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Asset Management & Coping Strategies in Burkina Faso

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1 Introduction

Rural households in most developing countries rely on agriculture for a significant portion of their income. Yields and crop prices are often highly volatile (Jensen, 2000; Bellemare et al., 2013). Household's livelihood can be adversely affected by many factors, such as insufficient rainfall or falling crop prices. Other unforeseen expenditures, such as illness, can also negatively affect household welfare. In the absence of formal safety nets, households often depend on local risk-pooling to cope with negative economic shocks (Townsend, 1994). While such mechanisms can be effective in dealing with idiosyncratic risks, they fail to insure against aggregate risks that affect entire communities. Households may have to reduce current consumption if their incomes are sufficiently reduced. Alternatively, they may use savings or seek loans to meet current consumption needs.

In developing countries such as Burkina Faso, most households have low levels of savings. Assets often play a role as a store of value (Deaton, 1991). Productive assets play a doubly important role; not only are they needed to generate income, they can also be sold when needed. A large literature discusses the use of livestock as buffer stock to smooth consumption over time (Binswanger and McIntire, 1987; Swinton, 1988; Fafchamps et al., 1998; Kazianga and Udry, 2006). Since livestock is used for agriculture activities (e.g. plowing) and produces output (e.g. milk), it is an important economic asset demanded by most households and markets exist for their sale and purchase. Hence, households can buy and sell assets to manage their consumption levels over time.

In places with missing credit and insurance markets, Binswanger and McIntire (1987) suggest that livestock is the major form of wealth and a substitute for insurance. Rosenzweig and Wolpin (1993) show that Indian farmers buy and sell bullocks, which are an important productive asset, to smooth consumption across time. Swinton (1988) notes that cattle, sheep and goats were sold by households in response to a large drought in Niger.

Fafchamps et al. (1998) provide one of the first formal tests of livestock inventories being used smooth consumption over time. While they find that Burkinabe households sold cattle, sheep and goats in response to droughts, the sales were much less than what theory would predict. Similarly, Hoogeveen (2002) and Fafchamps and Lund (2003) find lower than expected assets sales and consumption smoothing.

Carter and Lybbert (2012) attempt to explain this empirical regularity with a poverty traps model; they suggest that households at critical asset thresholds would be less willing to sell that asset. Such households would asset smooth rather than consumption smooth, leading to lower levels of average consumption smoothing over all households. Using the same Burkina Faso data as Fafchamps et al. (1998) and Kazianga and Udry (2006), they find that only households with a large herd size sell livestock to off-set income shocks.

Lybbert et al. (2004) and Santos et al. (2006) had previously found evidence of multiple equilibrium and poverty traps amongst pastrolists in Southern Ethiopia, while Carter et al. (2007) find behavior consistent with poverty traps for households in Ethiopia and Hondarus. Barrett et al. (2006) find evidence of asset based poverty traps in Northern Kenya and Southern Madagascar, but not in the central highlands of Madagascar. This is suggestive that poverty traps exist in remote areas with few livelihood generating opportunities and limited access to credit and markets. Adato et al. (2006) also find a large number of South Africans lack the means to find a way out of poverty, and discuss how the lack of social capital for the poorest restricts their upward economic mobility.

Most of these studies use flexible semi/non-parametric techniques (Lybbert et al., 2004; Adato et al., 2006; Barrett et al., 2006; Santos et al., 2006; Lybbert and McPeak, 2012) or Hansen's threshold method (Carter et al., 2007; Carter and Lybbert, 2012; Janzen and Carter, 2013) to find an asset threshold above and below which two different regimes exist. One exception is Hoddinott (2006), which uses the importance of a pair of oxen in agricultural production to compare oxen sales of households with one or two oxen with those with more oxen.

However, a number of studies outside the African context fail to find similar evidence. Naschold (2013) finds that households in rural Pakistan and Ethiopia face static and structural poverty, while Naschold (2012) and Dercon and Outes (2009) share similar findings for India. Similarly, Quisumbing and Baulch (2013) for Bangladesh, Lokshin et al. (2004) for Hungary and Russia, Jalan and Ravallion (2004) for China and Antman and McKenzie (2007) for urban Mexico fail to find evidence of poverty traps.

