in 2004	0.0015	***	0.0004
Distance to market for agricultural inputs in 2004	0.0013		0.0027
Distance to market for agricultural outputs in 2004	-0.0045		0.0086
Distance to market for nonagricultural goods in 2004	-0.0243	***	0.0080
Is there electricity available within 5km in 2004?	0.2599	***	0.0820
Is there a river or lake located within 5km in 2004?	0.0916		0.0636
Constant	0.6729	***	0.2403

Note: p<0.010 is denoted with *, p<0.005 as ** and p<0.001 with ***. The errors are clustered at the community level.

The probit regression, displayed in table 2, presents considerable evidence that the attrition is non-random.   Six of the included variables are significant predictors of attrition (at a p-value < 0.01), while two variables have a p-value smaller than 0.10. A Wald test confirms that these eight variables (denoted by * and *** in table 2) are also jointly significant with a Chi² statistic of 190.99 (with 8 degrees of freedom).

To avoid biased estimates due to this sample attrition, the analyses in section four are adjusted by using a simple method called "inverse probability weights" (Fitzgerald et al. 1998; Wooldridge 2002). In estimating these weights we were guided by Baulch and Quisumbing (2010). The first step is to run the same (unrestricted) probit regression presented in table 2, but instead of using attrition as the dependent, the reverse value of attrition is used and made into a dummy variable.   The second step is to run a set of restricted probit regressions on the same reversed attrition dummy, but now only the non-significant variables from the previous regression are included. If a variable turns significant, it is dropped and the regression is performed again on the remaining variables, until all are non-significant.   In our case, the model that ultimately remains includes land holdings, gender ratio, whether the household lives in an IDP camp and whether a lake or river is present within 5km of the community. A Walt test shows that the variables are also jointly non-significant, with a Chi² statistic of 3.26 (4 degrees of freedom) and a p-value of 0.51. The weights are obtained by dividing the predicted value of the restricted regression by the predicted value of the unrestricted regression. In the regression analyses presented in section four, these inverse probability weights will, in general, give more weight to households that resemble households that dropped out of

the sample in 2008, than to households with characteristics that make them more likely to have remained in the sample.

4. Methodology

In estimating the asset dynamics in the region and investigating the long term effects of shocks, the available data offers only two detailed snapshots, one taken in 2004 and one in 2008. This requires an inventive empirical strategy in search for conclusive evidence.

4.1 Preliminary work: building an asset index

The panel survey contains information on both household consumption and asset holdings. The analysis presented in this thesis uses household asset holdings as a measure of welfare -instead of consumption- for three reasons. First, welfare is dependent on asset holdings (Ellis and Bahiigwa 2003) and is a good predictor of future welfare (Sahn and Stifel 2003). Second, asset based measures are less volatile and can distinguish between stochastic and structural welfare transitions (Carter and Barrett 2006). Third, asset holdings are typically more accurately captured by surveys. It is easier to tell an enumerator what you currently own, than to recall what you consumed in the past week, month or year (Moser and Felton 2007; Naschold 2012).

It is necessary for the regression equations presented in the following paragraphs to compress the multidimensional concept of assets into a one dimensional index. The majority of the articles performing similar analysis cited in this thesis used a method proposed by Adato et al. (2004). They constructed an asset index in which the index-weights of the assets variables are given by the estimates that result out of a regression between consumption and the different asset variables that are included. The weights are essentially determined by the ability of the asset to generate consumption. However, the weakness of this method is that it only takes into account the ability of assets to generate *current* consumption and this implies that buffer assets are given relatively lower weights[9]. As a result, the effects of shocks on asset holdings in this index could be underestimated. Therefore, we opt instead for principal component analysis (PCA). This is a technique for extracting a set of uncorrelated linear combinations out of a group of correlating variables (Jolliffe 2002). The components can be ranked according to the amount of variation they cover. The first principal component explains the largest amount of variation in the original data and the corresponding vector of coefficients of that component can function as weights in an asset index (Filmer and Pritchett 2001).

Principal component analysis assumes, however, that the variables included are normally distributed (Qian et al. 1994), while the asset data collected in the survey is discrete (count or ordinal data). This type of data tends to be skewed and can exhibit kurtosis, particularly when the data points are concentrated in a single category (Kolenikov and Angeles 2009). Using discrete data in ordinary PCA, like Filmer and Pritchett (2001) and many others do, would not render useless results (Jolliffe 2002), but is not optimal either. Recently, Kolenikov and Angeles (2009) introduced an alternative named "polychoric PCA", which is a method that can deal with discrete data more efficiently and can generate components that explain a larger part of the underlying variance.

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[9] See the discussion in section 2.3 about buffer and productive assets

Polychoric PCA treats asset variables with 10 values or more as continuous, like ordinary PCA does, while assets with less than 10 different values are treated as discrete. It assumes that the discrete data are observations of an underlying continuous variable.

Included in the index are physical assets (i.e. housing materials and buffer and productive assets) and human capital (i.e. number of educational years of household members). Health (human capital), social-, financial- and natural capital are excluded, because of data limitations. There is no information on financial capital present in the survey and land holdings are only captured in 2004. Although the survey contains some information on social capital and health, it does in our view not adequately measure these complex concepts in a consistent manner.

The analysis is performed on asset holdings in 2004 and 2008 combined, to allow for relative comparisons across time periods (Moser and Felton 2007). The natural order of the asset values is kept intact to optimally utilize all information that is available in the data. The results are presented in appendix A. The first principal component has an eigenvalue of 6.7008 and can explain 41.94% of the variance in the data (while ordinary PCA would have only been able to explain 23.52 %).

The results are easily interpretable. A high positive coefficient means that owning a specific asset, is highly correlated with owning other assets, while a negative coefficient means that it is less likely that the household is wealthy. A coefficient of zero means that owning the corresponding asset holds almost no information about holding other types of assets.

One of the advantages of polychoric PCA that become noticeable in view of the results is that it can account for non-constant marginal effects. For example, owning a television increases the asset index with 0.63, compared to not owning one, while owning a second television only implies an increase in the index of about 0.035. Another advantage is that also the knowledge that a household does not own an asset is used in constructing the asset index. This is an improvement as sometimes not owning something can convey more than owning it (Moser and Felton 2007). According to the results, not owning a bicycle, for example, considerably lowers the probability that the household owns many other assets, as the corresponding coefficient has a value of -0.1429.

Once the coefficients are obtained, the asset index for a household is determined as follows. First, the amount of each 'continuous' variable owned (normalized and expressed in standard deviations) is multiplied by the corresponding coefficients and aggregated. Second, the coefficients of the discrete variables, corresponding to the amount owned or type of housing material used, are simply added to that amount.

4.2 Uncovering the asset dynamics in the region

According to theory presented in section 2, the long term effect of a shock in an environment with poorly functioning credit and insurance markets not only depends on shock severity and on whether the household asset stock is affected, but also on the shape of a household's stable asset growth path. This growth path is the long term expectation of the asset level under stable conditions. If the stable asset growth path

implies that asset accumulation is slow, households will recover slower from a shock and persistence will be greater. Furthermore, a shock can only have permanent effects if there exist multiple asset equilibriums. In that case a shock can send a household that was converging to the higher equilibrium, to the lower equilibrium instead, where it is trapped.

It is impossible to observe a household specific asset growth path by observing only two periods. Therefore, instead we have to assume for now, like most authors who have done similar analysis (e.g. Adato et al. 2004; Naschold 2005; McKay and Perge 2011; Naschold 2012), that all households follow the same unconditional growth path. This assumption allows us to estimate the expected growth path of a household, by using two-period panel data[10]. Later we can relax this assumption a bit by disaggregating the sample into different groups, such as households with an educated or non-educated head and households living in rural or urban areas.

The difficulty in modeling asset dynamics is that theory suggests that the function is potentially highly non-linear (Carter and Barrett 2006). Furthermore, if the asset dynamics are indeed S-shaped, observations around the unstable equilibrium might be too sparse to be picked up by parametric specifications. Non- parametric techniques offer a popular solution (e.g. Adato et al. 2004; Lybbert et al. 2004; Barrett et al. 2006; Quisumbing and Baulch 2009; McKay and Perge 2011), but have the disadvantage that they cannot control for other variables (Barrett and Carter 2012). We therefore apply both parametric and non-parametric techniques in an attempt to model the underlying asset dynamics and potentially identify multiple equilibriums.

