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AFTER THE DROUGHT:
THE IMPACT OF MICROINSURANCE ON CONSUMPTION SMOOTHING AND ASSET PROTECTION

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ABSTRACT

When natural disasters afflict poor communities that lack buoyant access to financial markets, households face the unsavory choice of reducing consumption in order to protect remaining assets, or selling assets at low prices in order to maintain consumption and nutrition. Both choices are costly and damage future economic potential. Formal insurance markets would seem to offer large private and social returns in these circumstances. This paper studies a drought-induced insurance payout from a pilot project in Kenya to determine whether insurance protects households from asset and consumption destabilization. Average treatment effect estimates show that insurance significantly reduces both kinds of costly coping. A closer examination using threshold estimation methods reveals that insurance has different impacts for different kinds of households. Households with larger asset bases--those shown to be most likely to sell assets in order to cope with a shock--are 64 percentage points less likely to do so when insured. Households with fewer assets--those most likely to decrease food intake as a coping strategy--are 43 percentage points less likely to do so with insurance. These results suggest that insurance can have a large impact on both the productivity of the current generation and the human capital of the next.

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1 Introduction

When extreme drought strikes the pastoralist regions of northern Kenya, the effects are devastating. Livestock, the primary asset and source of livelihood, weaken and die. Distress sales of livestock flood the market, causing downward pressure on livestock prices (Barrett et al. 2003; Kerven 1992). The combination of livestock loss and pro-cyclical price swings debilitate households' main productive resource, making recovery after the drought all the more challenging for households that choose to sell assets in order to smooth and maintain consumption standards. Alternatively, in an effort to maintain assets, households may instead choose to cut back on meals and other consumption. Yet by reducing consumption, households undercut critical investments in human capital, inhibiting both current and future productivity. In these ways a single negative shock can lead to chronic poverty by restricting the ability of multiple generations to generate current and future income. In this paper we assess whether insurance offers an effective alternative to these costly coping strategies.

Microinsurance has been heralded over the past decade as a market-based risk transfer mechanism that has the potential to act as a safety net, preventing catastrophic collapse. Although development of microinsurance pilot projects have been widespread, relatively little is known about their impacts. There is a small but growing body of evidence showing that microinsurance can influence households' *ex ante* risk management decisions. However, little is known about the effectiveness of insurance after a shock is realized for the simple reason that these impacts are observable only after an insured population receives a shock. This analysis offers one of the first empirical assessments of the impact of a market-based index insurance contract on a household's ability to cope with shocks *ex post*. We report the impact results of the index-based livestock insurance (IBLI) pilot in Marsabit district of northern Kenya. Since 2010, pastoralists in northern Kenya have had the opportunity to purchase a novel index-based insurance contract to protect against livestock mortality losses due to drought. A harsh drought swept the Horn of Africa in 2011 activating the first IBLI payout. We use households' reported coping strategies at the time of the payout to empirically study the impact of insurance on consumption smoothing and asset protection. Because the IBLI pilot was rolled out as part of a large-scale randomized controlled trial, we are able to utilize randomly distributed information and price discount treatments to cleanly identify the impacts of insurance on coping behavior.

We first consider the average impacts of insurance on household coping strategies. Our results reveal that compared to uninsured households, insured households on average expect to radically reduce their dependence on costly coping strategies which impair their future productivity. Insured households are *on average*: 1) 36 percentage points less likely to anticipate selling livestock in the wake of the 2011 drought (overall a 50% reduction), improving their ability to generate income after drought. 2) 25 percentage points less likely to reduce meals than their uninsured counterpart (an overall reduction of about one third). This latter behavioral change implies a reduction in the number of undernourished and malnourished individuals, including women and children, in this food insecure region.

We also conduct a more finely grained analysis, following the theoretical literature, and estimate the heterogenous impacts of insurance. There are a number of reasons to expect that the average impacts cover up more complex heterogeneous impacts. Both standard and poverty trap models of the accumulation of productive assets predict that asset poor

households will forfeit consumption in times of crisis in order to protect their limited productive assets and subsequent future income-generating capacity. Asset rich households, on the other hand, will be more willing to forfeit assets in order to smooth consumption when an adverse shock hits.

Motivated by this expectation of bifurcated coping behavior, we use Hansen's (2000) threshold estimation method, and provide evidence that a behavioral threshold does indeed exist in this setting: consumption smoothing is more common above an estimated threshold, and asset smoothing is more common below an estimated threshold. This finding implies that simply estimating the average effect of insurance may be misleading. The results of this threshold-based approach show that:

- Households holding assets above the estimated threshold, who are most likely to sell assets, are 64 percentage points less likely to anticipate doing so when an insurance payout is available. Insurance has no significant impact on meal reductions by these consumption smoothing households.

- Households holding assets below the estimated critical threshold, who are prone to destabilizing consumption, are 43 percentage points less likely to anticipate doing so with insurance. Insurance has no impact on livestock sales by these asset smoothing households.

Together, these results suggest that insurance can help households to protect assets during crises, without having a deleterious effect on human capital investments.

A growing body of evidence suggests that insurance can influence behavior even before an insurance payout is ever received. As a final part of the analysis, we consider whether anticipation of an insurance payout can influence a household's drought coping behavior, even before a payout is actually received. The results suggest that insured households (especially asset poor insured households), who are likely to know that they will soon receive an insurance payout, are indeed better able to smooth consumption. However, we find no impact of an anticipated payout on pre-payout livestock sales, suggesting two things. First, these same poor households are not drawing down assets in order to smooth consumption and second, insurance does not help asset rich households to protect assets during crisis until after the payout has been received.

The rest of the paper is organized as follows. Section 2 briefly reviews both the theoretical and empirical literatures that explain why we might expect to see heterogenous coping strategies when a poor community faces a large covariate shock, with some households smoothing consumption and others smoothing assets. Section 3 then provides an overview of the literature studying how insurance might help households to cope with uninsured risk and vulnerability, particularly in developing countries. In Section 4, we provide background information on the research setting, and discuss the available data. Our estimation strategy is outlined in Section 5. We use an instrumental variables approach to control for endogeneity in the decision to insure, combined with Hansen's (2000) threshold estimator to produce the expected heterogeneous impacts of livestock insurance payouts in northern Kenya. In Section 5.3, we present and discuss our main finding: that insurance, and specifically an insurance payout in the midst of a shock, dramatically reduces the need for a household to depend on costly coping strategies which undermine its future productivity. In Section 5.4

we take advantage of data regarding pre-payout drought coping strategies to analyze the impact of insurance on consumption and asset smoothing behaviors prior to receipt of an insurance payout. Section 6 concludes.

2 Heterogeneous Coping Strategies: Consumption and Asset Smoothing

As a prelude to considering the potential impacts of insurance, this section briefly reviews household coping strategies in the absence of insurance and borrowing options. Absent these options, households in the wake of a shock can choose to draw down assets to defend their consumption standard (consumption smooth), or they can preserve assets and destabilize their consumption (asset smooth). While consumption smoothing is sometimes discussed as if it were the primary goal of households' intertemporal savings decisions, there is a modest but growing body of evidence that some, especially lower wealth, households asset smooth.

In earlier empirical work on coping strategies, both Townsend (1994) and Jalan and Ravallion (1999) note that poor households less effectively smooth consumption than do wealthier neighbors. In later work, Hoddinott (2006) provides evidence that in the wake of the 1994-1995 drought in Zimbabwe, richer households sold livestock in order to maintain consumption. In contrast, poor households with one or two oxen or cows were much less likely to sell livestock, massively destabilizing consumption instead. In Ethiopia, Carter et al. (2007) also find evidence of asset smoothing by the poor, as households coping with a drought attempted to hold onto their livestock at the cost of consumption. Building on Kazianga and Udry's (2006) empirical finding that poor and wealthy households manage their savings and assets differently in the face of shocks, Carter and Lybbert (2012) propose a structural approach to this problem. They empirically estimate an asset threshold, and show that households above an estimated dynamic asset threshold almost completely insulate their consumption from weather shocks by drawing down assets, whereas households below the threshold do not, despite having the assets to do so.

