Background Paper

Barriers to adoption of products and technologies that aid risk management in developing countries

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BARRIERS TO ADOPTION OF PRODUCTS AND TECHNOLOGIES THAT AID RISK MANAGEMENT IN DEVELOPING COUNTRIES

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April 2013

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I. Introduction

Risk is an important facet of life in developing countries. Households are subject to both aggregate risks - droughts, floods, and other natural disasters, price volatility of agricultural outputs; lack of off-farm income-generating opportunities due to market frictions and seasonality; as well as idiosyncratic risks, such as sickness, theft, mortality (Dercon, 2008; Dercon, 2009; Dercon & Christiaensen, 2011). Low-income households have to manage unpredictable income streams and expenditure needs in an environment where basic safety nets are limited or non-existent. Consumption shortfalls and income fluctuations can have devastating and long-lasting welfare consequences, especially among young children and the most economically disadvantaged families (Jensen, 2000; Gertler & Gruber, 2002; Dercon & Hoddinott, 2004; Gubert & Robilliard, 2008).

There is extensive literature on risk management in developing countries documenting various strategies used by low-income households to manage daily risks and to protect themselves against income instability (Coate & Ravallion, 1993; Bhattamishra & Barrett, 2010). Evidence from several countries shows that risk induces rural households to engage in costly measures ex-ante that minimize income fluctuations, but cause farmers to forgo potentially profitable, risky opportunities (Rosenzweig & Binswanger, 1993; Carter et al., 2007; Morduch, 1995). Risk-coping strategies can be either ex-ante (before any adverse shock) - such as accumulation of savings and assets for precautionary purposes; or actions taken ex-post, such as borrowing and lending in formal and informal markets, or seasonal migration to diversify income sources (Udry, 1994; Townsend, 1995; Lim & Townsend, 1998; Fafchamps & Lund, 2003; Yang & Choi, 2007). Informal risk sharing between members of social networks is another commonly employed risk management scheme, but all evidence suggests that the insurance provided by informal networks is incomplete (Townsend 1994; Udry 1994; De Weerdt & Dercon, 2006), even among family members and spouses (Dercon & Krishnan, 2000; Duflo & Udry, 2003). Table 1 compares some common risk management, transfer and coping mechanisms available in high- and low-income countries, highlighting stark differences in the types of risk management options.

Poor households in rural areas of developing countries do have a few risk management tools available to them that have been shown to successfully mitigate important components of the risks that they are exposed to. These include financial products like index insurance (Mobarak and Rosenzweig 2012), other technologies like mobile phones that can provide updated market price information.
information for agricultural products in real time (Aker 2011) or reduce frictions in remittance transfers (Jack and Suri, forthcoming), and innovative behaviors like seasonal migration away from lean seasons in poor agrarian areas (Bryan, Chowdhury and Mobarak 2012). However, even when such products are made available to poor households, they are often unwilling to invest in them (Cole et al 2012, Gine and Yang 2010). The rural poor’s aversion to adopting financial products, technologies and behaviors that help them manage risk, uncertainty and consumption fluctuations is therefore important to identify and understand for us to develop a comprehensive risk mitigation and management policy. The low adoption rates could stymie economic growth, and have important implications for anti-poverty policy.

This background paper will not attempt to discuss all the economic and incentive issues relevant to risk management, but will instead focus on two specific aspects related to demand conditions:

(1) To review the latest state-of-the-art literature on the demand for insurance, for seasonal migration and for cell phone services relevant to risk management, in an effort to understand and elaborate on the precise reasons that adoption of risk management tools are being held back, and

(2) To broaden the scope of the discussion to the puzzlingly low demand for other types of income-generating and (ex-ante) risk-mitigating technologies, products and behaviors, because consumer behavior in these markets also hold important lessons for designing risk management and mitigation policies. Here we seek to highlight the most salient important aspects of human decision-making, and constraints facing poor households that keep the market penetration of welfare-improving products low. Prominent examples of such risk-management products include health-saving technologies like insecticide-treated bednets, improved cookstoves or nutritional supplements (all of which make future adverse health shocks less likely), agricultural technologies like fertilizer and improved seed varieties (which may be drought-resistant and make future adverse shocks to farmer livelihoods less likely), or financial instruments like savings (which allows poor households to self-insure). We also hope to identify remaining knowledge gaps and suggest direction for future research
Table 1. Agricultural Risk Management Tools: Low and High-Income Countries

