How basis risk and spatiotemporal adverse selection influence demand for index insurance: Evidence from northern Kenya

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\textbf{Abstract}

Weather-related shocks are a major threat to the health and livelihoods of vulnerable farmers and herders in low-income, arid, and semi-arid regions of the world. Index insurance represents a promising tool for mitigating the impacts of such risk but in practice has exhibited low uptake rates by potential clients. Basis risk—the remaining risk faced by an insured individual—is widely acknowledged as the Achilles heel of index insurance, and yet direct measurements of basis risk have never been used to study its role in determining demand for index insurance. Further, client knowledge of season-specific environmental information and spatial variation in basis risk introduces the possibility of adverse selection, a feature often presumed to be absent for index products. We used longitudinal household data to determine which factors affected demand for index based livestock insurance (IBLI). While both price and the non-price factors studied previously are indeed important, our findings indicate that basis risk and spatiotemporal adverse selection also play a major role in determining demand for IBLI.

1. Introduction

Risk management interventions have become a priority for social protection programs and development agencies as the enormous cost of uninsured risk exposure—especially to the rural poor—has become increasingly and widely appreciated. Improved risk management through insurance is hypothesized and in some cases has been shown to mitigate the impacts of shocks, crowd in credit access, induce investments in productivity, support informal social transfers, improve food security, and generally stimulate growth and poverty reduction (Barnett et al., 2008, 2007; Boucher et al., 2008; Giné and Yang, 2009; Hellmuth et al., 2009; Hess et al., 2005; Jensen et al., 2017; Karlan et al., 2014; Lybbert and Sumner, 2012; Skees and Collier, 2008; Skees et al., 2006, 2007; Hellmuth et al., 2009; Hess et al., 2005; Skees and Collier, 2008; Skees et al., 2006; Zeller and Sharma, 2000). Although insurance products offer a proven means to manage risk through formal financial markets, asymmetric information problems—adverse selection and moral hazard—and high fixed costs per unit insured effectively preclude conventional indemnity insurance for many smallholder crop and livestock farmers in developing countries.

Index insurance products have generated excitement over the past decade as a promising approach to address these obstacles (Barnett et al., 2008, 2007; Hellmuth et al., 2009; Hess et al., 2005; Skees and Collier, 2008; Skees et al., 2006). These products use easily observed, exogenous signals to provide insurance coverage for covariate risk. Anchoring indemnity payments to external indicators and not to policyholders’ realized losses eliminates the need for claim verification, a particularly costly process in remote areas having poor infrastructure, and mitigates the familiar incentive challenges associated with moral hazard and adverse selection that plague traditional insurance products. These gains do come at a cost, however; “basis risk” is the...
residual risk borne by those with insurance coverage due to the imperfect association between experienced losses and indemnification based on index values. Furthermore, a form of adverse selection may persist if prospective purchasers have information about expected indemnity payments that the product’s pricing does not reflect. Such adverse selection could reflect inter-temporal information on upcoming conditions that would affect insured covariate risk (such as climate forecasts) or knowledge that the effective loading (subsidy) rate varies across space—either of which would have implications for demand patterns and insurer profits.

Growing interest in index insurance has resulted in a proliferation of pilot programs across the developing world. For example, since 2003, the Global Index Insurance Facility (GIIF), which provides technical and financial support to index insurance programs across sub-Saharan Africa, Asia, Latin America, and the Caribbean, “has facilitated more than 1.8 million contracts, covering approximately 8 million people” (http://mailchi.mp/worldbank/global-index-insurance-facility-newsletter-March-2390953). At the same time, the pilot projects have prompted a burgeoning literature addressing various aspects of theoretical and applied concerns related to the design, implementation, and assessment of index insurance products (Barrett and Mahul, 2007; Barrett et al., 2007; Binswanger-Mkhize, 2012; Chantarat et al., 2017; Clarke, 2016; Jensen and Barrett, 2017; Miranda and Farrin, 2012). Although its celebrated promise, the uptake of index insurance in pilot programs worldwide has been generally low, and no examples demonstrating clear success with a demonstrable capacity for scalability or sustainability over the long run have appeared (Hiazell and Hess, 2010; Leblois and Quiron, 2013; Smith and Watts, 2009). As a result, research on index insurance has focused on identifying barriers to insurance uptake. The existing literature has found demand for index insurance to be price sensitive, and, with one exception, uptake has been low even at heavily subsidized prices (Cole et al., 2013; Hill et al., 2016; Karlan et al., 2014; Mobarak and Rosenzweig, 2012). With evidence that price plays only a small role in determining demand, researchers have turned to examining that of household-specific, non-price factors. Risk aversion, wealth, financial liquidity, understanding of the product, trust in the provider, and access to informal risk pooling have been commonly shown to exert significant, although sometimes inconsistent, impacts on demand (Cai et al., 2011; Chantarat et al., 2009; Clarke, 2016; Cole et al., 2013; Dercon et al., 2014; Giné et al., 2008; Janzen et al., 2013; Liu and Myers, 2016; McIntosh et al., 2013; Mobarak and Rosenzweig, 2012; Pratt et al., 2010).