These empirical findings on asset smoothing are consistent with a number of theoretical perspectives. While often overlooked, a standard model of the inter-temporal accumulation of productive assets can imply that lower wealth households (those with post-shock asset holdings well short of their desired steady-state levels) will exhibit asset smoothing behavior whereas wealthier households will not.[1] Multiple equilibrium poverty trap models (*e.g.*, see discussion in Barrett and Carter (2013)), in which accumulation behavior bifurcates around

[1]Deaton's (1991) deservedly influential model of risk and savings in the face of credit constraints obscures this point because it features a simple buffer asset with a non-diminishing (linear) rate of return (making it possible to impose impatience, which cannot hold under Inada condition). While the model implies constrained full consumption smoothing (assuming no autocorrelation), this result falls away for the case of productive assets which are held not just as buffer stocks but to generate income. As in the standard Solow model, agents with productive assets (capital) short of the steady level will exhibit a high savings rate because marginal returns to assets are quite high. In a stochastic model, this intuition implies that an agent short of the steady state who receives a negative shock to income or assets will substantially reduce consumption in the next period relative to an agent who is positively shocked away from the steady state. For this latter agent, the marginal benefits of additional assets is relatively modest and the agent will exhibit relatively smooth consumption.

a critical minimum asset threshold, amplify this asset smoothing logic. Specifically, for households in the vicinity of this threshold, assets have a strong dynamic/strategic value and incentivize asset smoothing.[2] Both the standard and the poverty trap models indicate that we should expect consumption and asset smoothing behavior to coexist in a population with strictly positive, but heterogenous, levels of assets.

Asset smoothing behavior lends particular importance to insurance and other risk management interventions. As Hoddinott (2006) points out, even though asset smoothing is an attempt to preserve assets, consumption is an input into the formation and maintenance of human capital. Hoddinott pointedly argues that, "The true distinction lies in households' choices regarding what type of capital - physical, financial, social or human (and which human) - that they should draw down given an income shock." While asset smoothing strategies may be rational (in some sense), they likely come at the cost of immediately reduced consumption, with potentially irreversible losses in child health and nutrition (Carter et al., 2007).

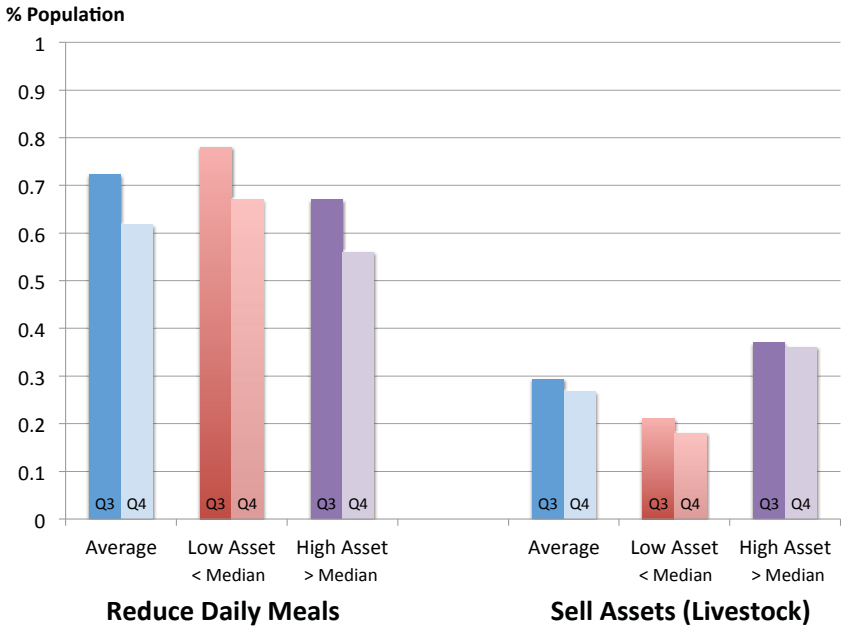
The outcomes of undernutrition and malnutrition are well known. In children, these conditions can lead to muscle wastage, stunting, increased susceptibility to illness, lower motor and cognitive skills, slowed behavioral development, and increased morbidity and mortality (Ray, 1998; Martorell, 1999). Those that do survive suffer functional disadvantages as adults, including diminished intellectual performance, work capacity and strength. In women, undernourishment during childhood can be the cause of lower adult body mass, which means increased risk of delivery complications and lower birthweights for the next generation (Martorell, 1999). These outcomes set the stage for a pernicious intergenerational cycle of undernutrition and its destructive effects. Even during adulthood, severe consumption cutbacks diminish muscular strength and increases susceptibility to disease. Such undernourishment in adults can also lead to a nutrition-based poverty trap if it decreases the capacity to do productive work (Dasgupta and Ray, 1986).

Figure 2.1 previews the coexistence of consumption and asset smoothing in the northern Kenya study area. The data underlying the figure are described in Section 4.2. The height of the bars represent the fraction of surveyed households that reported reducing daily meals and selling livestock during the third (Q3) and fourth (Q4) quarters of the 2011 drought year. On average, 60 to 70% of households reduced their daily meals, while almost 30% reported selling livestock to cope with the drought. In considering these figures, it is important to note that 95% of all surveyed households had some livestock that they could in principal have sold had they wished.

While Figure 2.1 shows that asset and consumption smoothing coexist, it also shows that the relative deployment of these strategies varies by household wealth. Arbitrarily splitting the sample around median livestock holding, we see that lower wealth households are roughly 10 percentage points more likely to reduce consumption relative to higher wealth households, and 15 percentage points less likely to sell assets. These differences in means are statistically significant by a standard t-test. In this context, insurance that indemnifies against large losses would seem to be able to protect consumption smoothing households from losing productive assets, while affording asset smoothing households a coping strategy that does not impair the human capital of current and future generations.

[2]See Carter and Lybbert (2012) for more details on how the irreversible consequences of falling below a critical threshold results in extreme asset smoothing behavior.

Figure 2.1: Coexistence of Consumption and Asset Smoothing



3 Prior Evidence on the Impacts of Microinsurance

Insurance is a market-based product which has the potential to act as a safety net (Barrett et al., 2007; Skees and Collier, 2008). It offers an alternative means of coping with negative shocks, allowing the potential smoothing of consumption and nutrition, as well as avoidance of costly asset depletion (Dercon et al., 2008). A growing literature has been devoted to studying the benefits of insurance for poor households in low income countries. This type of insurance (targeted to poor households, and available at low cost) has become known as microinsurance. Barnett et al. (2008), Dercon et al. (2008) and Cole et al. (2012) provide summaries of the literature. The literature highlights two primary avenues through which insurance might bring about positive impacts. These avenues reflect the fact that households make both *ex ante* risk management decisions and *ex post* risk coping decisions.

Section 2 suggests that poor households are limited in their ability to cope with risk *ex post*. Often such households are forced to choose between destabilizing critical consumption and depleting productive asset stocks, and either decision can result in permanent consequences. In the absence of insurance, there are several potential avenues for *ex ante* risk management, though all similarly involve tradeoffs. One option is to simply allocate resources toward activities with lower risk. However, these lower-risk activities generally produce a lower return. Another option is to build up precautionary savings, but such savings must come at the cost of (often critical) investment or consumption today. Households may also choose to reduce their risk exposure by diversifying crop choice, assets or other entrepreneurial activities, but such diversification is not always possible, and is only beneficial when the risk involved is not perfectly correlated across the various activities (Dercon et al., 2008).

Insurance provides an alternative risk management tool that may reduce the use of these

and other *ex ante* risk management strategies. By altering the ability of households to cope with risk *ex post*, insurance may also change optimal behavior before a shock is actually observed. To demonstrate this effect, de Nicola (2011) estimates a dynamic stochastic model of weather-related agricultural insurance. The model predicts that insurance will increase the adoption of riskier but more productive seeds, while simultaneously stimulating decreased investment, as households shift towards higher levels of consumption. This may reflect the idea that investment is a form of precautionary savings in the model. Janzen et al. (2013) use similar methods while accounting for a critical asset threshold, around which optimal behavior and equilibrium outcomes bifurcate. The Janzen et al. model shows that households above the threshold follow de Nicola's prescription: decreased investment and increased consumption as households move away from holding assets as precautionary savings. However, increased investment occurs around the threshold as households assume greater risk in order to attain higher productivity and a higher equilibrium.