Contrary to parametric specifications, univariate non-parametric regressions do not make any assumptions about the functional form, but simply fits a smooth function on a set of two-dimensional data points (Naschold 2005). In our case, the function is defined as

(6) $$A_{i,t} = f(A_{i,t-1}) + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma_\varepsilon^2)$$

where A_{it} is the asset index in period t. This function is estimated by using a locally weighted regression for smoothing scatter plots (LOWESS), which has proven itself able to identify a potential S-shaped asset dynamics curve (Lybbert et al. 2004; Barrett et al. 2006). LOWESS separately performs a weighted regression for each observation $A_{i,t-1}$, in which data points that lie closer to $A_{i,t-1}$ are assigned a higher weight (Cleveland 1979). The smoothed fit is then given by the predictions of the weighted regressions for each observation, $A_{i,t-1}$ (Naschold 2005).

The parametric specification will have a dual function. First, it is used to model the dynamic asset function (like is done by the non-parametric regression), but now it is possible to control for household and community characteristics. Second, it used to test

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[10] We should, however, avoid any conclusions regarding whether the poor are converging towards the rich, based on this dynamic cross-sectional analysis to avoid falling into Galton's fallacy. In this respect, the same pitfalls exist as in the macro-economic growth theory (as described by Friedman (1992) and Quah (1993)).

whether covariate shocks in Northern Uganda have persistent effects on household asset holdings directly (which is further discussed in the next section).

Following a combination of methods presented in Carter et al. (2007), Dercon (2004), Lokshin and Ravallion (2002) and Barret et al. (2006), the change in the asset index as a function of a fourth order polynomial of the lagged asset index is estimated by the following equation

(7)
$$A_{ij,2008} - A_{ij,2004} = \alpha + \beta_1 A_{ij,2004} + \beta_2 A_{ij,2004}^2 + \beta_3 A_{ij,2004}^3 + \beta_4 A_{ij,2004}^4 + \gamma L_{ij,2004} + \delta H_{ij,2004} + \theta C_{j,2004} + \varphi S + \varepsilon_i$$

where $A_{i,2008}$ - $A_{i,2004}$ is the asset accumulation achieved by household i residing in community j between 2004 and 2008, $A_{ij,2004}$ is the household's asset level in 2004, which is included as a fourth degree polynomial to facilitate for non-linearity, $L_{ij,2004}$ are the 2004 land holdings in acres and $H_{ij,2004}$ is a vector of initial household characteristics, such as household size in adult equivalents, the dependency ratio, measured as the number of children divided by the number persons in the household and the gender, age and age squared (to control for life cycle effects) of the household head. Other studies often include a community fixed effect, but as our variables of interest are community shocks, instead we have to entangle this effect into a vector of different community characteristics, $C_{j,2004}$. Included in the community characteristics are the distance to the nearest tarmac road, financial institution and non-agricultural market, and a set of dummies that indicate whether the household lives in an IDP camp, whether they live in a rural or urban area and whether there is a river/lake and electricity present nearby. S is a vector of shock dummies further specified in next section. Household and community characteristics measured in 2008 are excluded, because they could potentially be influenced by the same processes that bring about 2008 asset levels and result in an endogeneity bias (Baulch and Quisumbing 2010).

The standard errors are clustered to attribute for the inclusion of community variables in a regression that is performed on a household level and hence for the dependence in observations. Households that moved to another community within the four years between 2004 and 2008 (about 2% of the total number of households included in the sample), are necessarily removed, as we cannot control for two different communities. The regression is weighted using the inverse probability weights constructed in section 3.3, to attribute for sample attrition.

In both the non-parametric and parametric specification, asset holdings are not defined per person. In the four year between the two surveys many households changed composition. Babies were born and children were adopted, while adolescents started their own households and, inevitably, people died. These changes would immediately have an impact on household asset levels per person. Obviously, asset level fluctuations due to changes in household size are not in our interest and would in fact only distort our actual interests: the expected accumulation of assets under stable conditions and the true effects of shocks. A change in household composition, could, however, be viewed as a shock and can be controlled for by adding the change in household size, expressed in adult equivalents as an independent variable in the parametric regression.

4.3 The persistence of shock

Theory tells us that any asset reducing shock in an environment with a poorly functioning credit market has a persistent effect on household welfare as it leads to lower income until the asset stock is recovered. A shock can be considered persistent until a household recovered all the way to its level it would have been if no shock would have occurred. This full recovery can only take place when the stable asset growth path is convergent as hypothesized by the theoretical model. The convergent nature of the growth path makes the difference between a household's asset level after a shock and the hypothetical asset level in case no shock would have occurred, decreasing through time to a minimum. This is also illustrated by figure 7 below.
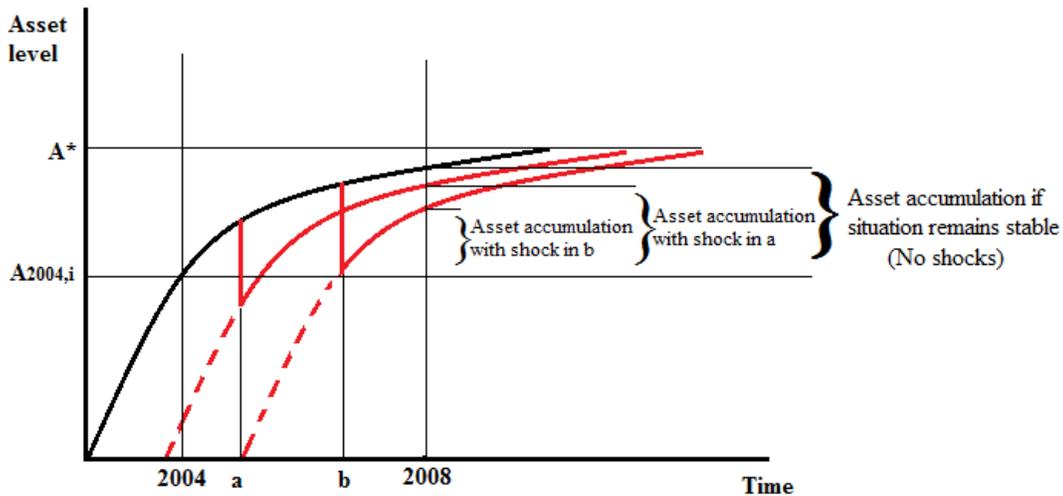
Figure 7: Empirical strategy for measuring the persistence of shocks

The figure depicts the stable asset growth path over time (the black line). The two red lines illustrate two scenario's in case a sharp decrease in asset level occurred, due to a shock at t=a or t=b. In line with this graph, a shock is still persistent if at some time after the shock the household asset level is not at the level it would have been in case no shock would have happened. The only information available to us to test whether shocks in Northern Uganda can have such persistent effects is given at two snapshots taken in 2004 and 2008.

Given that the household has an asset level of $A_{2004,i}$ in 2004, we would expect the household to accumulate assets up to the level corresponding to the black line at t=2008. In the unfortunate event of a shock that occurred between 2004 and 2008 we would expect the amount accumulated to be lower. Moreover, a shock that happened closer to the measurement in 2008 (e.g. at t=b) is expected to have a larger impact on the 2008 asset level than the exact same shock that occurred earlier (e.g. at t=a). Of course, only the actual household asset level is observed and not the expected level. To overcome this problem we run the parametric regression specified by equation (7) in previous section, which will allow us to estimate the effects of different shocks in different years on asset accumulation between 2004 and 2008, while controlling for household and community characteristics.