This paper uses data from Burkina Faso to better understand how households cope with negative economic shocks. In the local context, agriculture is mostly rain-fed and droughts can significantly impact crop output and household incomes. Excessive rain can also destroy crops and damage household belongings. Both droughts and floods have been very common in Burkina Faso in the last few decades. The World Bank (2011) notes that between 1991 and 2009, the country experienced eleven major floods (affecting 383,203 people) and three major droughts (affecting 96,290 people). The floods left inundated fields, destroying standing crop, and caused damage to dwellings and other assets. Floods early in the agricultural seasons also carry away parts of the fertile top soil, leaving the land barren. Droughts led to insufficient moisture for crops, and lower crop yields. These events increase the vulnerability of agricultural households in Burkina Faso, who often need to resort to ex-post strategies to deal with losses due to bad weather.

Similar to other developing countries, most rural Burkinabe households own livestock. This is one of the most important assets, and is more liquid (and more commonly owned) than other assets such farm machinery. Oxen are commonly owned and used as a traction animal, primarily for ploughing. Smaller animals, such as goats and sheep, are common and may be more easy to sell in times of need. Many households are also engaged in poultry, while other animals such as donkeys may be used as draft animals.

This paper adds to the consumption smoothing/asset stock management literature by analyzing intrahousehold aspects of asset sale decisions. In specific, I test whether the presence of young children increases the asset sales in response to a shock. I also test whether women's assets are more likely to be sold rather than those of men, which would add to the vulnerability women face in tough economic times.

2 Conceptual Model

The following model is based on Carter and Lybbert (2012) and it describes the intertemporal optimization problem of households:

$$max_{[c,L^m,L^f]} E_0[\sum_{t=0}^{\infty}(1/(1+\delta)^t)u(c_t)] \tag{1}$$

$$x_t(L_t^m, L_t^f, \theta) = F(L_t^m + L_t^f) + (1-\tau)\theta_t(L_t^m + L_t^f) \tag{1a}$$

$$F(L_t^m, L_t^f) = max[F^h(L_t^m + L_t^f), F^l(L_t^m + L_t^f)] \tag{1b}$$

$$c_t < x_t \tag{1c}$$

$$L_{t+1}^m = (x_t - c_t)/2 \tag{1d}$$

$$L_{t+1}^f = (x_t - c_t)/2 \tag{1e}$$

$$L_t^m \geq 0 \; \forall \; t \tag{1f}$$

$$L_t^f \geq 0 \; \forall \; t \tag{1g}$$

$$\partial F^h/\partial(L^m + L^h) \geq \partial F^l/\partial(L^m + L^h) \forall L^m + L^h \leq \tilde{L} \tag{1h}$$

$$F^l(L^m + L^f) \geq F^h(L^m + L^f) \; \forall \; L^m + L^h \leq \tilde{L} \tag{1i}$$

c_t is the household consumption at time t, L_t^m and L_t^f are the asset holdings of men and women at time t, $u(.)$ is the time-invariant utility function, δ is the discount rate while τ is the depreciation rate. F is the production function, which depends on the assets of the household. The asset stock produces positive output with diminishing returns. θ_t is an iid stochastic term that shocks the cash-on-hand at time t, x_t, which is defined as the sum of value of output and assets.

Households have access to a high and a low type of technology. The marginal return to capital is greater under the high type technology compared to the low type technology ($\partial F^h/\partial(L^m + L^h) \geq \partial F^l/\partial(L^m + L^h)$). However, the high type technology is subject to fixed costs so the total output is higher under the low type technology until a minimum level of capital,$\tilde{L}$, is reached: $F^l(L^m + L^f) \geq F^h(L^m + L^f) \; \forall \; L^m + L^h \leq \tilde{L}$. These properties of the production function create a discontinuous jump in the marginal returns to assets at the point.

The remaining equations are that consumption at time t is bounded by cash-on-hand at time t, assets at time t+1 are the difference of cash-on-hand and consumption at time t, and a non-negativity constraint for assets.

Under this framework, households try to maximize their lifetime utility by choosing their consumption and asset stocks over time. In the absence of credit markets, they can only invest in their productive assets by foregoing current consumption.

The main difference from the Carter and Lybbert (2012) model is the introduction of male and female assets. Since they are combined and used for household production and are homogeneous, the gender of the owner should not affect the optimal levels of assets.

This model suggests that on average households will cope with a one-period negative shock by selling assets and increasing current consumption. Few households are at key asset thresholds at any given point in time, since these are dynamically unstable level of assets. This makes identification of these households more difficult.

Carter and Lybbert (2012) use a numerical example to show that this model allows for the existence of poverty traps. That is, there is a sudden increase in the derivative of the value function with respect to assets at a level less than $\tilde{L}$.

