Developing Index-based Livestock Insurance for Managing Livestock Asset Risks in Northern Kenya

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This study develops an index-based livestock insurance (IBLI) product for managing key livestock asset risks of pastoralists in the arid and semi-arid lands of northern Kenya, where insurance markets are effectively absent and uninsured risk exposure is a main cause of persistent poverty. It uses a combination of field experiments and surveys conducted in summer 2008, and pre-existing household-level panel data sets in: (1) designing a market-viable contract; (2) conducting ex-ante household-level welfare analysis; and (3) eliciting willingness to pay (WTP) for the product among the targeted population. IBLI offers compensation based on a predicted location aggregate livestock mortality index constructed from a strong statistical relationship between household herd mortality rates and high quality, objectively verifiable, remotely-sensed measures of vegetative cover on rangelands that are not manipulable by insured parties. It thus has potential to resolve the transaction costs and asymmetric information problems that cripple traditional insurance. The presence of a threshold-based poverty trap in East African pastoralism leads to nonlinear IBLI valuation, as found both in the simulation-based welfare analysis and in WTP estimates elicited through field surveys and experiments. This implies that IBLI could be both a commercially viable insurance product for better-off pastoralists, as well as a pro-poor instrument to use as a safety net for pastoralists vulnerable to losing their herds and collapsing into chronic poverty. The IBLI contract originally designed in this study has been slightly modified and launched in a pilot in January 2010 in the Marsabit district of northern Kenya by a Kenyan commercial insurer with retail distribution/brokerage by a leading private financial institution, international reinsurance by Swiss Reinsurance, with the International Livestock Research Institute (ILRI) leading the effort and the associated monitoring and evaluation program.

Background and Methods

In Kenya's arid and semi arid lands (ASALs), catastrophic livestock loss, especially induced from drought, is the most pervasive hazard encountered by households on a widespread level. This is especially true for northern Kenya, where more than 3 million pastoralist households are regularly hit by increasingly severe droughts. In the past 100 years, northern Kenya recorded 28 major droughts, four of which occurred in the last 10 years. For livelihoods that rely solely or partly on livestock, the risk – and especially the realization – of catastrophic livestock mortality losses has devastating effects, driving them into extreme poverty and making it difficult for them to escape once they fall destitute.

The economic and social returns to an effective program that insures the pastoral and agro-pastoral population against catastrophic livestock losses can be substantial. First, because it provides indemnity payments after a shock, livestock insurance should help stem the collapse of vulnerable-but-presently-non-poor households into the ranks of the poor following a drought due to irreversible losses from which they do not recover. Second, insuring assets against catastrophic loss lessens the high risk of investment in such environments. This should improve incentives for households to build their asset base and climb out of poverty. Third, private creditors presently

unwilling to lend for such ventures due to the covariate risk associated with big shocks like drought might become willing to lend if the assets that secure their loans could be insured. Insurance can thereby "crowd-in" much-needed credit for enterprises in the region without leaving poor ASAL residents excessively vulnerable to losing assets when nature fails them.

Formal insurance, especially against covariate livestock loss, is rarely available for small-scale pastoral households in high risk, infrastructure-deficient areas due to problems of asymmetric information, transaction costs and covariate risk. Index based livestock insurance (IBLI) offers a means to fill in this missing market. In contrast to traditional insurance, which makes indemnity payments based on the actual loss of the insured, IBLI pays out based on an objectively and transparently measured index (e.g., rainfall, predicted livestock loss based on objectively measured vegetative condition, etc.) that is strongly associated with insurable loss but cannot be influenced by both contract parties.

By construction, IBLI thus avoids the twin asymmetric information problems of adverse selection and moral hazard as no contract party can influence the probability of insurance payment. Transaction costs of monitoring

and verification of the insurance contracts can also be substantially reduced, as now insurance companies and insured clients need only monitor the index to know when a claim is due and indemnity payments must be made. They do not need to confirm the veracity and cause of individual losses. Finally, properly indexing locally covariate risk opens up opportunities for risk transfer into a broader risk pool via international capital markets. These advantages, however, come at a cost of spatial or intertemporal "basis risk", which results from the necessarily imperfect correlation between the index and any individual's loss experience.

Given these tradeoffs and the novelty of the IBLI concept – especially among a previously-uninsured population – the key challenges in developing IBLI in northern Kenya were: (1) identifying high quality data that could serve as an objectively measured indicator – it has to be available cost-effectively in near-real-time and not manipulable by contract parties; (2) statistically establishing a an optimal insurance index based on a strong relationship between household-level livestock loss and the objectively measured indicator; (3) crafting contract terms that are easy to understand and that match the risk management needs of the targeted clientele; and (4) building informed demand for the contract among a target clientele largely unfamiliar with insurance.