The household questionnaire contains a section on shocks experienced by the household, but it lacks information on when the shock occurred. The year of occurrence is vital for any investigation involving the persistence of shocks. Therefore, we will ignore idiosyncratic shocks and concentrate on covariate shocks instead. The community questionnaire contains a section in which the community official is asked to recall whether any major shock has struck the community since 2004. The shocks are divided in four general types, namely: (1) *adverse weather conditions* (e.g. droughts, heavy rains, floods, strong winds, fire and untimely rains), (2) *harvest losses,* unrelated to weather (e.g. destruction by wildlife, birds or livestock, pests, diseases, poor storage and theft), (3) *insecurity, violence and destruction* (e.g. rebels, cattle raids, robbery and family disputes) and (4) *epidemics (e.g.* cholera, ebola, diarrhoea and hepatitis E*).* For each shock type, the official can list a maximum of three shocks, with corresponding details, regarding the nature of the shock and the estimated percentage of households affected. Only the most severe shock listed within a shock type is assigned a year. These most severe shocks are included in the regression as dummies, but only when they are estimated (by the official) to have affected at least more than 75% of the community. These dummies take a value of 1 if the community in which the household resides experienced the specified shock in the specified year. The years 2004 and 2005 are combined as one period, because very little shocks were reported in 2004. If a shock that happened more than a year ago (in 2007, 2006, 2005 or 2004) still has a significant negative effect on asset accumulation, it indicates that household could not recover within a year and that the shock has therefore a persistent impact on welfare.

The inclusion of many community variables, including the shock dummies, could be worrisome as this might introduce multi-collinearity in the model. Although, the general usefulness of the model would not be affected, it could affect the significance levels of the shock variables. Fortunately, the individual VIF (variance inflator factor) values of the community variables included in the current model are all smaller than 2 and this reassures us that multi-collinearity will not bias our conclusions regarding the persistence of shocks[11].

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[11] As a rule of thumb a VIF value higher than 5 indicates multicollinearity, see O'Brien (2007).

5. Results

5.1 Descriptive statistics

Table 3 presents the descriptive statistics of the asset indices.

Table 3: Description of Asset indices				
	Mean	**Std. Dev.**	**Min**	**Max**
Asset index 2004	-.4102	1.0355	-2.668	6.587
Asset index 2008	.0931	1.1881	-2.420	8.217
Asset index 2004 per adult equivalent	-.1930	.4046	-3.421	3.127
Asset index 2008 per adult equivalent	-.0479	.4057	-2.420	3.066

It shows that on average there was an increase in asset holdings of about 0.5 points between 2004 and 2008. The asset holdings per adult equivalent did increase as well in the same period, but note that this growth is partially dependent on changes in household size. On average, household size increased considerably from 3.61 to 3.87 adult equivalents.

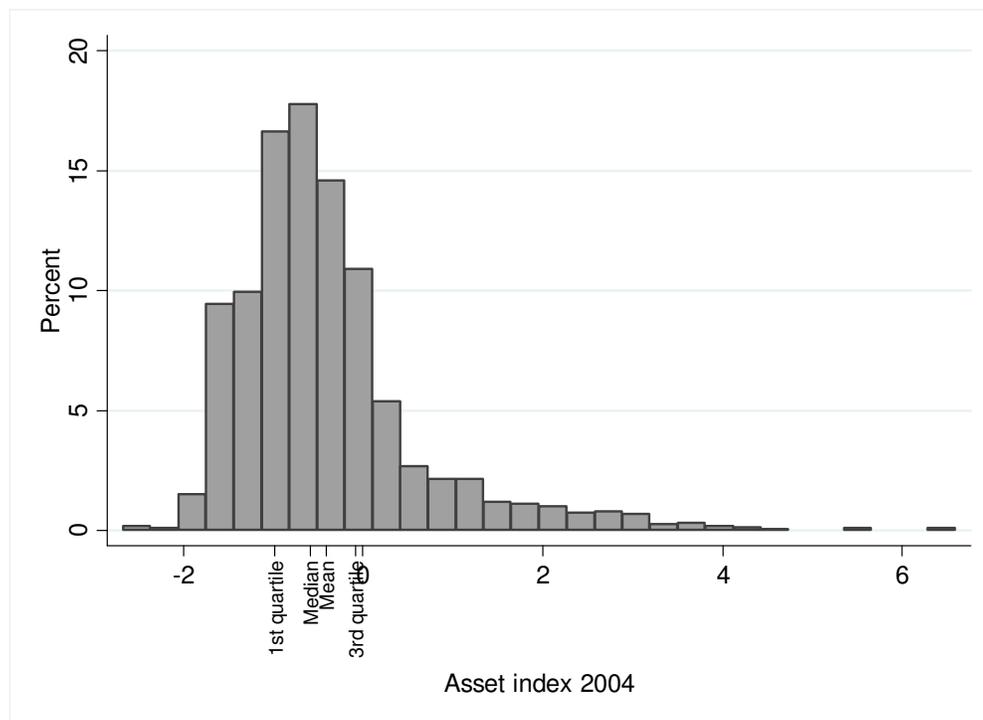**Figure 8: The distribution of asset holdings across households in 2004**

Figure # shows that the distribution of wealth is rather skewed as 75% of the households had a 2004 asset level between -2.668 and -0.085, while the remaining 25% 'richer' households had an asset level between -0.085 and 6.587. About 60% of the people in Northern Uganda lives below the poverty line (UBOS). The poorest 60% in asset

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holdings all have an asset index which is lower than -0.41. This number could be used as a reference line, but should not be used for statistical inference.

Table 4 presents the remaining household and community characteristics

Table 4: Descriptive statistics of household and community characteristics			
Variable	Unit	Mean	Std. Dev.
Household variables			
Land holdings 2004	Acres	3.2543	13.6100
Head is male?	Dummy (1=male, 0=female)	0.6895	0.4627
Age of head	Years	41.5930	14.8454
Years of education head	Years of education	4.7737	4.6061
Dependency ratio	Number of children/children+adults	0.4832	.2497
Household size	Adult equivalents	3.4681	1.5942
Growth household size 2004-2008	Adult equivalents	0.2605	1.3730
Community variables			
Distance to tarmac road	Km	66.4520	76.5049
Distance to financial inst.	Km	30.7988	31.3507
Distance to non-agricult. market	Km	5.9095	16.4008
Presence of public electricity?	Dummy (1= yes/0=no)	0.2426	0.4287
Presence of private electricity?	Dummy (1= yes/0=no)	0.2533	0.4349
Presence of river or lake?	Dummy (1= yes/0=no)	0.3763	0.4845
IDP camp?	Dummy (1= yes/0=no)	0.1882	0.3909
Urban area?	Dummy (1= yes/0=no)	0.2062	0.4046

The descriptive statistics describe the average household in 2004. More than two-thirds of the household heads are male. The average head is about 42 years old and has had almost 5 years of education. The size of the household is expressed in adult equivalents (by assigning a weight of 1 to the first adult, 0.7 to subsequent adults and 0.5 to children) and averages at almost 3.5. The average household has 5.5 members, of which half are children (< 15 years). About 75% of the households own at least more than 0.1 acre of land, while the average land holding is about 3.25 acres. About 19% of the communities are IDP camps and 21% can be labeled as 'urban'. The average community lies about 66 km from the nearest tarmac road, 31 km from the nearest financial institution and 5 kilometer from the nearest non-agricultural market. Public electricity is present in about 24% of the communities, while privately generated electricity is present in about 25% of the cases.

5.2 Descriptive statistics continued: the distribution of shocks in Northern Uganda

Table 5 displays the descriptive statistics of the shocks which are included in the regression analyses. These shocks are reported on a community level and are believed to have affected at least 75% of the people. Although more shocks of one type might have occurred in the community, only the most severe ones were assigned a year and only those are therefore included in the analysis.

Table 5: Report rate of covariate shocks included in the regression (% of hh's affected by shock and year)				
Shock	2008	2007	2006	2004-2005
Adverse weather conditions	45.4%	39.2%	14.6%	17.5%
Harvest losses	31.4%	10.9%	5.0%	4.4%
Insecurity, violence and destruction	7.6%	6.1%	3.5%	8.1%
Epidemics	4.0%	4.0%	0%	0.2%

Something that is immediately noticeable from table 5 is that shocks closer to the survey period (2008), have a higher reporting rate than shocks that occurred further away. This pattern is visible over all four types and therefore probably not a coincidence, but due to the limited memory of the respondents. On the other hand, the most severe shocks are most likely the ones which have been remembered and are, consequently, more likely to be included.