The sharp increase in the marginal value of assets is because beyond that point, called the Micawber threshold in the literature, it becomes dynamically rational for households to accumulate

assets to reach the high-level steady state asset level. They also note that "the marginal value of assets will be extraordinarily high in the neighborhood of critical wealth levels; households in these neighborhoods will be reluctant to liquidate assets even in the face of economic shocks." Under this framework, households just below the Micawber threshold would be willing to make substantial sacrifices of consumption to increase assets, and households just above the threshold to be willing to forgo current consumption to protect assets and avoid falling below the critical asset threshold.

While Carter and Lybbert (2012) show that poverty traps may arise in this setup, different parameter values would ensure they do not exist. Moreover, there may be reasons to not expect a poverty trap in the real world. The model depends on the credit constraint; if this constraint is taken away the poverty traps do not exist. While formal credit is not easily available in rural Burkina Faso, informal sources of credit can make this a less constraining factor. If households have access to multiple income generating activities, the importance of the Micawber threshold reduces. This is because other source of income can be accessed that do not depend on the asset.

Rental markets and informal ways of accessing the productive asset may also alleviate the need to own the asset. As long as the household has access to the asset, they would not necessarily own it or would be willing to sell it when needed.

The model also assumes the asset to be a continuous variable. However, many productive assets such as livestock are discrete. A single unit of larger animals, such as oxen and cows, can have a high upfront cost. This would weaken the case for the existence of a Micawber threshold, even if multiple livelihoods exist that require certain thresholds of assets. For example, a pair of oxen is needed for ploughing land and has been noted as an important asset threshold. Yet, the existence of a Micawber threshold is questionable. Given that purchasing a single ox requires incurring significant upfront cost, would households with one oxen consider themselves 'close enough' to the switching point that they accumulate resources to buy the second ox in the near future? In such cases, distinguishing between the Micawber threshold (if it exists) and $\tilde{L}$ may be empirically difficult.

Another factor to consider is that if many households try to sell an asset, its price may decrease, reducing the incentive to sell it. However, more of it will need to be sold if households require a minimum amount of money for immediate consumption. In the case of livestock, these effects are further complicated by the fact that it might be harder to maintain a herd because there is less land available for grazing. This would make maintaining a herd more expensive, which may reflect in the price of the asset. Some animals, such as goats, are more resistant to droughts since they can graze on grass and shrubs.

Livestock is an important productive asset and a store of value, but it also plays other important roles. Kondombo et al. (2003) note that livestock plays an important role in the cultural life of rural people in Burkina Faso, and are linked with prestige. Thus despite economic reasons for wanting to sell livestock, households may not sell them since its possession increases their utility.

The empirical strategy will test whether households sell assets to finance current consumption to off-set short-term negative economic shocks. I then test for asset smoothing at potential Micawber thresholds of livestock and other agricultural assets, based on the literature. The model predicts that households just above the Micawber threshold will asset smooth, rather than consumption smooth, when faced by shocks. Household behavior consistent with this prediction would suggest existence of poverty traps.

I also test whether assets owned by females are more likely to be liquidated compared to those owned by males. The model suggests that since the assets are homogeneous, there is no reason for assets owned by any gender to be sold more often.

3 Data

The study uses data from the Continuous Farm Household Survey/ Enquête Permanente Agricole (EPA), collected by the Ministry of Agriculture and Food Security of Burkina Faso. The sampling frame for the EPA is based on the 2006 Population Census. The EPA generates production, area and yield data for crops, serves as an early warning system for food insecurity, using a nationally representative sample of rural households across all 45 provinces for 2009/10, 2010/11 and 2011/12 (referred to as 2010, 2011 and 2012 in the remaining paper).

The survey gathers detailed plot-level agricultural data on plot characteristics, inputs applied and harvested amount. There is also data on quantity of crops stored by the household. The asset data contains quantity and value of farm machinery, and livestock owned by individual members within the household. The animals include cattle (oxen and cows), sheep, goats, donkeys, pigs and hens. There is data on the consumption, purchase, birth, death, sale and value of sales (and what the proceeds were used for).

There are also modules on household composition, self-reported food security, consumption of food groups and their frequency, and other sources of income. Since there is no detailed consumption module, I cannot directly test for the extent of consumption smoothing.

Rainfall estimates comes from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), which uses 0.05° resolution satellite imagery with weather station data to create a gridded time series. The GPS coordinates of villages are then used to extract the precipitation data ranging from 1981-2012.