To address these challenges, we focus our study on five locations in Marsabit District in northern Kenya, where extensive prior research has identified covariate livestock mortality as a key uninsured risk faced by communities and where there already exist two sources of household-level panel data sets: (i) an annual one from the Government of Kenya's Arid Land Resource Management Project (ALRMP), from 2000-present, and (ii) quarterly data 2000-2002 from the USAID Global Livestock Collaborative Research Support Program's (GL-CRSP) "Improving Pastoral Risk Management on East African Rangelands" (PARIMA) project.

Normalized Difference Vegetation Index (NDVI). NDVI represents the best candidate for a high quality, objectively measured indicator of covariate risk of livestock loss in this region. Constructed from data remotely sensed from satellites, NDVI reflects the level of photosynthetic activity in the vegetation observed in a given location. As livestock in pastoral production systems depend almost entirely on available forage for nutrition, NDVI serves as a strong indicator of the vegetation available for livestock to consume.

Surveys and experiments. In-depth household and community field surveys and simple experiments were conducted in the five study locations. The community survey was first fielded among approximately 15-20 key informants to present the concept of IBLI, exchange ideas and solicit their impressions and opinion about the appropriate contract design. A more in-depth household survey was then conducted in June-

July 2008. Forty-two (42) households in each location were randomly drawn using sampling stratified by three livestock wealth classes. These sampled households were later brought together to take part in an experimental game designed to replicate existing pastoral production systems, which we used to illustrate how IBLI would work. Having educated participants on the general structure of IBLI, we then returned to each household for a follow-up interview where we used contingent valuation methods to elicit and understand respondents' willingness-to-pay (WTP) for insurance. The research methodology uses the survey data to complement existing data sets in designing the IBLI contract, performing simulation-based welfare analysis and studying WTP patterns.

Findings

Designing the IBLI contract. An empirical forecasting relationship between seasonal area-average livestock mortality and vegetation index was estimated using 10 years of ALRMP and NDVI data. The NDVI series were standardized to control for heterogeneity of non-climate factors across locations. Due to the cumulative nature of drought-induced livestock loss, cumulative vegetation variables were constructed as the main explanatory variables. The seasonal forecasting relationships were estimated using a regime switching model, where the cumulative vegetation outcome observed at the end of the season determines the regime (either good-vegetation year or bad-year regime) for which the empirical relationship between NDVI and livestock mortality was established. This approach captures how livestock mortality response to vegetation conditions differed between good and bad rainfall years.

Ultimately, two spatially distinct clusters were identified, one for the Chalbi (a very arid zone of camel and smallstock-based pastoralism) and the other for Laisamis (a semi-arid zone with cattle and smallstock-based pastoralism). The predictive relationships performed very well out-of-sample (when tested against the PARIMA data), predicting household-specific mortality loss with 87% probability of forecasting errors within 10% of the true value, and correctly triggering insurance payout 75-88% of the time.

A location-specific predicted seasonal livestock mortality index can then be constructed based on historical observations of NDVI data and the regime switching model estimates. Seasonal IBLI contracts were developed for each location using these predicted livestock mortality indices to trigger insurance payments. Pastoralists pay the premium before the season starts and receive an indemnity payment at the end of the season if the predicted morality index exceeds the pre-specified strike level. Both the premium and the indemnity are proportional to the total value of livestock insured, which the pastoralist chooses. The actuarially fair seasonal premium rates vary across locations due to

heterogeneity in vegetation condition, from 2.2-4.9% of total insured livestock value for a 10% strike contract, down to 0.5-1.5% for a 20% strike contract. Risk exposure analysis of the insurance underwriter suggested that a high degree of spatial and temporal aggregate risk diversification could be achieved with IBLI.

Simulated welfare analysis of IBLI contract. We then conducted an ex ante evaluation of the effectiveness of IBLI in northern Kenya, where prior empirical research has found strong evidence of threshold-based poverty traps characterized by at least one herd threshold of around 15 tropical livestock units (TLU) below which livestock accumulation collapses, and above which livestock grows over time to a much higher equilibrium herd size. We built a dynamic structural model of household wealth dynamics and parameterized it using rich panel data from ALRMP, PARIMA and experimental risk preference data elicited in the 2008 survey. The simulations allowed us to establish the likely welfare effects of IBLI and to investigate patterns of household-specific willingness to pay for this asset index insurance.