The majority of households (87%) live in a community that at least experienced one severe covariate shock, but the average community in the sample experienced two severe shocks. By far the most common type of covariate shocks experienced are adverse weather conditions. Almost 83% of the households have experienced at least one shock of this type in the four year period. Most often a severe adverse weather condition came in the form of a drought (46% of the cases) or heavy rainfall/flooding (31%)[12] . Harvest losses have been experienced by about 47% of the households within the period. Most common causes were pests and diseases (46%) and destruction by wildlife/birds/livestock (28%). Still 23.7% of the households in the sample experienced insecurity, violence or destruction within the four years between surveys; most often by rebels (55%) or because of cattle raids (29%). An epidemic is the least often reported type of shock, as about 8% of the sample experienced an epidemic within the survey window. Most often the type of epidemic remains undefined (52%). Otherwise, diarrhea is most often experienced.

5.3 Identifying asset dynamics

The asset recursion diagrams of the non-parametric and parametric regressions are plotted in figure 9 and 10, respectively[13]. Following Naschold (2005), the asset recursion diagram obtained from the parametric regression is generated by adding the predicted asset accumulation to the 2004 asset index values. Both figures show a very similar asset dynamics line (the red line).

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[12] See figure 14 in appendix B for a the distribution of all shock sub types
[13] The parametric regression results are presented in section 5.4.
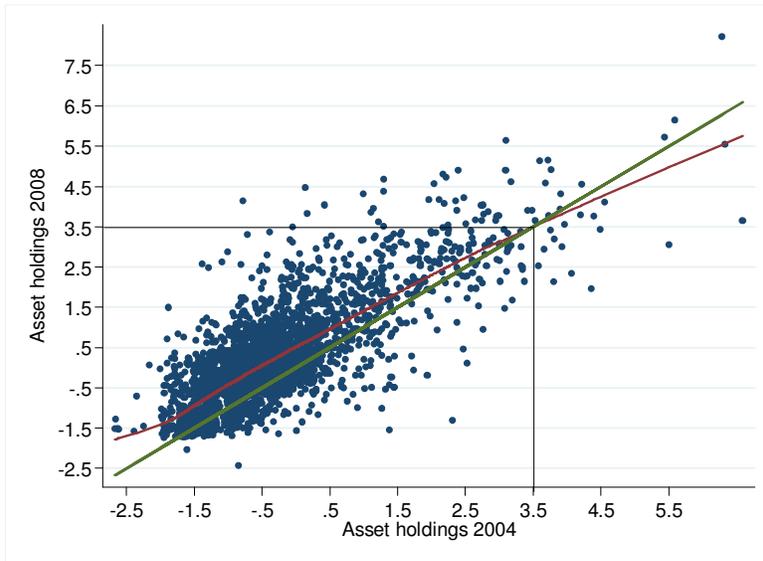
Figure 9: Asset recursion diagram from LOWESS regression
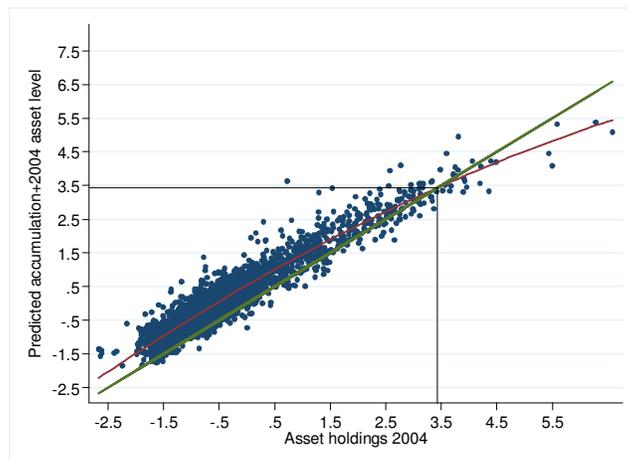
Figure 10: Asset recursion diagram from fourth degree polynomial regression

These two figures convey more than is expected from their simple shapes. First, both diagrams do not show S-shaped asset dynamics, described by the theory of Carter and Barrett (2006). This means we cannot present evidence for the existence of multiple equilibriums in Northern Uganda. Instead, the figures show a non-linear, slightly concave curve, which crosses the green diagonal (at which asset accumulation is zero) from above, implying a single stable equilibrium at an asset index of about 3.5. This suggests that shocks, singularly, cannot have permanent effects in this region. Second, as the asset dynamics curve is only slightly positioned above the diagonal line, average asset accumulation seems to be quite slow. The average rate of accumulation between the position of the poorest household and the equilibrium occurs at 0.51 points every four years. This implies that the poorest household would take more than 47 years to reach the equilibrium! Finally, the two scatter plots clearly show the same pattern as

indentified in section 5.1: a concentration of households at the poor end of the curve, with more than 75 % with an asset index lower than 0 in 2004. This might be caused by the convergent nature of the asset dynamics line, which implies that the expected asset accumulation rate gets smaller when a household gets nearer to the asset equilibrium.

The assumption that all households follow the exact same growth path is of course rather strong. It is more plausible that heterogeneity plays an important role in welfare dynamics; that (semi-)permanent personal characteristics, such as cognitive and non-cognitive ability, gender, race, adult educational attainment, inherited social connections and the physical environment influence productivity and lead to conditional convergence (Barrett and Carter 2012)[14]. It is expected that any unique combination of these characteristics leads to a different type of production function and, consequently to a different rate of accumulation and a different equilibrium. Unfortunately, the data only allows us to investigate the different asset dynamics for a few categories of households, namely of families with an educated household head and a non-educated head and between families living in urban and rural areas.

Education leads to higher productivity and increases the probability that a household engages in - and receives income out of - other activities than agriculture (Appleton 2001). We would therefore expect that a more educated household can accumulate assets faster and can reach a higher equilibrium. In testing this hypothesis, the education of the household head can acts as a proxy for educated labor in the household in general. We choose to perform the same non-parametric and parametric analyses as for the complete sample. The sample is divided between household heads that received seven years of education or less (finished primary school at most) and one on a sample with heads that received more than seven years of education. The resulting asset recursion diagram obtained by performing the parametric regression is displayed in figure 11.
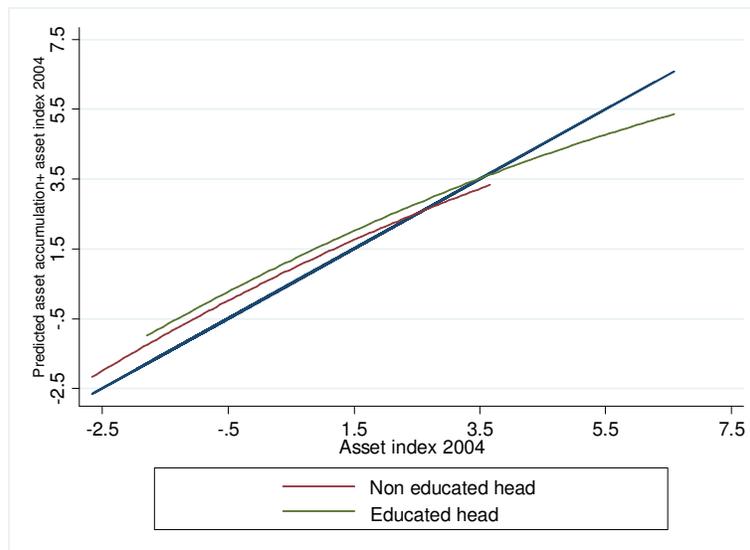
Figure 11: Asset recursion diagram on educated and non-educated heads

[14] See also Heckman (1981), for an empirical understanding of the difference between state-dependence and heterogeneity.

The diagram confirms the hypothesis. Households with an educated head outperform households with a non-educated head on both the rate of asset accumulation (0.69 vs. 0.47 points every four years on average) for every initial asset level and the height of the equilibrium (3.6 vs. 2.6). These differences are statistically significant. This result is in line with Appleton (2001) and provides evidence for the importance of education in development. The difference in asset accumulation gets particularly big as the households reach nearer to their equilibrium. Where the non-educated households accumulate assets at a snail's pace, especially closer to their equilibrium, the educated households rapidly accumulate assets regardless of initial asset holdings.