The livestock data is collected at the sowing period for the previous year; hence floods and droughts from the previous year are used to test for asset sales.

4 Identifying Shocks

Low (high) levels of rainfall should not be classified as a drought (flood). Typically, a drought (flood) is defined when precipitation levels are significantly lower (higher) than the long-term average. Hoddinott (2006) uses negative and positive standard deviations away from the long-term mean to measure adverse rainfall shocks. Fafchamps et al. (1998) use deviations away from the long-term mean and its square term to predict income shocks.

In this paper, I use the Standardized Precipitation Index (SPI), developed by McKee et al. (1993) to identify droughts and shocks. The rainfall data is used to fit a gamma distribution. The gamma distribution has been noted to model precipitation data well (Guttman, 1999). I use total rainfall in the growing season (June-August) to create the index. The cumulative distribution function is then transformed to a standard normal distribution function, with a Z-score less than -1 indicating a drought. A Z-score of greater than 2 is defined as a flood – this is because higher than average rainfall may be good up to a certain point, but extremely high rainfall has negative effects (such as inundating fields). Since these cut-offs are fairly arbitrary, sensitivity analysis is conducted for robustness of the results.

Since these variables are deviations from long-term trends, they can be considered unexpected events for households. While households in places with higher weather variability may be systematically different from those in other places, in the empirical analysis a household fixed effects model will be used to control for such differences.

5 Empirical Strategy

I first want to test whether weather shocks actually had an impact on household income. These weather shocks can have effects through two mechanisms, yield and cropped area. Households may also change their crop portfolio, especially in times of droughts. This may also reduce their agricultural income if they switch from high value crops to basic staples.

A household fixed effects model is used to test whether these shocks are correlated with crop yield.

$$Y_{ijht} = \alpha + \beta_1 drought_{ht} + \beta_2 flood_{ht} + \beta_3 X_{ihjt} + \gamma_h + \theta_j + \mu_t + \epsilon_{ijht} \tag{2}$$

The dependent variable, Y_{ijht}, is the yield (kg/ha) of crop j on plot i of household h in year t. $drought_{ht}$ and $flood_{ht}$ are dummy variables that equal one if the household was located in a village where a drought or a flood respectively occurred at time. The vector X_{ihjt} includes plot and plot manager characteristics, and household characteristics that vary over time. γ_h denote the household fixed effects, θ_j are dummy variables for crop type while μ_t are year dummies. The main specification does not control for inputs, since these might be the mechanism through which rainfall affects agricultural output – less fertilizer might be applied to crops because of insufficient rainfall. Additional regressions control for agricultural inputs for additional robustness of the results. The main coefficients of interest are β_1 and β_2. If the drought and flood reduce crop yields, these coefficients will be negative.

A similar specification will be used to test whether these rainfall shocks lead to less land being cultivated. This may be because households consolidate resources on few plots. In that case, the dependent variable is total cropped area (ha) and the model is estimated using a household level (rather than plot level) dataset.

Next, I test whether households sell their livestock in response to floods and drought. A household fixed effects model is used to test whether households that face droughts and floods sell more livestock.

$$S_{ht} = \alpha + \beta_1 drought_{ht} + \beta_2 flood_{ht} + \beta_3 X_{ht} + \gamma_h + \mu_t + \epsilon_{ijht} \tag{3}$$

S_{ht} is the livestock sales of the household at time t, and X_{ht} is a vector of household characteristics that are likely to affect livestock sales. If assets are sold in response to the weather shocks, $\beta_1 > 0$ and $\beta_2 > 0$.

To test for poverty traps, it is not possible to use the data to find important asset thresholds similar to the literature since the analysis is conducted on a short panel survey. Instead, similar to Hoddinott (2006), I will use the local production context to suggest an important asset threshold and test the behavior of households above and below it.

There is low mechanization for agriculture in Burkina Faso, and oxen are still the primary way of ploughing and preparing land. Without a pair of oxen, which is needed to prepare the land, households would have much lower efficiency in farming and have much lower incomes. Hence, this presents an important asset threshold for poor households in rural Burkina Faso. The model to test for differential asset sales for households above and below this threshold of two oxen is:

$$S_{ht} = \alpha + \beta_1 drought_{ht} + \beta_2 flood_{ht} + \beta_3 low_{ht} + \beta_4 drought_{ht} * low_{ht} + \beta_5 flood_{ht} * low_{ht} + \beta_6 X_{ht} + \gamma_h + \mu_t + \epsilon_{i} \tag{4}$$

This model will be on a sub-sample of households that own at least one oxen. The variables are defined the same as above. Additionally, following Hoddinott (2006), I define $low = 1$ if the household has one or two oxen, and equals $low = 0$ if it has more than two oxen.