Cole et al. (2012) conduct a systematic review of the effectiveness of microinsurance, and specifically index-based insurance, in helping smallholders manage weather-related risks. Their review identifies a substantial evidence gap in the literature on the impact of index-based microinsurance. Several papers have attempted to bridge this gap empirically, but all papers known to the authors focus on the impact of insurance on household's *ex ante* risk management strategies. These papers all show that insurance encourages investment in higher risk activities with higher expected profits. Mobarak and Rosenzweig (2012) provide evidence that farmers in India with access to insurance shift into riskier, but higher-yielding rice production. Cai et al. (2012) find that insurance for sows significantly increases farmers' tendency to raise sows in southwestern China, where sow production is considered a risky production activity with potentially large returns. Karlan et al. (2012) show that farmers who purchase rainfall index insurance in Ghana increase agricultural investment. Bellemare et al. (2013) find that cooperatives with access to area-yield index insurance for cotton increased risky cotton production (and subsequent cotton inputs) in Mali. Cai (2012) demonstrates that tobacco insurance increases the land tobacco farmers devoted to risky tobacco production by 20% in China, suggesting reduced diversification among tobacco farmers. The same paper also finds that insurance causes households to decrease savings by more than 30%, suggesting that households were building up extra savings in order to better smooth consumption in the case of a shock. Hill and Viceisza (2010) use experimental methods to show that in a game setting, insurance induces farmers in rural Ethiopia to take greater, yet profitable risks, by increasing (theoretical) purchase of fertilizer.

While the impacts of insurance on *ex ante* risk management decisions are important, none of these papers are able to assess how an insurance payout directly influences the ability of poor households to recover after a shock. This paper represents one of the first attempts to fill this gap by studying the impact of insurance on *ex post* risk coping decisions.

4 Research Setting and Data

This impact evaluation utilizes data from the index-based livestock insurance (IBLI) pilot project in northern Kenya's arid and semi-arid lands. This section provides background information about the research setting, the insurance pilot, and summary statistics from the

available data.

4.1 Drought Risk and the IBLI Insurance Pilot in Northern Kenya

More than 3 million pastoralist households live in northern Kenya's arid and semi-arid lands. The vast majority of these households rely on livestock for their primary livelihood. Previous analyses in this area provide empirical evidence of a poverty trap, suggesting that insurance may play an especially important role. Lybbert et al. (2004) and Barrett et al. (2006), for example, use different data and methods to demonstrate nonlinear asset dynamics, such that when livestock herds fall below a critical threshold, recovery becomes difficult, and herds tend to move toward a low level equilibrium. Toth (2012) hypothesizes that these nonlinear asset dynamics are due to a critical herd size necessary to support mobility. Small herds are restricted to degraded rangelands near the town centers, where growth becomes challenging. This problem is compounded by an absence of formal credit markets: households can't take out a loan to reach the dynamic asset threshold, thereby moving onto a higher welfare path[3]. Irrespective of whether poverty traps strictly exist in this environment, the evidence does suggest that asset losses in this environment have severe and long-lasting consequences.

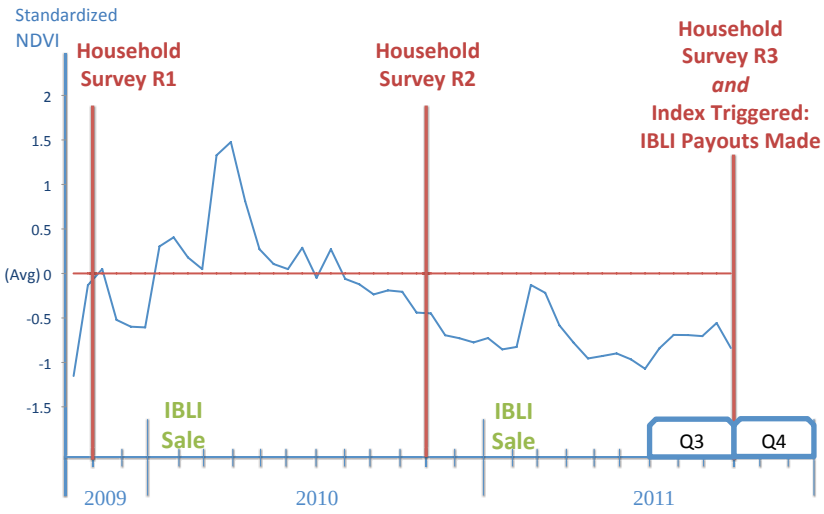
When drought hits this region, households confront large livestock losses, as well as decreases in current income flows and consumable by-products (such as milk) generated by livestock. According to the data used for this paper, in the recent drought that devastated the Horn of Africa in 2011, families lost on average more than one third of their animals. As we have already highlighted, during and after a drought, cash-strapped food-insecure households often have limited options for coping with the harsh effects of drought, and the options available often undercut future productivity.

In January 2010 the index-based livestock insurance (IBLI) pilot project was launched in Marsabit District of northern Kenya as a collaborative project of the International Livestock Research Institute, Cornell University, Syracuse University and the BASIS Research Program at the University of California Davis in an effort to help pastoralists manage drought risk. The IBLI index insurance contract uses satellite-based normalized difference vegetation index (NDVI) measures of available vegetative cover to predict average livestock mortality experienced by local communities. The IBLI index has been shown to be highly correlated with actual livestock mortality losses experienced by pastoralists in the region (see Chantarat et al., 2010, 2012 for details). Households choose the number of livestock they wish to insure, with the contract expressed in tropical livestock units (TLU), so that a single annual contract accommodates the various livestock species common in the region: goats, sheep, cattle, and camels.[4] The premium households pay depends on the risk associated with the geographic region in which they live (For example, Upper Marsabit is more susceptible to extreme drought than Lower Marsabit, so households insuring in Upper Marsabit pay a higher premium). Insured households receive any payouts at the end of each dry season, at the

[3]Santos and Barrett (2011) also show that access to informal credit is uneven across households and follows a pattern that would be expected in a world of poverty traps.

[4]In the IBLI contract, a goat or sheep is equal to .1 TLU, cattle are equal to a single TLU, and a camel is equal to 1.4 TLU.

Figure 4.1: Timeline of IBLI Sales, Surveys, Payouts and Standardized Area NDVI



beginning of October and again early in March, if the predicted average livestock mortality rate reaches the 15% deductible level, with the payout equal to the value of all predicted losses greater than 15%.

In order to study the impact of this insurance, IBLI was rolled out only in randomly selected districts within Kenya's arid and semi-arid lands. Within these "treatment areas," households were randomly selected for both information and price discounts meant to encourage purchase of the insurance. As part of this encouragement design, in each sales period 60% of surveyed households were randomly selected to receive coupons offering a 10-60% discount on the first 15 TLU insured. In addition, some households were randomly selected to participate in experimental games, which were used as a means of communicating the complex concepts of index insurance. The games were designed to demonstrate the intertemporal benefits of insurance by simulating herd dynamics over multiple seasons. They demonstrated that insurance would have to be purchased before the normal rainy season began, and for each subsequent year that coverage was desired. In addition, the games conveyed that indemnity payments were triggered by droughts, that IBLI would not cover non-drought-induced losses, and that if a drought did not trigger payments, the premium would not be returned (see McPeak et al., 2010 for details). Non-participants heard about IBLI from other participants, through village assemblies, by word of mouth or through local village insurance promoters. For the purposes of this analysis, we will focus only on data from the treatment area,[5] using the identification strategy detailed below.

Figure 4.1 depicts fortnightly NDVI averaged across the insured areas of Marsabit district over the 2010-2011 period in which the drought occurred. The measures are normalized by their long-term seasonal averages, so that if conditions had been statistically normal, the NDVI curve would appear in the graph as a horizontal line at zero. As can be seen, rangeland conditions began to deteriorate in late 2010 with the failure of the "long rains." Figure 4.1

[5]Data from control areas are collected by a different research organization on a different calendar which made it impossible to collect the information needed for this analysis in the control areas.

shows how the situation deteriorated throughout much of 2011 as a harsh drought swept across the Horn of Africa. The cumulative effect of these below average conditions triggered the first IBLI payouts in October-November 2011, as the predicted livestock mortality rose above the 15% deductible in all five insurance zones. These payouts were made to households who had purchased insurance earlier in the year. Households in our study received an average payout of about 10,000 Kenyan Shillings, or roughly $120. With a median family annual cash income of only $260 in the study area, these payments imply a substantial boost to families' cash on hand.