The same type of analysis can give insight in the different asset growth trajectories of households living in urban versus rural communities. Households living in or near urban areas are expected to have better access to employment opportunities, credit and insurance services, good education and adequate health facilities. Furthermore, they are expected to live in a less insecure area as they have more income diversifying opportunities and are less vulnerable for rebel attacks or cattle raids. We would therefore expect urban households to accumulate faster and to be able to reach a higher equilibrium. The results of the parametric regressions are plotted in figure 12.
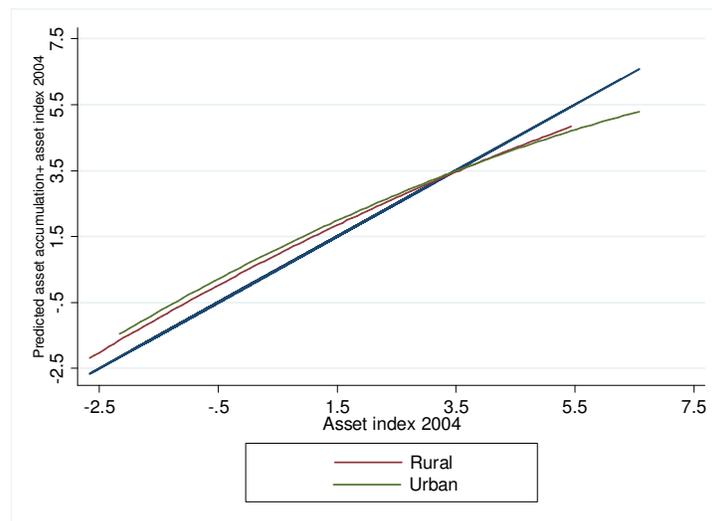
Figure 12: Asset recursion diagram on urban and rural population

The results indicate that the accumulation rate is indeed significantly higher for households that live in urban areas (0.58 vs. 0.49). However the equilibrium for both rural and urban areas is about equal.

Finally, distinct semi-permanent groups can also be formed by combining these two dimensions. Figure 13 displays the resulting four groups: uneducated or educated households living in rural or urban areas.
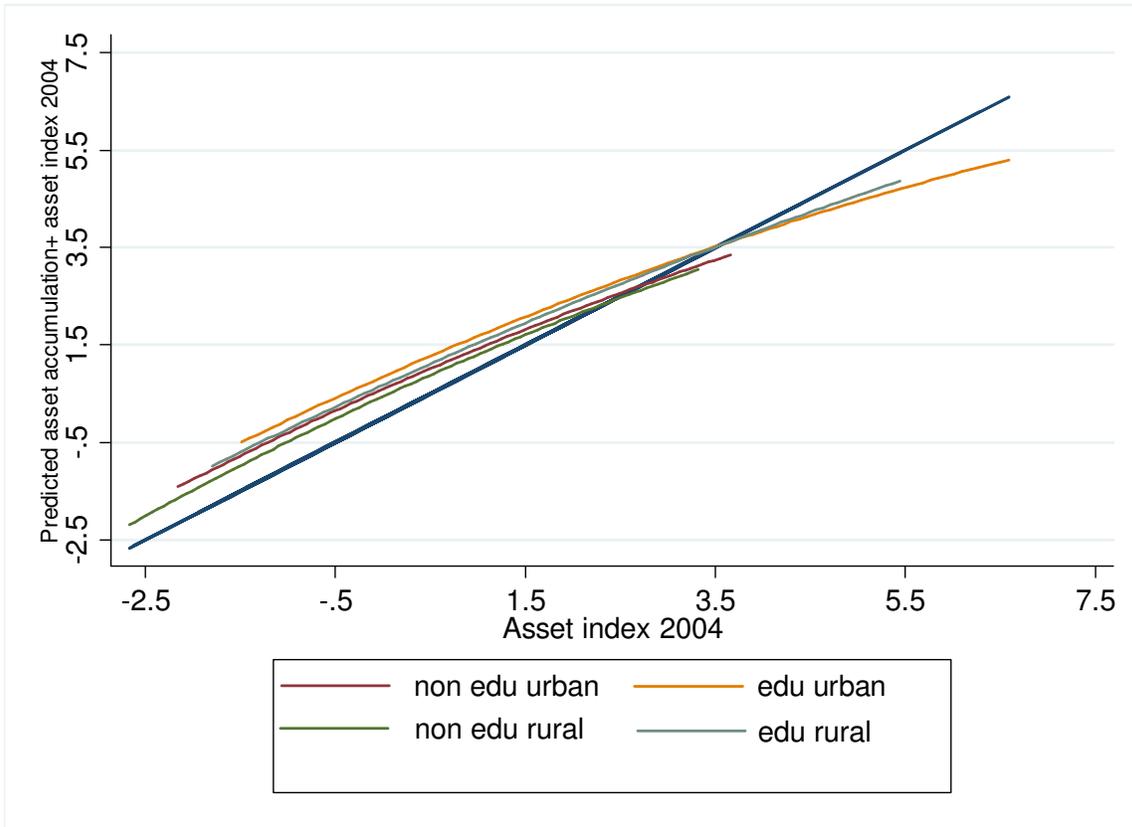
Figure 13: Asset recursion of urban educated and rural non-educated

Figure 13 shows that the uneducated households living in rural communities show a much lower asset accumulation rate (0.45 points on average every four years) and reach a lower equilibrium (at ±2.4) than the three other groups. The highest equilibrium (±3.6) and average accumulation rate (± 0.71 on average) is found for households that have an educated head. It does not make a significant difference whether this group lives in an urban or rural area. For non-educated households this does seem to matter. Although the equilibrium for the two groups is positioned at about an equal height, the accumulation rate is significantly higher for the households that live in urban areas.

Table 6 summarizes the results of this subsection by displaying for each subsample the estimated position of the equilibrium and its 95% confidence interval and the average predicted asset accumulation up to the equilibrium position. It can be observed that the equilibrium obtained from LOWESS regressions are more extreme than the ones obtained with the parametric method. The reason for this is twofold. LOWESS is first of all much more sensitive for individual observations and easily adapts its shape to a few observations at the high end of the distribution. Secondly, the parametric method already controls for a lot of heterogeneity, while the LOWESS regression does not.

Sample	N	Equilibrium determined by LOWESS	Equilibrium determined by parametric method	Predicted asset accumulation up to equilibrium
Table 6: Stable asset equilibriums and average asset accumulation by sub-sample				
Full sample	3014	3.5	3.5 (3.2 - 3.8)	0.51
Non-educated head	2443	2.8	2.6 (2.3 - 3.0)	0.47
Educated head	571	3.3	3.6 (3.3 - 3.8)	0.69
Rural	2456	4.2	3.3 (2.9 - 3.9)	0.49
Urban	558	3.2	3.5 (3.2 - 3.8)	0.58
Urban + non-educated head	348	3.4	2.7 (2.3 - 3.5)	0.55
Urban + educated head	210	3.3	3.6 (3.3-3.9)	0.72
Rural + non-educated head	2095	1.3	2.4 (2.0 - 3.0)	0.45
Rural + educated head	361	5.1	3.6 (3.1 - 4.4)	0.69

Note: The 95% confidence interval is displayed in parentheses. Asset accumulation is predicted by the LOWESS regression and is the absolute amount in asset index every four years.

These results teach us that the assumption of unconditional convergence is too strong. Instead, (semi)-permanent characteristics seem to determine a household's stable asset growth path. Given their characteristics, a household might be facing very sober expectations regarding their future asset holdings and welfare under current conditions. If the individual asset equilibrium would yield income below the poverty line, the household could even be considered trapped in poverty. Contrary, to the type of poverty trap hypothesized by Carter and Barrett (2006), the household will not stay poor because it is poor, but is poor and will stay poor because of its ill-fated persistent characteristics.

The fact that there are unlimited combinations of characteristics possible and that, consequently, every household has a unique stable asset growth path, immediately shows the big problem of the methodology used. The further we break down groups based on their characteristics, the closer we get to the individual asset growth paths of households in that group[15]. However, we can only break down the groups so far, as still a reasonable sample size has to remain. This means that this methodology will never

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[15] A more similar group leads to lower residuals. Moreover, in more similar groups a lower percentage of the residuals are explained by differences in characteristics, but more by shocks.

uncover the asset growth path of an individual household, but can only on average indicate what it means to belong to a certain group defined by its persistent characteristics.