Although basis risk and the possibility of adverse selection related to spatial or temporal heterogeneity unaccounted for by the premium structure (henceforth “spatiotemporal adverse selection”) are widely understood as prospective weaknesses of index insurance, empirical research has thus far not directly explored the role that either of these product-related factors plays in influencing product uptake. But if index insurance is imperfectly correlated with the stochastic welfare variable of interest (e.g., income, assets), then index insurance may offer limited risk management value; indeed, purchasing such a product can even increase, rather than decrease, purchasers’ risk exposure (Jensen et al., 2016). Furthermore, prospective purchasers may have access to information on the variation in covariate risk associated with space and/or time, thereby reintroducing the prospect of adverse selection.

Although both basis risk and adverse selection could affect uptake and pose a risk to insurers’ profits, these prospective weaknesses have not been carefully researched; research to date only includes a few studies that use coarse proxies for idiosyncratic risk—a component of basis risk—and those studies rely on hypothetical and untested relationships between the proxies and basis risk (Karlan et al., 2014; Mobarak and Rosenzweig, 2012). To the authors’ knowledge, no study examines the role of spatiotemporal adverse selection in demand for index insurance. This lacuna arises primarily because the vast majority of products fielded remain unable to determine the level of basis risk inherent in their product design; they lack the required data because the products were designed from data series of index variables (e.g., rainfall, crop growth model predictions), not from longitudinal data of household assets or income from the target population to be insured.

The research described in this paper fills this important gap. Employing an unusually rich longitudinal dataset from northern Kenya, a research design that included randomized inducements to purchase index-based livestock insurance (IBLI), and a randomized IBLI education intervention that improved understanding of IBLI, the research examined the role of basis risk and spatiotemporal adverse selection on index insurance uptake. Ours was the first research to use observed data on losses to examine the role of basis risk in demand for index insurance in a low-income country context. In addition, specific features of the contracts and data allowed us to examine the impact of adverse selection on demand, a topic wholly unstudied with respect to index insurance because it is often assumed to be nonexistent or negligible.

Echoing the prior literature, we found that price, liquidity, and social connectedness affected demand in the expected ways. In addition, increased basis risk was associated with lower demand, and households’ responses to basis risk were stronger among those with experimentally increased knowledge of IBLI. Although we argue and provide evidence that basis risk is almost surely exogenous, we were unable to vary it experimentally and so can make no causal claims.

Furthermore, demand patterns we observed were consistent with spatiotemporal adverse selection. Spatially, households in divisions exhibiting greater average losses (insurable risk) and those in divisions with less basis risk had greater demand for index insurance. Again, response to basis risk, i.e., average division basis risk, was stronger among those that had a better understanding of the product. Inter-temporally, households were more likely to purchase insurance and to purchase greater coverage before seasons in which remotely sensed data indicated coming covariate threats, tendencies with large implications for underwriters’ profits. Additional analysis of the relationship between subjective expectations with respect to impending rangeland conditions and demand showed that households also respond to private information concerning future conditions.

These findings suggest that product design is an extremely important factor. Thus, while expensive, collecting household-level demand and loss data is crucial to improve the quality of products offered and to monitor the effects of basis risk and adverse selection on demand and insurer profits, two important elements of any insurance project.

The remainder of this paper is organized as follows. Section 2 discusses risk among pastoralists in northern Kenya and the motivation for and design of the IBLI product they were offered. Section 3 develops a stylized model of livestock ownership and the role of insurance, which is then developed into four hypotheses on the structural determinants of demand. Section 4, which presents the research design and data, is followed by an explanation and summary of key variables in Section 5.
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