4.2 Data and Descriptive Statistics

The data available includes household-level information collected annually (beginning in 2009) for 673 randomly selected households living in various sub-locations across Marsabit district, all with access to IBLI.[6] In each round of the survey, households were asked to answer questions about health, education, livestock holdings, herd migration, livelihood activities, income, consumption, assets, and access to credit. Each household also participated in an experiment to elicit their risk preferences. In the surveys following the baseline, households were also asked questions about insurance purchases, access to information about insurance, and tested on their level of insurance understanding.

The third round of the panel survey coincided with the October-November 2011 IBLI payout. At that time, every household was asked about the ways in which they had been coping with the drought over the three months prior to the survey (Q3 of 2011, as shown in Figure 4.1), and how they anticipated coping with the drought over the 3 months following the survey (Q4). Specifically, households were asked about reliance each period on common coping behaviors, including selling livestock, reducing meals and relying on food aid. Insured households were asked about anticipated fourth quarter coping behavior after the enumerator told them exactly how much they would receive as an insurance payment. In a few cases, households had already received the payment prior to the interview. Most received the payment a week or two after the survey.

Table 1 reports summary statistics on key variables disaggregated by whether a household was insured during the 2011 drought. All households had the opportunity to insure, but only 24% had actually purchased insurance. The top four lines of the table report information for the coping measures that are the focal point of this analysis. As can be seen, with the exception of Q3 (pre-payout) livestock sales, insured and uninsured households behave quite differently. The differences are particularly pronounced for Q4 meal reductions (33% of insured households report cutting meals, whereas 71% of uninsured households report an intention to rely on that strategy), and Q4 animal sales (11% versus 32%). While these differences are statistically significant, the key question of course is whether they represent a causal impact, or simply a spurious correlation induced by the fact that different types of households chose to purchase insurance.

The second portion of Table 1 gives some preliminary insight into this question. While

[6] A larger sample was collected, but a substantial number (203) of observations were dropped due to a glitch in the data collection software used when the third round survey was initially launched. The glitch specifically affected the answers regarding household coping strategies during the drought.

Table 1: Summary Statistics

Variable	By Insurance Purchase			By Discount Coupon		
	Insured	Uninsured	Difference in Means	Received Coupon	No Coupon	Difference in Means
Probability Reduce Meals *(Q3, prior to payout)*	.64 (.04)	.75 (.02)	.11*** (.04)	-	-	-
Probability Reduce Meals *(Q4, after receiving payout)*	.33 (.04)	.71 (.02)	.38*** (.04)	-	-	-
Probability Sell Livestock *(Q3, prior to payout)*	.34 (.04)	.28 (.02)	-.06 (.04)	-	-	-
Probability Sell Livestock *(Q4, after receiving payout)*	.11 (.02)	.32 (.02)	.20*** (.04)	-	-	-
Years of Education, household head	.85 (.21)	1.18 (.15)	.340 (.293)	1.07 (.15)	1.17 (.21)	.104 (.259)
Risk-taking *(dummy=1 if risk-taking)*	.25 (.03)	.29 (.02)	.036 (.041)	.29 (.02)	.27 (.03)	-.011 (.036)
Risk-moderate *(dummy=1 if risk-moderate)*	.50 (.04)	.45 (.02)	-.050 (.045)	.45 (.02)	.48 (.03)	.036 (.040)
Non-livestock Asset Index 2011 *(from factor analysis)*	.12 (.10)	-.01 (.04)	-.134 (.094)	-.04 (.04)	.13 (.08)	.173** (.083)
Number of TLU Owned (Oct. 2010)	12.49 (1.11)	11.86 (.64)	-.631 (1.29)	11.85 (.61)	12.28 (1.08)	.427 (1.147)
Number of TLU Lost (between Oct. 2010-2011)	7.54 (.87)	7.64 (.50)	-.101 (1.02)	7.71 (.56)	7.46 (.69)	-.244 (.903)
Expected TLU Losses (between Oct. 2011-2012)	6.99 (.61)	7.46 (.36)	.466 (.732)	7.71 (.39)	6.73 (.52)	-.983 (.647)
Credit Constrained[a] *(dummy=1 if true)*	.42 (.04)	.38 (.02)	-.041 (.044)	.42 (.02)	.33 (.03)	-.084** (.039)
Participated in 2009 IBLI Game *(dummy=1 if true)*	.27 (.04)	.24 (.02)	-.029 (.039)	-	-	-
Received IBLI Discount Coupon *(dummy=1 if true)*	.88 (.03)	.56 (.02)	-.319*** (.042)	-	-	-
Value of IBLI Discount Coupon *(of: 0, 10, 20, 30, 40, 50, 60)*	23.79 (1.83)	16.52 (.96)	-7.27*** (1.98)	-	-	-
Observations	161	512		426	247	

Standard errors, including the standard errors of the difference in means, are reported in parentheses.
For the difference in means tests: *** p<0.01, ** p<0.05, * p<0.1.
[a] A household is classified as credit constrained if they say it's difficult to acquire a loan.

those that purchased insurance are slightly wealthier on average than those who did not,[7] the differences are not statistically significant. Education levels, risk attitudes and credit constraints also vary little between the groups, as do both realized and expected livestock losses.

While it is perhaps surprising that there are not stronger differences in observable characteristics between those who did and did not purchase insurance, these two groups may still differ along unobserved dimensions. The last three lines of Table 1 report the values for the information and discount coupon treatments that were randomly offered across the entire population. These descriptive statistics show that the discount coupons were effective in boosting up-take. Fully 88% of insurance purchasers received a coupon, whereas only 56% of non-purchasers received a coupon. The value of the coupon received also differs sharply between the two groups. As will be discussed in the section that follows, this encouragement design provides useful instruments for our endogenous regressor (insurance), being highly correlated with the decision to insure yet uncorrelated with the outcomes of interest except through purchase of insurance. In contrast, receipt of an invitation to play the insurance information treatment appears uncorrelated with the purchase decision.

5 Estimation Strategy and Results

While the descriptive statistics signal a statistically significant correlation between insurance coverage and third and fourth quarter coping strategies, these differences cannot be given a causal interpretation because the decision to purchase insurance was endogenous and perhaps correlated with factors expected to independently influence coping strategies. The goal of this section is to identify the causal impact of insurance by econometically exploiting a set of randomly distributed encouragements designed to boost insurance uptake. After explaining the basic identification strategy based on these instruments, the section next lays out a threshold-based method of testing for the presence of consumption and asset smoothers, and for the differential impacts of insurance on the behavior of these two groups. Finally, this section reports the key empirical results which find economically and statistically significant results for both asset and consumption smoothers, as predicted by theory.

5.1 Estimating the Average Impact of Insurance on Coping Strategies

The analysis of the impacts of insurance would be simplest if we could compare a cohort of households randomly assigned to an insurance "treatment" with a control group denied access to insurance. Although IBLI was implemented with a randomized spatial rollout, the data needed for the analysis here are available only within the treatment area (see Section 4.1 above). For this analysis we are thus limited only to a population in which all households

[7] In addition to livestock wealth, we also report summary statistics for a non-livestock asset index constructed from the first principle component using factor analysis. Variables used to generate the asset index include housing characteristics (such as materials used in the wall or for flooring in the house), cooking appliances, access to water, and possession of large assets such as a motorbike, boat, sewing machine, grinding mill or television.

had the opportunity to insure their livestock, though not all households chose to do so. Since households must self-select into purchasing insurance, we must account for selection into the insurance treatment.

In the absence of randomized treatment assignment, a variety of techniques exist to control for selection bias. These methods vary according to the underlying assumptions that must be made to use them. Because the endogenous decision to insure is likely to depend on unobservables, our preferred estimates are based on an instrumental variables (IV) approach. Using IV, selection bias on unobservable characteristics is corrected through the use of an appropriate instrument.