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Supplementing agricultural income with locally-available off-farm work is common risk-management strategy worldwide. Access to other labor markets creates new opportunities for earnings and human capital investment that change the relative costs of both on and off-farm activities. Banerjee and Duflo (2007) document an extremely high fraction of households reporting that they earn income from more than one type of activity: from 10-20% in Nicaragua, Panama, Timor Leste and Mexico, to 50% in Indonesia, 72% in Cote d'Ivoire, 84% in Guatemala and 94% in Udaipur, India. The types of work vary, but typically include day labor or small entrepreneurship. Kochar (1995) argues that engaging in several kinds of economic activities—more so than informal borrowing—is a primary method of smoothing consumption in India: by increasing wage income, small, medium and large farm households in India are able to compensate for 45%, 62% and 41% (respectively) of small income shocks due to crop loss. Similarly, Giles (2006) documents that increased access to off-farm labor reduces households’ exposure to agricultural shocks.
However, lack of local employment opportunities during the off-season and concurrent downward pressure on local wages often prevent reallocation of labor from the family farm to off-farm work. Temporary migration for work from rural to urban areas is a common response to the lack of local employment opportunities in many developing countries. It has been a crucial income-smoothing strategy in many developing countries. Globally 740 million people migrate internally—nearly four times the number of international migrants (U.N. Human Development Report 2009). The rates of internal migration vary widely: For instance, in Udaipur, India, 60% of the poorest households report that at least one household member had migrated for work in the past year (Banerjee & Duflo, 2007), and estimates in China show about 23% of working age laborers working outside their home county (De Brauw & Giles, 2008). In recent decades, temporary migration for work has become the dominant form of internal labor mobility, outpacing permanent rural-to-urban migration (Deshingkar, 2006).

Policies to support or regulate internal migration are high on the agenda of many policymakers and development practitioners. Many believe that liberalization of internal labor mobility is a more effective policy for poverty reduction than international migration, and it is central to the urbanization process in the developing countries. Internal migration requires lower upfront costs than international migration and internal remittances can reach a much broader base of poor families. In addition, internal migrants constitute an important factor in domestic labor force which can address seasonal labor shortages in labor-intensive sectors in urban and semi-urban areas and improve market efficiency (Deshingkar, 2006). Temporary or circular migration offers migrants access to urban capital and earnings opportunities while allowing them to maintain access to land and agricultural employment at the origin.

2.2. The Returns to Migration

Much research attention has been directed to estimating the impacts of international migration, particularly in the context of labor market effects in receiving countries. This is largely due to lack of reliable and consistent data on internal mobility, especially in the developing countries. In addition, estimating the returns to migration is hampered by the selection problem. Simple comparisons of economic outcomes among migrant and non-migrant households produces biased results because households that choose to send a temporary migrant are likely to be different from non-migrant households in both observable and unobservable ways that are also correlated with their outcomes. Selection bias is a central methodological concern in migration literature, and the
direction of the bias is not clear a priori. For instance, McKenzie, Gibson and Stillman (2010) find that the selection bias may be substantial among Tongans migrating to New Zealand: due to positive selection non-experimental methods overestimate the gains from migration by 20-82%. Studies in this literature have used many different approaches to address selection bias. For instance, McKenzie et al. (2010), Gibson et al. (2010) and Clemens (2010)\(^2\) rely on quasi-natural experiments that exploit sudden changes in government immigration policies, while De Brauw and Harigaya (2007) and Du et al. (2005) use instrumental variable techniques. Martinez and Yang (2005) and Yang (2008) study the effects of natural variation in economic conditions at the migration destination.