The simulation results indicate that the welfare effects of IBLI vary greatly across households. Due to the asset threshold-based poverty trap, IBLI is most valuable to vulnerable non-poor households when it protects their herd from falling beneath the critical threshold and thus helps them avert a collapse into destitution. It provides the least welfare improvement for the poorest households, who are already beneath the herd size threshold and for whom paying for IBLI premium accelerates their decline into destitution. The largest, non-vulnerable herd owners benefit significantly from IBLI as well, although not as much as the vulnerable non-poor. The estimated welfare effects of IBLI are thus highly nonlinear in individual herd size, peaking for those at or slightly above the critical herd threshold. Initial herd size thus was found to be the key dominating determinant of IBLI performance in this setting, not basis risk, location or individual risk preferences.

Since the greatest value of IBLI arises due to its provision of an effective safety net, we then explored the likelihood of commercial uptake among those who might otherwise need assistance. For the 10% strike contract that has the greatest estimated welfare effects, only those with relatively large herds would be willing to pay commercial mark-ups (above actuarially fair rates) of at least 20%, corroborating our survey evidence that WTP among vulnerable groups may not suffice to stimulate uptake of commercially viable contracts, which typically have mark-ups of 30-50% to cover insurer costs and profits. We then used simulations to show that targeted subsidization of IBLI premiums might serve quite effectively as a safety net program. Indeed, this appears more cost-effective in reducing headcount poverty measures than direct need-based transfers to the poor.

Investigating demand for IBLI using field experiments. IBLI demand estimated using structural dynamic simulation models can be compared with the estimated willingness-to-pay (WTP) based on survey data. Pastoralists were asked to decide what proportion of their herd they would wish to insure. Then, conditional on their chosen proportion, they were asked a sequence of dichotomous WTP questions, responses to which were used to form bounds for their unobserved WTP. We then estimated WTP conditional on household-specific characteristics.

Wealth, risk preferences, perceived basis risk and a herder's subjective expectation of herd loss are the key WTP determinants, conditional on understanding how IBLI works. The mean proportion of herd that respondents chose to insure was nearly 70%. Mean WTP only marked up the actuarially fair rate by an average of 15%, not enough to generate effective demand for a commercially viable contract. As in the simulation-based analysis, estimated aggregate demand appears highly price elastic. At a 30% mark up on actuarially fair rates, effective IBLI demand drops to only 16% of the sample. Those households most vulnerable to falling into a poverty trap exhibited the highest price elasticity of demand, despite their potentially higher dynamic welfare gains from the insurance.

Practical Implications

The IBLI contract originally designed in this study has been slightly modified and launched in a pilot in January 2010 in the Marsabit district of northern Kenya by a Kenyan commercial insurer, UAP Provincial Insurance Company Ltd., with retail distribution/brokerage by a leading private financial institution, Equity Bank, and international reinsurance by Swiss Reinsurance, with the International Livestock Research Institute (ILRI) leading the effort and the associated monitoring and evaluation program. This outcome is very encouraging. But it also opens up further research questions the team intends to pursue.

First, complex index insurance products can be difficult to understand, especially for populations with low levels of literacy and minimal previous experience with formal insurance products. Preliminary field experiments show significant promise for simulation games played by prospective insurance purchasers as a means for both explaining how index insurance products work and generating product demand (Lybbert et al., 2009).

Second, development of cost-effective agent networks for reliable, low-cost product marketing and service remains a challenge. In the northern Kenya IBLI case, our commercial partners can tap into a network of local agents equipped with electronic, solar rechargeable point-of-sale (POS) devices being extended throughout northern Kenya by a commercial bank working with the central government and donors

on a new cash transfer program. These POS devices can be easily configured to accept premium payments and to register indemnity payments for certain insurance contracts. Financial sector interests are attracted by the potential economies of scope involved in introducing another range of products for devices otherwise used purely for government transfers and debit payments. It remains to be seen how large these economies of scope will prove and how replicable this model will be without the fortuitous existence of a POS network.

Third, IBLI underwriters and their commercial partners must make difficult choices in balancing the administrative simplicity and marketing appeal of offering IBLI contracts priced uniformly over space and time, versus more complex pricing to guard against the possibility of spatial or intertemporal adverse selection. Little is known about these tradeoffs.

These implementation challenges notwithstanding, IBLI shows considerable promise in the pastoral areas of East Africa. By addressing serious problems of covariate risk, asymmetric information and high transactions costs that have precluded the emergence of commercial insurance in these areas to date, IBLI offers a novel opportunity to use financial risk transfer mechanisms to address a key driver of persistent poverty. The basic design should be replicable in other locations where covariate risk exposure is significant and existing insurance products do not adequately meet households' insurance needs. Extended time series of remotely sensed data are available worldwide at high quality and low cost. Wherever there also exist longitudinal household-level data on an insurable interest (livestock, health status, crop yields, etc.), similar types of index insurance can be designed using the basic techniques outlined here.

Further Reading

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