The encouragement design implemented with IBLI (as described in Section 4.2) provides three potentially suitable instruments: participation in an insurance game, receipt of an insurance coupon and the subsequent value of the discount coupon. All are the result of randomization, so none should be correlated with coping strategies, but we expect all to be correlated with insurance uptake. The descriptive statistics reported in Table 1 suggest that the coupon (both its receipt and value) is indeed highly correlated with the decision to insure, and thus constitutes a good instrument. Unfortunately, participation in the insurance game is not as highly correlated with insurance uptake as we might expect, and turns out to be a weak instrument which we do not use. The right hand columns of Table 1 also checks the balance of the covariates, to ensure that the receipt of the coupon was indeed random. Although coupons were distributed at random, households who received discount coupons are slightly less wealthy than households that did not recieve coupons, and they find it more difficult to obtain a loan.

Using IV we obtain the local average treatment effect of insurance on coping strategies. To obtain this effect, we estimate the following first stage regression equation, where I_i is an indicator variable equal to 1 if a household purchased insurance, Z_i is a vector of instrumental variables (including receipt and value of coupon), and X_i is a vector of covariates that influence a household's drought-coping behavior:

$$I_i = Z_i\,\delta + X_i\,\theta + v_i \tag{5.1}$$

We then estimate the impact of insurance (β) on y_i^Q (a binary indicator of household i's use of a particular coping strategy in quarter Q) with the following second stage regression:

$$y_i^Q = \beta\,\widehat{I}_i + X_i\,\phi + \varepsilon_i \quad , \tag{5.2}$$

where predicted insurance uptake ($\widehat{I}_i$) is obtained from the first stage estimation 5.1.

As with any encouragement design, there may be some concern that the encouragement itself induces an artificial selection into the program, with, for example, households expecting less benefit from the insurance purchasing it only because of the discount coupon. For the specific case of index insurance for pastoralists, this concern should be minimal as all households use the same production system and are subject to the same shocks. In addition, as analyzed in detail by Mullally (2012), the major barrier to the uptake of index insurance as a novel financial technology, appears to be trust and understanding of the contract, rather than heterogeneous willingness to pay for insurance. In this circumstance, encouragement coupons are likely to substantially reduce the mean square error of impact estimates.

Because the assumptions necessary for IV are minimal given the available data, this is our preferred approach. However, several alternatives to IV exist. Although we do not discuss or present alternative methods in this paper, we obtain very similar results using both matching and Heckman selection methods (see footnotes 9 and 10 below).

5.2 Testing for Consumption versus Asset Smoothing

As discussed in Section 2, a number of theoretical perspectives suggest that less wealthy households may hold on to (productive) assets in the wake of a shock rather than liquidate them to smooth consumption. Poverty trap theory suggests a particularly sharp discontinuity between conventional consumption smoothers and these asset smoothing households. Figure 2.1 shows that both asset and consumption smoothing behaviors are found in the data. The key question is whether all households pursue a mixed strategy, or whether there are really two distinctive behavioral regimes, as some earlier work has suggested is likely (*e.g.*, Carter and Lybbert (2012)). In the latter case, estimated average treatment effects (β in equation 5.2) would be a data-weighted average of the behavior in the two regimes that disguises how microinsurance works for any particular individual.

Drawing on the theoretical perspectives summarized in Section 2, we hypothesize that coping behavior will bifurcate as we move along a wealth or asset continuum. Above some critical or threshold wealth level, we expect the relatively asset rich households to largely smooth their consumption by destabilizing their asset stocks during a shock. We would thus expect that microinsurance will result in a reduction of asset sales for these asset rich households if insurance helps them to better protect their assets. In contrast, asset poor households below the hypothesized threshold would find that the intertemporal value of assets is extremely high, and thus be unwilling to part with their productive assets even at the cost of hunger. We would expect that microinsurance will help these asset poor households to better smooth consumption during a shock, even as they cling to their current asset stocks. In terms of our measures, insurance should lead to fewer meal reductions for these households, reducing current hunger and better protecting the human capital of their children.

Following Carter and Lybbert (2012), we explore these differential impacts of insurance on behavior by using Hansen's threshold estimation technique (Hansen, 2000) to test for the presence of a critical asset (livestock) threshold that splits our sample into two meaningfully different behavioral regimes based on a household's coping strategies. This procedure employs a likelihood ratio statistic to test for the threshold parameter. If a threshold is determined to exist, its location, A^*, is estimated and used to separate the sample into two regimes: asset poor households with fewer than A^* assets, and asset rich households who own A^* or greater assets. The threshold disaggregated impacts of insurance (β_{low} and β_{high}) are then estimated as follows:

$$y_i^Q = \begin{cases} \beta_{low}\, \widehat{I}_i + X_i\, \phi_{low} + \varepsilon_{i,low} & \text{if } A_i \leq A^* \\ \beta_{high}\, \widehat{I}_i + X_i\, \phi_{high} + \varepsilon_{i,high} & \text{if } A_i > A^* \end{cases} \tag{5.3}$$

where $\widehat{I}_i$ is the same as before and A_i is within vector X_i.

5.3 Impacts of Insurance Payouts on Anticipated Fourth Quarter Consumption and Asset Smoothing

In this section we present the results of the impact analysis using the combined IV and threshold estimation strategies. We present both population *average* impacts and threshold-disaggregated impacts. The details of the first stage probit selection equation used to obtain IV estimates are provided in Table 2. Because we use probit for the first stage regression, we report the Wald test for joint significance of the two instruments: receipt and value of the IBLI discount coupon. Each of these were the result of randomization, so we can be reasonably certain that they do not influence a household's response to the drought, except through the purchase of insurance.

We focus on the impact of an insurance payout on two primary outcomes of interest: *expected* livestock sales and *expected* reduction in the number of daily meals consumed. Selling livestock reflects an inability to protect assets, and meal reduction suggests an inability to smooth consumption. The results are presented for both outcomes in Table 3. Columns (1) and (4) show the population average impacts for livestock sales and meal reductions, respectively. Columns (2)-(3) and (5)-(6) present the threshold-disaggregated impacts.

Hansen's threshold estimator applied to anticipated livestock sales and meal reduction in Q4 yields a threshold estimate near the median herd size (which is 7.3 TLU) of $\hat{A}^* = 8.4$ TLU using livestock sales or $\hat{A}^* = 5.5$ TLU using daily meal reduction. Figures 5.1a and 5.1b present the likelihood ratio statistic and confidence interval for the threshold estimation. The horizontal axis displays the asset continuum and the test statistic is represented for every possible asset level where a threshold might exist. Under the null hypothesis, the threshold is not identified. Only when the test statistic falls below the indicated 95% critical value is there evidence that a threshold exists. For both figures, the range over which a threshold might exist is fairly narrow, stretching from about 5 to 11 TLU. For the purposes of this analysis, we choose the threshold value with the highest level of significance: the values that minimize the likelihood ratio test statistic in Figure 5.1a for livestock sales and Figure 5.1b for reducing meals. For both the livestock sales and meal reduction regressions, the estimated thresholds are significant at the 1% level, suggesting that the optimal behavioral response to the drought diverged around the estimated threshold, with households above and below these thresholds responding differently to the 2011 drought.[8]

Considering first the the impact of insurance on curbing the sale of productive assets, the results presented in Table 3 suggest that an insurance payout substantially reduces the probability that a household intends to sell livestock. The average impact results presented in Column (1) imply a 36 percentage point reduction in the number of households who anticipated selling livestock in the short run in order to cope with the 2011 drought.[9] This represents an overall reduction of about one half, relative to behavior without insurance.

[8] Although we use the optimal threshold in both cases, it's worth noting that a second threshold estimate for consumption behavior is significant at the 95% confidence interval. This second estimate is much closer to both the livestock sales threshold estimate and the Q3 threshold estimates presented in Section 5.4, suggesting that if a single behavioral threshold exists, then the sales threshold estimate may in fact be closer to the true threshold value.

[9] Heckman selection methods yield an estimate of a 27% point drop, while matching methods yield an average impact of a 30% point drop. Full results are available from the authors.