Again, $\beta_1 > 0$ and $\beta_2 > 0$ if oxen are sold in response to weather shocks. Additionally, $\beta_4 < 0$ and $\beta_5 < 0$ is consistent with the poverty traps model. That is, households with fewer oxen are less willing to sell them since they fear being stuck in a low level equilibrium.

I also test some related intrahousehold resource allocation questions on the main asset sales model. In specific, I test whether the presence of infants in the household results in greater asset sales - presumably to sustain consumption levels. We know the first 1000 days from conception till the child's second birthday are crucial for their development and have lifelong effects (Cusick and Georgieff, Cusick and Georgieff). Given the importance of nutrition for children at early ages, households should be more willing to sell assets rather than if the children were older. However, these children are not decision-makers in the household and depend on adults in the household to take into account their long-term well being and ensure their needs are met. To test whether households sell more assets when children are in the households, I include explanatory variables for number of infants in the household and their interaction with drought and flood.

Another question I explore is whether women's assets are more likely to be sold to deal with a shock than assets owned by men. We know that woman are more vulnerable to shocks (Bolin and Stanford, 2006) , including weather shocks (Miguel, 2005). But if their assets are sold first, it also damages their ability of generating income in future.

6 Results

The regression based on equation (2) shows that crop yields decrease by 15 percent when floods occur and 9 percent in drought times. The results are statistically significant at the 1 percent level, and do not change when I include agricultural inputs.

Additionally, droughts lead to about 7 percent less area being cropped by the household. This may be because households prefer to consolidate resources on a few plots to ensure they produce enough to meet the food security needs of the household. This reduction comes almost entirely from less area growing non-cereal crops, which reduces by over 20 percent. The area of main cereal crops (maize, millet and sorghum) is not affected, since they are important for food security and more resilient to drought conditions. The crop area is unaffected in times of flood.

Since agriculture is a major source of livelihood for most households in rural Burkina Faso, these are fairly large shocks to their income. To meet short-term consumption needs, households may be forced to sell assets. The results show that oxen are not often sold in response to these shocks. The coefficients on drought and flood are not statistically significantly different from zero, and have fairly tight confidence intervals around zero. Rather, there is a large increase in the sale of sheep during droughts. While majority of Burkina Faso does not consume pigs, there is an increase in pig sales amongst the communities that do.

The poverty traps specification for oxen sales shows that while some oxen are sold in response to droughts, there does not seem to be differential behavior between households with one or two oxen and those with more. The point estimates are very close to zero.

There is some evidence that the assets of women are sold when households face these shocks. This result may perhaps be surprising, since generally the head of household (who is almost always male) is responsible for food security and may be expected to liquidate assets to provide for the household. Yet the results suggests that the livestock of women is sold in times of need.

There is also some evidence that households are more likely to sell assets if it has a baby (0-2 years) boy, but not if it has a baby girl. There is a large intrahousehold resource allocation literature that shows preferential treatment for boy compared to girls in various developing country contexts, and such behavior would be consistent with patriarchal culture and the economic realities. Girls are more economically disadvantaged in the labor market and households will invest more in those children that face better labor market opportunities, hence leading to more resources being allocated to boys within the family.

7 Conclusion

Many households in Burkina Faso, as in much of the developing world, earn income in the agricultural sector. Their incomes depend on many factors outside their control, such as rainfall. The climate in this region is highly volatile, and this variance is expected to grow over time due to climate change. Thus, these households needs mechanisms to better deal with negative economic shocks.

Floods destroy crops and reduce yields. Droughts not only reduce crop yields, but also lead to less land being cultivated and fewer higher value crops being grown. This leads to households earning less income. Most households are poor and have few savings, and often have to resort to selling their livestock to meet short-term consumption needs. I find that they sell smaller animals, such as sheep, rather than cows and oxen. There is evidence that they are more likely to sell these assets when there are infant boys in the household but not infant girls. I also find that households are more likely to sell assets owned by women, which increases their vulnerability during and following such negative economic shocks.

By identifying vulnerable groups, such as infant girls, social safety nets can better target those in need and use their resources effectively. There is also a need to understand long lasting effects of such shocks, and whether they change intrahousehold bargaining positions of family members.

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