These micro-data based studies generally report positive and substantial contributions of international migration to migrant income, but the effects on family members at the origin are less clear. McKenzie, Gibson and Stillman (2010) estimate a 263% increase in income from migrating to New Zealand after just one year, while Gibson et al. (2011) find ambiguous effects of international migration on several important socioeconomic outcomes such as household investment decisions, consumption and expenditure on health and education. By contrast, Yang (2008) finds that a positive (exogenous) shock to the value of remittances set by Filipinos leads to increased educational expenditures, enhanced entrepreneurship, and no effect on current consumption at the origin, while Martinez and Yang (2005) document reduced poverty rates as a result of positive income shocks. Other research finds that migration and remittance flows are positively correlated with household investment decisions (see Yang 2011 for a comprehensive discussion). A growing body of literature finds that overseas remittances provide insurance against consumption shocks at the origin (Yang and Choi, 2007; Clarke and Wallsten, 2004), and Katz and Stark (1986) show that remittances are used to finance rural investments in developing countries.

Rigorous empirical evidence on the impacts of internal migration is scarce (Human Development Report 2009). In a recent randomized controlled trial by Bryan et al. (2013), a sub-set of households in rural Bangladesh received a small financial incentive (equal to a round-trip bus ticket) to migrate to the nearest urban destination during the lean season, known as Monga. This small financial incentive induced 22% of households to send a seasonal migrant to a nearby urban area (Figure 1).

\(^2\) For instance, McKenzie et al. (2010) and Gibson et al. (2010) exploit unique policy in New Zealand which allows a quota of Tongans to immigrate each year. Since a random ballot is used to choose among excess number of applicants, those not selected to migrate by lottery create a valid comparison group.
This study offers among the first experimental evidence of large returns to seasonal migration. Specifically, the authors find that consumption at the origin increased by 30-35% among family members of induced migrants, and their caloric intake improved by 550-700 calories per person per
Most strikingly, households in the treatment areas continue to migrate at a higher rate even after the incentive is removed: The migration rate is 10 percentage points higher in treatment areas a year later, and this figure drops only slightly to 8 percentage points 3 years later.

2.3 Barriers to Migration

Given such high returns to seasonal migration, it is puzzling why households in Bangladesh chose not to take advantage of off-farm temporary employment when faced with a threat of famine. The problem of low levels of labor mobility, despite high returns, is not confined exclusively to rural Bangladesh: many households in developing countries fail to take advantage of opportunities presented by temporary migration and often families who stand to gain the most are the least mobile (Deshingkar, 2006).

There are various reasons that explain relatively low levels of temporary internal migration in the developing countries. Mobility is often restricted. Well-known examples of administrative restrictions on domestic mobility include hukou system in China, bo khan in Viet Nam and propiska in the Soviet Union. Segmentation is widespread in many other countries and regions where barriers are of social and cultural in nature (Human Development Report 2009). Even if mobility is unrestricted, migration is inherently a risky endeavor because it requires an upfront payment in exchange for often uncertain return. Katz and Stark (1986) note that migration constitutes an actuarially unfair risk since income earnings at the destination are often not being guaranteed prior to the migrant’s arrival. Indeed, behavior under such risk is central to understanding why low-income households in many developing countries are hesitant to engage in temporary or seasonal migration, and there are several theoretical models linking risk-aversion to poverty traps (Mosley & Verschoor, 2005; Yesuf et al., 2009).