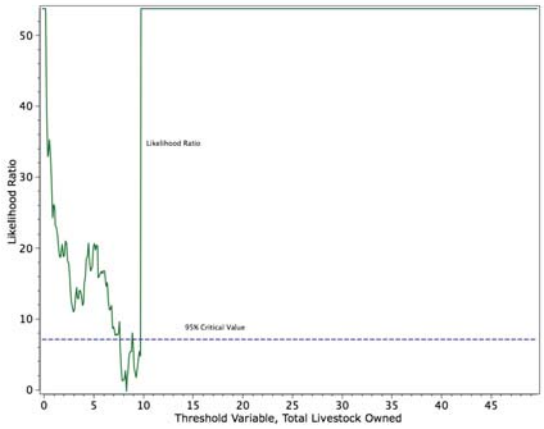
Table 2: Demand for Insurance: First Stage Probit Selection Regression

	(1)
Received IBLI discount coupon *(instrument #1)*	1.466***
	(0.203)
Value of IBLI discount coupon *(instrument #2)*	-0.004
	(0.004)
Years of education (head)	-0.040
	(0.025)
Risk-taking	0.175
	(0.159)
Risk-moderate	0.205*
	(0.124)
Non-livestock asset index	0.221**
	(0.086)
TLU owned	0.007
	(0.005)
TLU losses in past year	-0.000
	(0.005)
Expected TLU losses	-0.005
	(0.009)
Credit constrained	0.041
	(0.119)
Ethnicity fixed effects	yes
Location fixed effects	yes
Observations	662
Pseudo R^2	0.261
Wald test for joint significance of instruments	84.18

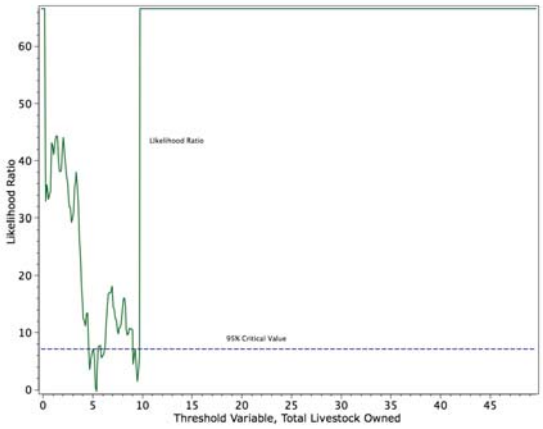
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 5.1: Threshold Significance Tests

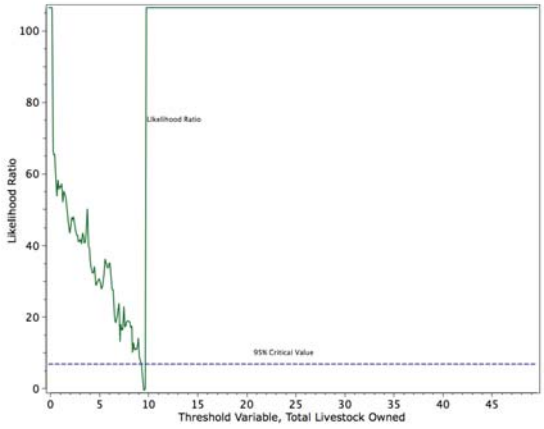
(a) Q4 Post-payout Livestock Sales



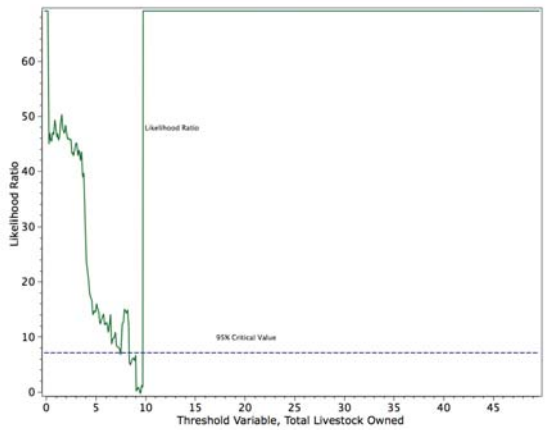
(b) Q4 Post-payout Meal Reduction



(c) Q3 Pre-payout Livestock Sales



(d) Q3 Pre-payout Meal Reduction



However, as the threshold-disaggregated results show, this average impact is largely driven by the behavior of asset rich households. Column (2) indicates a small and statistically insignificant impact of insurance on livestock sales for poor households, relatively few of whom sell off livestock even in the absence of insurance. In contrast, Column (3) shows that asset rich households are 64 percentage points less likely to plan on selling livestock after receiving the insurance payout. These results suggest that insurance helps stop the households prone to give up productive assets from engaging in that costly coping strategy which would otherwise damage their productive asset base, harming the household's future income-earning potential.

As discussed earlier, when poor households endeavor to maintain scarce productive assets during a shock, it often imposes a high cost on consumption. Columns (4)-(6) of Table 3 report the estimated impact of insurance on meal reduction as a coping strategy. Focusing first on the local average treatment effect in Column (4), an insurance payout results in a 25 percentage point drop in the number of households that anticipate decreasing the number of meals eaten each day when under stress from a drought.[10] Overall, this is a reduction of about one third. But as with livestock sales, the average effect again disguises two quite distinctive behavioral regimes. Columns (5)-(6) show that the magnitude of the insurance impact on meal reduction (consumption destabilization) is larger for asset poor households. Poor households, who are most likely to destabilize consumption as a coping strategy, are 43 percentage points less likely to reduce the meals eaten in their household when an insurance payout is received. The impact of insurance on expected consumption destabilization for richer households is much smaller, and not significantly different from zero. This latter result is not surprising given that wealthier households already consumption smooth (through asset sales) even absent insurance.

In summary, these results indicate that receipt of an insurance payment allows households to reduce their reliance on often costly autarchic coping strategies.[11] For modestly better off households, insurance allows households to continue to defend their usual consumption standard without relying on costly livestock sales at depressed prices. For less well-off households, insurance allows them to better smooth consumption while holding on to stocks of productive assets. This latter result is of particular importance as it suggests that these households do not undercut the growth and future potential of children.

[10]Both Heckman and matching methods estimated the average impact of insurance to be a 37% point drop in reliance upon meal reductions as a way to cope with the drought.

[11]In this section we have tested multiple hypotheses. Intuitively, the more hypotheses we check, the higher the probability of making a Type I error. The Bonferroni-Holm method is one way to address this issue of a familywise error rate. We conduct the Bonferroni-Holm test using the calculated p-values for each of the threshold-disaggregated insurance impact coefficients. Using this method, we fail to reject the null hypothesis of joint significance for the key *ex post* impacts of insurance: insurance improves the ability of asset rich households to smooth assets, and strengthens the capacity of asset poor households to smooth consumption.

Table 3: Impacts of Insurance Payouts on Anticipated Q4 Consumption and Asset Smoothing

	Impact #1			Impact #2		
	Q4 Post-Payout Sell Livestock			Q4 Post-Payout Reduce Meals		
	(1)	(2)	(3)	(4)	(5)	(6)
	Average	Asset Poor < 8.4 TLU	Asset Rich > 8.4 TLU	Average	Asset Poor < 5.5 TLU	Asset Rich > 5.5 TLU
Insured (instrumented)	-0.359***	-0.211	-0.644***	-0.247**	-0.430**	-0.167
	(0.114)	(0.133)	(0.190)	(0.121)	(0.166)	(0.181)
Years of education	-0.001	-0.008	0.011	0.000	0.001	-0.001
	(0.005)	(0.006)	(0.009)	(0.007)	(0.010)	(0.010)
Risk-taking	0.036	0.048	0.015	-0.075	-0.060	-0.120*
	(0.045)	(0.056)	(0.068)	(0.049)	(0.074)	(0.061)
Risk-moderate	-0.013	-0.003	-0.036	-0.011	-0.034	-0.036
	(0.040)	(0.051)	0.062	(0.046)	(0.074)	(0.057)
Asset index	0.0123	0.041	-0.027	-0.059**	-0.044	-0.071*
	(0.023)	(0.027)	(0.043)	(0.024)	(0.037)	(0.033)
TLU owned	0.006***	0.029***	0.004**	0.000	0.011	-0.001
	(0.001)	(0.009)	(0.002)	(0.001)	(0.015)	(0.001)
TLU losses past year	0.003	-0.001	.0004**	-0.003	-0.012***	-0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
Expected TLU losses	-0.004*	0.002	-0.008***	0.003	-0.012***	0.007***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)	(0.002)
Credit constrained	0.027	0.087**	-0.006	0.055	0.058	0.048
	(0.034)	(0.041)	(0.055)	(0.037)	(0.053)	(0.051)
Ethnicity fixed effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	662	359	303	662	286	376
R^2	0.164	0.121	0.263	0.172	0.200	0.260