5.4 The persistent effect of shocks on asset-accumulation

The estimation results of equation 7 are presented in table 7. It confirms our previous findings. The more education and the location nearer to certain facilities have a positive effect on household asset accumulation. The most important conclusion that can be drawn from the results is that adverse weather conditions, harvest losses and epidemics all can have a significant negative impact on household asset accumulation. Shocks of insecurity, violence and destruction that occurred in the period 2004-2005 also have a significant impact, but the sign is positive and therefore not in line with expectations. The regression on the full sample further demonstrates that some shocks that occurred further than one year back, such as the reported epidemic shocks in 2007 and the adverse weather conditions in 2007 and 2006 are not yet recovered from and are therefore persistent up to 2008.

In the previous paragraphs we saw how heterogeneity might play a significant role in this type of analyses. In this case we expect the same shock to have different effects on different households. Wealthier people, for instance, should be less sensitive to shocks, because in our sample they have a more diversified income and are less often engaged in agriculture. We furthermore expect them to have better access to insurance and credit, because they are better able to pay insurance fees and are more likely to fulfill any collateral requirements. On the other hand, it are the more wealthy households who have the most to lose, while the households that own nearly nothing, probably have most of it left after a shock. Previous empirical literature confirms that households with very little asset holding often do not sell assets to smooth consumption, but choose to lower consumption instead as they need to retain a minimum asset-base to secure their income generating ability in subsequent periods (Zimmerman and Carter 2003; Schindler and Giesbert 2010).

The middle and right column of table 7 present the results for samples that respectively include 75% of the 'poorest' and 25% of the wealthier people. Where the asset accumulation of the rich is not affected at all by the included shocks, the poor seem to be extremely sensitive. All shocks in all periods included in the regression have a significant negative effect on the asset level of the poor, except for the confusing effects of violence and destruction and the adverse weather conditions in 2004-2005. These results clearly indicate that shocks experienced multiple years ago, still affect 2008 asset levels of poor households and this presents evidence for the persistence of shocks. The poor seem unable to efficiently cope with adverse events, as harvest losses and to a lesser extent adverse weather conditions are predominantly *income* shocks and do not destroy assets directly. Therefore, poor households seem to smooth consumption by selling part of their asset stock or by reducing investments, while they can only recover very slowly from any depletion in assets.

	Full sample		Poorest 75%		Wealthier 25%	
Variable	Coeff.	Robust Std. Error	Coeff.	Robust Std. Error	Coeff.	Robust Std. Error
Household characteristics						
Initial asset level	-0.2501 ***	0.0377	-0.4898	0.4685	-0.3275	0.2777
Initial asset level²	0.0270 **	0.0129	0.0332	0.7351	0.1186	0.2732
Initial asset level³	-0.0201 **	0.0089	0.1364	0.4348	-0.0553	0.0873
Initial asset level⁴	0.0020	0.0018	0.0556	0.0841	0.0057	0.0084
Initial land holdings	0.0005	0.0004	0.0006 **	0.0003	-0.0003	0.0037
Head is male?	-0.0135	0.0348	-0.0104	0.0271	-0.0942	0.0849
Age of head	-0.0151 ***	0.0046	-0.0101 **	0.0042	-0.0285 *	0.0162
Age of head²	0.0001 ***	0.0000	0.0001	0.0000	0.0003	0.0002
Years of education head	0.0311 ***	0.0118	0.0468 ***	0.0049	0.0236 *	0.0109
Dependency ratio	-0.1091	0.0672	-0.1357 **	0.0647	0.0421	0.1884
Household size	0.1220 ***	0.0133	0.1159 ***	0.0141	0.1406 ***	0.0235
Growth household size	0.1707 ***	0.0117	0.1610 ***	0.0125	0.1907 ***	0.0234
Community characteristics						
Distance to tarmac road	-0.0017 ***	0.0002	-0.0018 ***	0.0002	-0.0014 **	0.0006
Distance to financial inst.	-0.0019 ***	0.0006	-0.0013 **	0.0006	-0.0040 **	0.0016
Distance to non-agrimarket	-0.0014 ***	0.0005	-0.0018 ***	0.0004	-0.0011	0.0063
Presence of public electr.?	0.0383	0.0423	0.0200	0.0450	-0.0051	0.0825
Presence of private electr.?	0.0651 *	0.0350	0.0246	0.0344	0.1301	0.0794
Presence of river or lake?	-0.0268	0.0306	-0.0069	0.0303	-0.0596	0.0784
IDP camp?	-0.0282	0.0433	-0.0618	0.0426	0.4187 **	0.1841
Urban area?	0.1460 ***	0.0434	0.0974 **	0.0468	0.1854 **	0.0813
Shock type 1:						
Adverse — 2008	-0.1334 ***	0.0325	-0.1190 ***	0.0303	-0.1098	0.0726
Weather — 2007	-0.0826 ***	0.0350	-0.0849 ***	0.0305	-0.0453	0.0736
Conditions — 2006	-0.0705 *	0.0391	-0.0825 **	0.0349	-0.0639	0.0997
2004-05	-0.0602	0.0478	-0.0507	0.0454	-0.0373	0.0981
Shock type 2:						
Harvest losses — 2008	-0.0909 ***	0.0328	-0.0813 **	0.0336	-0.1262	0.0809
(not weather — 2007	-0.0398	0.0527	-0.0895 **	0.0382	0.0586	0.1502
related) — 2006	-0.0765	0.0596	-0.1072 **	0.0513	0.0254	0.1937
2004-05	-0.0515	0.0505	-0.1132 **	0.0539	0.0587	0.1043
Shock type 3:						
Insecurity, — 2008	-0.0047	0.0724	0.0555	0.0461	-0.0428	0.1588
violence and — 2007	-0.0579	0.1091	0.0835	0.0528	-0.2201	0.2003
Destruction — 2006	0.0130	0.0608	0.0639	0.0491	-0.3118	0.2093
2004-05	0.1085 **	0.0551	0.1449 ***	0.0543	-0.0724	0.1542
Shock type 4:						
Epidemics — 2008	-0.1081	0.0700	-0.1937 ***	0.0492	0.0419	0.1864
2007	-0.1624 **	0.0643	-0.1462 **	0.0586	-0.2493	0.1648
2004-05	0.0045	0.0700	-0.1771 **	0.0775	0.0992	0.1531
Constant	0.5310 ***	0.1657	0.3094 *	0.1824	-0.0152	0.5184
N	3014		2240		774	
No. communities	416		394		291	
R²	0.24		0.2648		0.2502	

Note: p<0.010 is denoted as *, p<0.005 as ** and p<0.001 with ***. The errors are clustered at the community level.

The value of a coefficient corresponding to a shock is best understood as the average effect on asset accumulation of all the reported shocks within the specified category and year. The effect sizes of the shocks are considerable and can cancel out asset accumulation or decrease assets already owned. For instance, an average rural household with an uneducated head is expected to accumulate 0.1125 asset index points every year. The average 2008 adverse weather event in the sample will cost this household more than this entire amount. Moreover, poor households that experienced an adverse weather condition in 2006 on did not recover and have an asset level in 2008, which is on average still 0.825 points lower.

According to the theoretical and empirical model we would expect that the coefficients of shocks that occurred further away from 2008 show smaller values than shocks that occurred closer to 2008, given that the number of communities that reported the shock is sufficiently large. The most often reported shock, adverse weather conditions, shows exactly this pattern. This suggests that weather shocks indeed affect asset accumulation as expected; the household experiences a drop in assets after which it continuous to follow their original concave growth path.

Similar, but slightly less decisive conclusions can be drawn from the regressions on households living in urban or rural areas and on households with an educated or non educated head. See table # in appendix A. The regression results for the group having lower educated household heads, is very similar to the sample including the poorest three quartiles, except that 2007 harvest losses are not significant. Furthermore, households with educated heads and households living in urban areas hardly are affected by any shock, which was also the case with the 25% wealthier households.