When outcomes are uncertain and there are no means of insuring against potentially unsuccessful migration, households may refuse to temporarily migrate, even when the likelihood of the negative outcome is small. Bryan et al. (2013) develop a theoretical model showing that risk aversion can explain low temporary migration from famine-prone rural Bangladesh during the lean season. Temporary migration carries considerable risk due to probability of not finding employment at the destination and wasting precious resources on travel and accommodations at the time when these resources are scarce. Faced with uncertainty about employment opportunities, rational households choose not to migrate, even though they expect a positive return. Consistent with the model, the authors find that households who are very poor (those living close to subsistence) were
less likely to migrate prior to program because they faced the greatest threat in case of a failed attempt to secure employment, but they also were more responsive to the incentives provided. The fact that households continued to migrate years after the initial intervention is suggestive of a positive learning experience at the migration destination, at least for some households. Offering households a chance to learn about the benefits of temporary migration or allowing them to establish a relationship with a potential employer may be an effective strategy to encourage future migration. Another potential solution is insuring against failure. A case in point is an additional set of experimental treatments in rural Bangladesh, one of which offered a migration insurance product to cover losses associated with migration due to excessive rainfall at the destination which can have an adverse effect on employment opportunities (Bryan et al., 2013). Demand for such insurance contract turned out to be substantial and statistically just as effective in encouraging migration as conditional credit. For the subset of migrants for whom the insurance program design was particularly appropriate (those who had an affinity for the destination at which rainfall was measured on which insurance payouts were based), insurance had an even larger effect on migration propensity.

Facilitating internal labor mobility from low- to high-productivity areas may be an effective policy instrument for managing key sources of risk in the developing countries, but more rigorous research is necessary to develop proper policy responses. Migration affects risk management in two dimensions: (a) it allows for income diversification for the migrant and his immediately family, and (b) it may allow the migrant to remit money and better share risk with other network members. Future research should address key open questions along both these dimensions, including the role of migrant control over remittances and their remitting decisions; sensitivity of remittance flows to the costs of sending remittances; and general equilibrium effects of temporary migration, both at the origin and at the destination. The advent of mobile phone technology, which we discuss later, has a potential to reduce transaction costs with remittances and increase risk sharing. Muto (2012) finds that mobile phones facilitate temporary migration in search of off-farm job opportunities in Uganda by strengthening communication and improving information flows within social networks. An emerging body of research poses new questions about trans-national household finance (Seshan & Yang, 2012) and the effects of lowering barriers to savings and remitting (Aycinena et al., 2010; Chin et al., 2010; Ashraf et al., forthcoming). Finally, we need to learn more about the conditions of migrants at the destination, including work conditions and safety, access to basic services, and human capital and skill investment.
2.4. Index-based weather insurance

Agriculture is the primary economic activity for nearly three-fourth of the 1.3 billion people worldwide living on less than US $1 per day (World Bank, 2005). Agricultural output in low-income countries is sensitive to seasonal rainfall: low or poorly distributed precipitation can lead to massive harvest loss (Ginè et al., 2008; Hazell et al., 2010; Cole et al., forthcoming). In India only 43 percent of the total cultivated land has a functioning irrigation facility (Rao, 2013). Lack of irrigation infrastructure exacerbates vulnerability of rural households to the whims of nature, especially in regions where agriculture is primarily rainfall-dependent. Faced with weather-related risk, farmers take actions to shield themselves against agricultural income variability but often at the expense of more profitable opportunities: as Rosenzweig and Binswanger (1993) have shown, low-income farmers in areas of high agricultural risk choose to plant drought-resistant crops that have lower variance but also lower returns; or they may be reluctant to invest in agricultural inputs such as improved fertilizer that would be lost in the event of a flood or drought.

Emerging empirical evidence also links household income shocks to lasting, long-term effects on the quality of their livelihoods, especially on children’s health and development (Jensen, 2000; Dercon & Hoddinott, 2004; Carter et al., 2007; Gubert & Robilliard, 2008; Baird et al., 2011; Friedman & Sturdy, 2011; Rabassa et al., 2012). Climate change, accompanied by rising temperatures of the atmosphere, rising sea levels and more intense extreme weather events, is projected to have far-reaching implications for future weather patterns and agricultural production, imposing greater burden on the most vulnerable households (Aguilar & Vicarelli, 2011).