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4 Impacts of Anticipated Insurance Payouts on Third Quarter Consumption and Asset Smoothing

In addition to the behavioral changes made upon receipt of a payout, we are able to explore whether or not the anticipation of an insurance payment altered behavior prior to receipt of a payout. Referring to Figure 4.1, we see that rangeland conditions had steadily deteriorated over the course of 2011. The IBLI insurance team regularly posts information on the state of the insurance index following the methodology laid out in Carter et al. (2011). By the third quarter of 2011, insured individuals would have both been suffering losses in income and livestock as well as receiving information that an insurance payout was likely. Because the survey on which this study is based took place at the end of the third quarter, we had the opportunity to query respondents about the coping strategies they had employed in Q3. As reported in Figure 2.1, some 70% of households had reduced the number of daily meals in the third quarter and another 30% were selling off livestock assets in order to cope with the drought.

Before exploring whether or not insurance caused changes in Q3 behavior, it is worth thinking through the likely impacts that anticipated insurance payments would have on the behavior of both consumption smoothing and asset smoothing households. For the former, we might expect anticipated payments to have no impact, under the realistic assumption that an anticipated payment cannot be used to secure loans. That is, consumption smoothing households anticipating payments would still be expected to sell assets exactly like uninsured households in order to defend their normal consumption standard in Q3. Thus, for wealthier, consumption smoothing households, we would expect to see no Q3 impact of insurance on livestock sales.

In contrast, we might expect insured asset smoothing households to alter Q3 behavior, if they had confidence that an insurance payment was about to be made. That is, insured asset smoothing households might be expected to less severely restrict consumption in Q3 compared to uninsured asset smoothers if they are willing to dip into food stores or other savings, or engage in temporary asset sales because of the eminent payout. We thus might expect insurance to cause asset smoothers to consume more (reduce meals less) in Q3 and perhaps engage in some asset sales, as a way to provide the liquidity for the additional consumption.

Militating against this kind of Q3 coping strategy is the fact that livestock prices had already dropped by about 70% in Q3 (Ng'etich, 2011), making it costly to sell animals at that time. In addition, it isn't obvious that insured individuals would have had sufficient confidence in the insurance to alter their coping strategy in fundamental ways prior to an actual receipt of a payout. During focus group interviews held in mid 2010, households reported a "wait and see" attitude towards insurance, indicating a lack of trust in the product until a payout was actually observed. Given that no IBLI payout had occurred prior to 2011, it therefore seems likely that many households would be unwilling to adjust behaviors in Q3, suggesting that Q3 impacts might be smaller than the Q4 impacts in Table 3, even for asset smoothers.

To explore these ideas empirically, we employ the econometric approach laid out in Section 5 and again estimate average and threshold-disaggregated impacts of insurance on consumption and asset smoothing behaviors in Q3, immediately prior to the insurance payout. Table

4 presents the results in which the purchase of insurance is again instrumented using the specification reported in Table 2. For both the asset sales and meal reduction regressions, there are again statistically significant thresholds, which are similar in magnitude to the post-payout estimates: $\hat{A}^* = 9.7$ TLU for pre-payout livestock sales, and $\hat{A}^* = 9.6$ TLU for pre-payout meal reduction. Figure 5.1c and 5.1d present the likelihood ratio test statistic at each possible value of the asset threshold, showing that the threshold estimates are both significant at the 1% level. Note that the data generating these estimates have the benefit of being based on reports of coping behavior that had already taken place, rather than the stated intentions of the Q4 data.

The results themselves are largely consistent with expectations. For asset rich, consumption smoothing households, insurance has no impact on either meal reduction or asset sales. This finding is what would be expected for these households irrespective of whether or not they trusted the insurance.

Interestingly, despite some qualitative evidence of distrust in insurance, it is estimated that insurance significantly reduced asset poor households' reliance on consumption destabilization strategies, even before the payout is received. The point estimate–a 29% percentage point reduction in reliance on meal reduction as a coping strategy–is about two thirds of the impact estimated in the Q4, post-payout data. There is no evidence, however, that insured asset poor households engaged in Q3 asset sales in order to fund these higher consumption levels. One likely explanation is that these households were more willing to spend down other sources of savings in Q3 in the expectation of an upcoming insurance payment.

6 Conclusion

When adverse shocks strike in developing countries, poor households are often forced to choose between drawing down their physical productive assets or their human capital. Either way, uninsured risk may have permanent consequences if the household's choice undermines its future productivity. In this paper we assess whether insurance can function as a safety net, protecting assets and smoothing consumption, thereby improving the human capital of future generations. Our findings suggest that IBLI insurance payouts in Marsabit district of northern Kenya during the drought of 2011 provided substantial immediate benefits to insured households. On average, insured households who receive a payout are much less likely to sell livestock, improving their chances of recovery. Insured households on average also expect to maintain their current food consumption, rather than reduce meals as their uninsured neighbors do.

We also show that households in our sample behave quite differently depending on their asset holdings. Using Hansen's threshold estimator, we cannot reject at the 1% level the hypothesis that there are two, quite distinctive behavioral regimes, with distinctive insurance impacts. Livestock-poor households were more likely to smooth assets and destabilize consumption, whereas livestock-rich households were more likely to smooth consumption during the 2011 drought. One reason (although certainly not the only reason) why we might anticipate a threshold disaggregated behavioral response to drought is the presence of a structural poverty trap.

These findings indicate that simply estimating the average effect of insurance may mask

Table 4: Impacts of Anticipated Insurance Payouts on Q3 Consumption and Asset Smoothing

	Impact #1			Impact #2		
	Q3 Pre-Payout Sell Livestock			Q3 Pre-Payout Reduce Meals		
	(1)	(2)	(3)	(4)	(5)	(6)
	Average	Asset Poor < 9.7 TLU	Asset Rich > 9.7 TLU	Average	Asset Poor < 9.6 TLU	Asset Rich > 9.6 TLU
Insured (instrumented)	-0.063	-0.043	-0.076	-0.197*	-0.295**	-0.155
	(0.109)	(0.128)	(0.184)	(0.111)	(0.128)	(0.207)
Years of education	-0.000	-0.003	0.005	-0.003	-0.000	-0.010
	(0.005)	(0.007)	(0.008)	(0.006)	(0.006)	(0.012)
Risk-taking	0.003	0.068	-0.067	-0.042	0.048	-0.190***
	(0.046)	(0.053)	(0.072)	(0.046)	(0.057)	(0.069)
Risk-moderate	-0.043	0.006	-0.126*	-0.000	0.051	-0.085
	(0.041)	(0.048)	(0.064)	(0.042)	(0.053)	(0.066)
Asset index	0.036	0.056*	-0.031	0.001	0.006	0.036
	(0.024)	(0.029)	(0.045)	(0.024)	(0.028)	(0.049)
TLU owned	0.004***	0.014*	0.005**	-0.001	0.010	0.001
	(0.001)	(0.007)	(0.002)	(0.001)	(0.007)	(0.002)
TLU losses past year	0.001	0.006	0.002	-0.003	-0.006	-0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
Expected TLU losses	-0.004*	0.010***	-0.012***	0.003	-0.010***	0.014***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Credit constrained	-0.050	0.056	-0.189***	0.127***	0.094**	0.124**
	(0.035)	(0.043)	(0.058)	(0.034)	(0.040)	(0.059)
Ethnicity fixed effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	662	392	270	662	389	273
R^2	0.200	0.189	0.353	0.165	0.189	0.256

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

an interesting heterogenous impact of insurance. The threshold-disaggregated estimates show that insurance helps stop the households most likely to give up productive assets from reducing their asset base, otherwise harming the household's future income-earning potential. In addition, insurance helps prevent those households most likely to reduce consumption from doing so, thereby protecting vulnerable household members from undernutrition and malnutrition, and improving the human capital of future generations. Considered jointly, these impacts imply that insurance functions as a flexible safety net, allowing smoothing of consumption and nutrition, while preserving productive assets and future livelihoods. In this way, insurance promotes asset smoothing without having the deleterious long term consequences of destabilized consumption.