6. Conclusion and discussion

6.1 Conclusion

This thesis investigated the persistent impact of covariate shocks on household asset accumulation in Northern Uganda between 2004 and 2008. It demonstrates, that uninsured adverse weather conditions, epidemics and harvest losses not only can cause consumption and income fluctuations, but have long-term effects on asset holdings.

Inspired by the Solow model, we developed an endogenous household growth model that assumes that households have no access to credit and therefore have to accumulate assets by investing part of their income. Similar to the original Solow model the resulting stable asset growth path is convergent and leads to a single equilibrium. This model seems to apply to many households in Northern Uganda, where access to credit and other financial service like insurance, remains uncommon. Here, a generic shock, can reduce household's assets level bouncing it back to a lower level along the growth path. Such a reduction in assets derives from the household's attempt to sustain consumption by lowering investments or selling assets. As a consequence, the household can only gradually recover their asset base by retaining part of their income. As shown in figure 7, such a shock will have long term consequences on asset accumulation, therefore it will take a substantial amount of time for the household to recover and reach the level it would have reached in case no shock occurred. An alternative theory developed by Carter and Barret (2006) acknowledges the possibility of multiple equilibriums. In this model a shock can have a permanent effect when a household, previously converging towards a higher equilibrium, loses enough assets to make it converge to a lower equilibrium instead.

Although we used techniques that can account for non-linearity, the estimated asset dynamics show no sign of multiple equilibriums, and therefore we cannot present evidence that a singular shock could permanently affect household welfare. Instead, we found a convergent pattern with a single equilibrium, suggesting that a shock will have persistent welfare-effects, when the household asset stock is affected. The type of estimation techniques we used (as well as almost all other authors doing similar analysis) assumes that households follow the same asset growth paths. However if we relax this assumption somewhat, by estimating the asset dynamics for groups with distinct (semi) permanent characteristics (i.e. differences in adult educational attainment and rural versus urban locations), we find that different groups have different asset dynamics. Rurally located households with non-educated heads are, for example, found to grow assets with a lower rate and converge towards a lower equilibrium than their urban educated counterparts. This presents supportive evidence for the importance of education in household welfare and shows that the expected asset growth path depends on persistent household characteristics.

Heterogeneity plays a similar role in investigating the persistence of shocks. Controlling for household and community characteristics we parametrically estimated the impact of

different shocks occurring in different years on household asset accumulation between 2004 and 2008. Results indicate that adverse weather conditions, harvest losses and epidemics have a destructive impact on long term asset holdings of households that belong to the poorest three wealth quartiles. In sharp contrast, the asset holdings of wealthier households seem completely untouched. Having a less diversified income and being more dependent on agriculture makes poor households in our sample more vulnerable to risk. At the same time they seem unable to quickly recover due to a limited availability of coping mechanisms (which often results in the sale of assets as a last resort), in combination with the fact that expected accumulation rates are found to be very small. The estimated impact of the shocks is considerable. On average, adverse weather conditions reported in 2008, for example, cancelled out the expected asset accumulation for that year. While epidemics reported in 2008 has an even more destructive impact and on average reduced asset holdings by almost double that amount. The fact that shocks that occurred in 2004/2005 and 2006 still have significant negative effects on 2008 asset levels, confirms that shocks have persistent effects on welfare.

Northern Uganda is a shock prone region where it is common to see one shock followed by another. Considering that expected asset accumulation is slow and shocks have long-term effects on asset holdings, it is likely that the product of the insecurity in the region in the form of a continuous series of adverse events will keep a poor household from reaching its equilibrium state. In this respect, the insecurity in Northern Uganda has a continuous and therefore structural impact on the growth aspirations of the poor and forms a constraint on the development of the region.

6.2 Policy implications

Theory suggests that policy in the form of asset or cash transfers in an environment with multiple asset equilibriums can result in leveraged social returns. This is only the case when households are provided with the right type of assets that can help them cross the threshold and reach the higher equilibrium. However, we did not present evidence for the existence of multiple asset equilibriums in Northern Uganda and, consequently, asset transfers in this region cannot result in structural welfare improvements. Although, this of course does not render asset or cash transfers useless, as they still can be used to speed up the asset accumulation process, other tools, discussed in next paragraph might be more effective in structurally reducing poverty or stimulating development in Northern Uganda.

The conclusion that any asset reduction potentially leads to long term welfare losses clearly reaffirms the importance of making efficient risk coping strategies available for poor households in the region. Currently, households are often forced to sell part of their assets to sustain consumption and avoid hardship. Any alternative mechanism that affects future earnings less or for a shorter period would therefore be preferable above the sale of assets and would improve the asset growth expectations of poor households. Examples of potentially fruitful policy interventions that can limit the depletion of household asset holdings are the creation of off-farm employment (e.g. government food-for-work projects in the aftermath of covariate shocks) and making credit and insurance better available, especially for the poor.

6.3 Limitations

The boundaries of this thesis largely arise out of data limitations. This thesis only covered the welfare effects from ex-post risk, while the effects from ex-ante risk are largely ignored (i.e. the effects of uninsured risk on activity decisions and preferences). Moreover, the list of shocks included in the estimation, although comprehensive, is not complete; besides the ignored idiosyncratic shocks we do not included the effects from price fluctuations. This makes the estimated negative welfare effects of risk in Northern Uganda yet underestimated.

Additionally, using community-level shock dummies leads to undesirable distortion in our estimations. Households are treated like they are uniformly affected by a community shock, but in reality some households might not have been affected at all, while others have lost everything. The same is true on a village level. An adverse weather condition, for example, can come in many forms and in many grades of severity, but all reported shocks of a specified type in a specified year are assumed to have the same impact across all communities. The resulting distortion does not affect the current conclusions, but the conclusions might have been more precise and detailed if our shock measure controlled for shock severity and was based on household reports.

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Appendix A: additional tables

Table 8: First component from polychoric principal component analysis							
Eigenvalue		= 6.7099					
Proportion explained		=41.94%					
Asset		**Coeff.**	**Asset**		**Coeff.**	**Asset**	**Coeff.**
Tropical livestock units		0.0261	**Mobile phone**			**Wall materials**	
Total years of education		0.2051		0	-0.0823	Mud and poles	-0.3952
Plough		0.0325		1	0.4443	Wood	-0.2228
Hoe		0.0624		2	0.5873	Unburnt bricks with mud	0.0128
Buildings		0.0044		3	0.6320	Unburnt bricks with cement	0.2579
Motor vehicle				4	0.6447	Stone with cement	0.2641
	0	-0.0219		5	0.6524	Concrete	0.2647
	1	0.6621		6	0.7763	Cement Blocks	0.2677
	2	0.6771	**Radio**			Burnt bricks /w mud	0.3221
	3	0.8054		0	-0.1465	Burnt bricks /w cement	0.5205
Motorcycle				1	0.2030	**Fuel for lighting**	
	0	-0.0227		2	0.4286	Cow dung or grass	-0.6601
	1	0.5380		3	0.4674	Firewood	-0.4263
	2	0.5675		4	0.4762	Candles	-0.298
	3	0.6737		5	0.4784	Paraffin (Tadooba)	-0.1080
Bicycle				7	0.4790	Paraffin (Lantern	0.2089
	0	-0.1429		21	0.5680	Gas	0.4938
	1	0.1367	**Television**			Electricity	0.6134
	2	0.3328		0	-0.0264	**Roof material**	
	3	0.3823		1	0.6081	Banana leaves/fibers	-0.899
	4	0.3920		2	0.6423	Grass/Papyrus	-0.092
	5	0.3943		3	0.6476	Tins	0.2779
	6	0.3950		4	0.7684	Concrete	0.2788
	12	0.4684				Asbestos	0.2798
Generator						Tiles	0.2808
	0	-0.0172				Iron sheets	0.4437
	1	0.6634				**Floor material**	
						Wood	-1.0831
						Rammed earth	-0.9511
						Cement screed	-0.067
						Bricks	0.4675
						Concrete/stone	0.5571