These results come at a critical time for policymakers. There has recently been a grand push from development agencies to scale up microinsurance pilots with the goal of reaching a larger number of households. This push has transpired in spite of an incomplete understanding of microinsurance impacts. The results presented here provide some of the first empirical evidence that insurance can improve outcomes when negative strikes occur. We recognize that our main results are based on immediate expectations regarding a specific insurance pilot project, and are therefore not immediately generalizable. Indeed, further impact analyses will help to generalize the results more broadly. However, this research provides an important first step. If the declared intentions of pastoralists in northern Kenya closely follow their true behavior, which we believe they will, then the highly anticipated long term positive welfare impacts of IBLI and other similar microinsurance projects are likely to be observed in the near future.

References

Barnett, Barry J., Christopher B. Barrett, and Jerry R. Skees, "Poverty Traps and Index-Based Risk Transfer Products," *World Development*, 2008, *36* (10), 1766 – 1785.

Barrett, Christopher B. and Michael R. Carter, "The Economics of Poverty Traps and Persistent Poverty: Empirical and Policy Implications," *Journal of Development Studies*, 2013, *49* (7), 976–990.

_ , Barry J. Barnett, Michael R. Carter, Sommarat Chantarat, James W. Hansen, Andrew G. Mude, Daniel Osgood, Jerry R. Skees, Calum G. Turvey, and M. Neil Ward, "Poverty Traps and Climate Risk: Limitations and Opportunities of Index-Based Risk Financing," Technical Report 07-02, IRI September 2007.

_ , Francis Chabari, DeeVon Bailey, Peter D. Little, and D. Layne Coppock, "Livestock Pricing in the Northern Kenyan Rangelands," *Journal of African Economics*, June 2003, *12* (2), 127–155.

_ , Paswel Phiri Marenya, John McPeak, Bart Minten, Frank Place, Jean Claude Randrianarisoa, Jhon Rasambainarivo, and Justine Wangila, "Welfare dynamics in rural Kenya and Madagascar," *Journal of Development Studies*, 2006, *42* (2), 248–277.

Bellemare, Marc F., Ghada Elabed, Michael R. Carter, and Catherine Guirkinge, "Impact Evaluation of an Area-yield Index Insurance Contract for Cotton Farmers in Mali," 2013.

Cai, Hongbin, Yuyu Chen, Hanming Fang, and Li-An Zhou, "The Effect of Microinsurance on Economic Activities: Evidence from a Randomized Field Experiment," 2012.

Cai, Jing, "The Impact of Insurance Provision on Households' Production and Financial Decisions The Impact of Insurance Provision on Households' Production and Financial Decisions," October 2012.

Carter, Michael R. and Travis J. Lybbert, "Consumption versus asset smoothing: testing the implications of poverty trap theory in Burkina Faso," *Journal of Development Economics*, 2012, *99* (2), 255 – 264.

_ , Elizabeth Long, and Andrew G. Mude, "The IBLI Color Legend: Translating Index-Based Mortality Predictions into Meaningful Signals," *I4 Brief*, 2011, (2).

_ , Peter D. Little, Tewodaj Mogues, and Workneh Negatu, "Poverty Traps and Natural Disasters in Ethiopia and Honduras," *World Development*, 2007, *35* (5), 835 – 856.

Chantarat, Sommarat, Andrew G. Mude, Christopher B. Barrett, and Michael R. Carter, "Designing Index-Based Livestock Insurance for Managing Asset Risk in Northern Kenya," *Journal of Risk and Insurance*, 2012, pp. no–no.

_ , Andrew Mude, Christopher Barrett, and Calum Turvey, "The Performance of Index Based Livestock Insurance in the Presence of a Poverty Trap," 2010.

Cole, Shawn, Gautam Gustav Bastian, Sangita Vyas, Carina Wendel, and Daniel Stein, "The effectiveness of index-based micro-insurance in helping smallholders manage weather-related risks," Technical Report, EPPI-Centre, Social Science Research Unit, Institute of Education, University of London 2012.

Dasgupta, Partha and Debraj Ray, "Inequality as a Determinant of Malnutrition and Unemployment: Theory," *The Economic Journal*, December 1986, *96* (384), 1011–34.

de Nicola, Francesca, "The Impact of Weather Insurance on Consumption, Investment, and Welfare," July 2011.

Dercon, Stefan, Martina Kirchberger, Jan Willem, and Jean Philippe Platteau, "Literature review on microinsurance," Technical Report 1, International Labour Office, Geneva 2008.

Hansen, Bruce E., "Sample Splitting and Threshold Estimation," *Econometrica*, May 2000, *68* (3), 575–603.

Hill, Ruth Vargas and Angelino Viceisza, "An Experiment on the Impact of Weather Shocks and Insurance on Risky Investment," Discussion Paper 00974, IFPRI May 2010.

Hoddinott, John, "Shocks and their consequences across and within households in Rural Zimbabwe," *Journal of Development Studies*, 2006, *42* (2), 301–321.

Jalan, J. and M. Ravallion, "Are the poor less well insured? Evidence on vulnerability to income risk in rural China," *Journal of Development Economics*, 1999, *58* (1), 61–81.

Janzen, Sarah A., Michael R. Carter, and Munenobu Ikegami, "Valuing Asset Insurance in the Presence of Poverty Traps," October 2013.

Karlan, Dean, Robert Darko Osei, Isaac Osei-Akoto, and Christopher Udry, "Agricultural Decisions after Relaxing Credit and Risk Constraints," NBER Working Papers 18463, National Bureau of Economic Research, Inc October 2012.

Kazianga, Harounan and Christopher Udry, "Consumption smoothing? Livestock, insurance and drought in rural Burkina Faso," *Journal of Development Economics*, April 2006, *79* (2), 413–446.

Kerven, Carol, *Customary Commerce: A historical reassessment of pastoral livestock marketing in Africa*, Overseas Development Institute, 1992.

Lybbert, Travis J., Christopher B. Barrett, Solomon Desta, and D. Layne Coppock, "Stochastic wealth dynamics and risk management among a poor population," *The Economic Journal*, 2004, *114* (498), 750–777.

Martorell, Reynaldo, "The nature of child malnutrition and its long-term implications," *Food & Nutrition Bulletin*, 1999, *20* (3), 288–292.

McPeak, John, Sommarat Chantarat, and Andrew Mude, "Explaining index-based livestock insruance to pastoralists," *Agricultural Finance Review*, 2010, *70* (3), 333–352.

Mobarak, Ahmed Mushfiq and Mark Rosenzweig, "Selling Formal Insurance to the Informally Insured," Working Paper 97, Yale University, Department of Economics February 2012.

Mullally, Conner, "Perceptions and Participation: Research Design with Low Program Enrollment and Heterogeneous Impacts in Development," April 2012.

Ng'etich, Peter, "Livestock prices drop by 70 percent in arid zones," *Business Daily*, August 9 2011.

Ray, Debraj, *Development Economics*, Princeton University Press, 1998.

Santos, Paulo and Christopher B. Barrett, "Persistent poverty and informal credit," *Journal of Development Economics*, 2011, *96* (2), 337–347.

Skees, Jerry R. and Benjamin Collier, "The Potential of Weather Index Insurance for Spurring a Green Revolution in Africa," Technical Report, GlobalAgRisk, Inc. 2008.

Toth, Russell, "Traps and Thresholds in Pastoralist Mobility," November 2012.

Townsend, Robert M., "Risk and Insurance in Village India," *Econometrica*, May 1994, *62* (3), 539–591.