Table 9: WLS on asset accumulation between 2004 and 2008 for additional subsamples											
	Uneducated *Head has had 7 years of education or less*			Educated *Head has more than 7 years of education*			Rural			Urban		
Variable	Coeff.		Robust Std. Error	Coeff.		Robust Std. Error	Coeff.		Robust Std. Error	Coeff.		Robust Std. Error
Household characteristics												
Initial asset level	-0.332	***	0.045	-0.199	***	0.073	-0.298	***	0.037	-0.201	***	0.075
Initial asset level^2	0.037		0.034	0.024		0.049	0.006		0.018	0.102	***	0.032
Initial asset level^3	-0.006		0.009	-0.035		0.028	-0.008		0.010	-0.072	***	0.020
Initial asset level^4	0.001		0.004	0.004		0.004	0.003		0.002	0.008	***	0.003
Initial land holdings	0.001	*	0.000	0.000		0.005	0.001	**	0.000	0.002		0.004
Head is male?	-0.012		0.028	-0.106		0.117	-0.031		0.036	0.073		0.081
Age of head	-0.013	***	0.005	-0.012		0.018	-0.015	***	0.005	-0.020		0.015
Age of head^2	0.000	***	0.000	0.000		0.000	0.000	***	0.000	0.000		0.000
Years of education head	0.037	***	0.006	0.006		0.015	0.027	**	0.012	0.050	***	0.011
Dependency ratio	-0.127	*	0.073	-0.006		0.209	-0.170	**	0.070	0.070		0.171
Household	0.126	***	0.014	0.128	***	0.032	0.123	***	0.014	0.144	***	0.031
Growth household size	0.167	***	0.011	0.176	***	0.034	0.159	***	0.012	0.204	***	0.029
Community characteristics												
Distance to tarmac road	-0.002	***	0.000	-0.001	*	0.001	-0.002	***	0.000	-0.002	***	0.000
Distance to financial inst.	-0.002	***	0.001	-0.004	*	0.002	-0.002	***	0.001	-0.003	***	0.001
Distance to non-agrimarket	-0.002	***	0.000	0.006		0.005	-0.001	***	0.000	-0.002		0.005
Presence of public electr.?	0.043		0.045	0.037		0.097	0.019		0.050	0.069		0.105
Presence of private electr.?	0.045		0.036	0.090		0.092	0.058		0.038	0.140		0.092
Presence of river or lake?	-0.033		0.031	-0.022		0.083	-0.025		0.032	-0.017		0.094
IDP camp?	-0.023		0.044	-0.049		0.138	-0.021		0.042	-0.123		0.242
Urban area?	0.122	***	0.047	0.171	*	0.098						
Shock type 1:												
Adverse Weather Conditions — 2008	-0.155	***	0.031	-0.033		0.081	-0.149	***	0.034	-0.094		0.078
2007	-0.083	**	0.035	-0.068		0.085	-0.090	**	0.038	-0.095		0.079
2006	-0.060	*	0.032	-0.167		0.126	-0.052		0.043	-0.096		0.091
2004-05	-0.071		0.049	0.024		0.099	-0.052		0.049	-0.123		0.165
Shock type 2:												
Harvest loss (not weather related) — 2008	-0.088	***	0.034	-0.077		0.091	-0.100	***	0.035	-0.048		0.093
2007	-0.056		0.044	-0.111		0.142	-0.012		0.052	-0.241	*	0.131
2006	-0.155	***	0.052	0.339		0.219	-0.059		0.062	-0.307	*	0.170
2004-05	-0.091	**	0.046	0.104		0.136	-0.090	**	0.049	0.162		0.132
Shock type 3:												
Insecurity, violence and Destruction — 2008	-0.002		0.056	0.103		0.152	-0.020		0.075	0.175		0.123
2007	0.024		0.076	0.049		0.265	-0.049		0.106	-0.075		0.188
2006	0.078		0.059	-0.167		0.168	0.009		0.067	0.003		0.166
2004-05	0.160	***	0.052	-0.263		0.189	0.103	**	0.058	0.115		0.129
Shock type 4:												
Epidemics — 2008	-0.211	***	0.066	0.230		0.156	-0.121	**	0.065	-0.184		0.143
2007	-0.189	***	0.073	-0.076		0.127	-0.194	***	0.059	-0.114		0.195
2004-05	-0.277	***	0.095	0.337		0.365	-0.087		0.085	0.101		0.199
Constant	0.394	***	0.156	0.855	*	0.509	0.592		0.171	0.527		0.621
N	2443			571			2456			558		
No. communities	407			284			332			107		
R^2	0.2670			0.2343			0.2183			0.3184		

Note: p<0.010 is denoted as *, p<0.005 as ** and p<0.001 with ***. The errors are clustered at the community level.
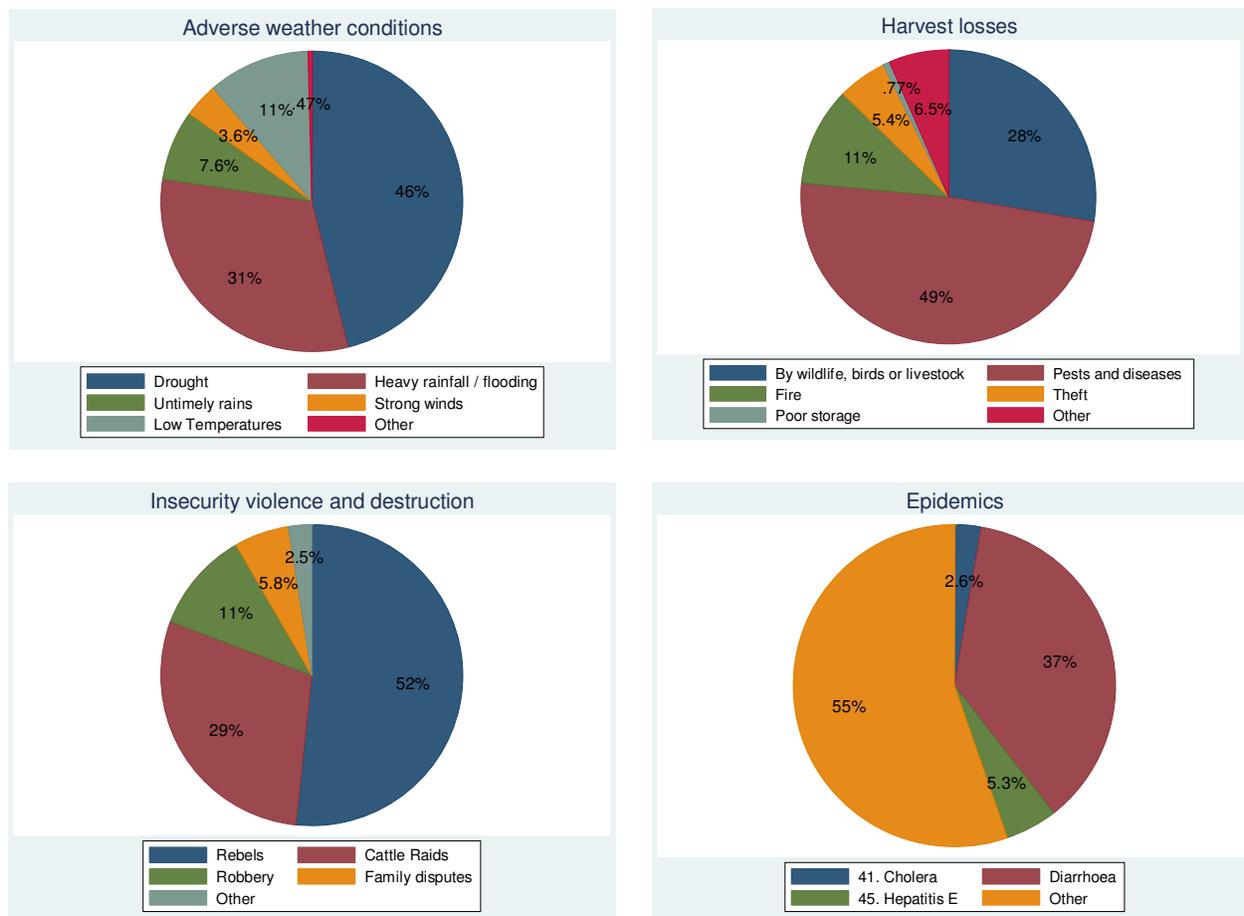
Appendix B: additional figures

Figure 14: Occurrence of different types of shocks.