Recent technological innovations in automated weather stations has facilitated the development of innovative index-based weather insurance (WII), a promising lower-cost alternative to traditional yield-based insurance products. Index insurance can indemnify against the primary production risks in rural areas and thereby address under-investment in productive but risky agricultural technologies. Indeed, WII has sparked much interest among development researchers and practitioners: Hazell et al. (2010) cites at least 36 pilot WII projects that are underway now in 21 developing countries as diverse as Ukraine, India, Nicaragua and other countries. India is one of the pioneers in the rainfall insurance markets, enjoying strong government support. The government of India has recently begun promoting index-based weather insurance as a way to mitigate the economic impacts of unpredictable monsoons and climate change. Two private insurers, ICICI Lombard General Insurance Company and IFFCO Tokio General Insurance Company, currently offer index-based insurance (Hazell et al., 2010). The government also funds the Agriculture
Insurance Company of India (AIC), a public company offering several indexed insurance products. In an attempt to boost demand for weather insurance among farmers, the government of India has allowed public and private index insurance programs to take advantage of subsidies, making the premium more affordable.

WII is a relatively simple and transparent insurance contract in which indemnity payments depend on publicly observable index (such as the amount and timing of rainfall) over a specified period of time, that is correlated with (or serves as a proxy for) on-farm losses. By de-linking indemnification from individual risk-taking decisions, in theory well-designed WII can address key challenges undermining the spread of conventional yield-based insurance products in rural areas (Hazell et al., 2010). WII addresses moral hazard and adverse selection problems because payouts do not depend on any farmers’ type or actions. Also, the administrative costs of implementing the insurance scheme are drastically reduced because individual policyholder field assessments are not required to make decisions on payouts, and it is no longer necessary to collect individual risk exposure information. Figure 2 shows an example of WII product where index is based on the amount of rainfall measured at the local weather station (Mobarak & Rosenzweig, 2012). Three triggers or thresholds determine the amount of potential payouts.

Figure 2. Example of rainfall index insurance contract

Source: Mobarak and Rosenzweig (2012). Payout is made if less than 30-40mm of rainfall is received at each trigger point
2.5 Effects of Weather Insurance, and the Low Take-up

Rigorous empirical evidence on the impact of rainfall insurance on production decisions and household welfare is nascent, but emerging findings are promising. Karlan et al. (2012) explore the impacts of providing farmers in northern Ghana with cash grants, grants or access to rainfall insurance or both on their investment decisions and agricultural income. Their study finds that agricultural investments respond strongly to the rainfall insurance grant, but there are relatively small effects of the cash grant. Specifically, farmers with insurance are found to invest 13% more in cultivation, 24% more in chemical fertilizer use, and 13% more in land preparation costs (such as tractor rental). Fuchs and Wolff (2011) study the effects of WII using quasi-natural experimental data in the timing of the rollout of insurance across rural counties in Mexico between 2002 and 2008. They find that WII had a positive impact on maize yields at the county level (6% increase) and also had a positive association with household per capita income and expenditures. Mobarak and Rosenzweig (2012) document greater investment in higher-yield agricultural technologies as a result of access to rainfall insurance.

Despite salient contracting features and gains in terms of agricultural productivity, take up rates for index-based insurance products have been surprisingly low, even when actuarially-fair rainfall insurance contracts are offered (Cole et al., forthcoming). This observation poses a puzzle: if insurance products have the potential to improve outcomes of low-income farmers, why is there no greater interest in this product?

Several recent field experiments, set primarily in India, explore various price and non-price factors that help to explain low take-up of WII, including liquidity constraints, contract complexity, trust, and limited liability credit (Ginè et al., 2008; Ginè et al., 2011; Gine & Yang, 2009; Cole et al., forthcoming; see Cole et al. 2012 for a comprehensive review of existing studies). In order to estimate price sensitivity of demand for WII, researchers randomly vary the price of the insurance product. Cole et al. (forthcoming) find that demand is highly price-sensitive in three Indian states: a 10 percent decline in the price of insurance increases the probability of purchase by 3.07 percentage points, or 10.4 percent of the baseline take-up rate (corresponding elasticity is 1.04). They conclude that due to high price sensitivity of demand, the take-up of WII at a large scale is not feasible, even if the insurance product is heavily subsidized. In contrast, Mobarak and Rosenzweig in their experimental study find households to be relatively less responsive to price changes: specifically, they find that a 50% subsidy increases probability of take-up by almost 18 percentage points (or 0.44 elasticity).
Consistent with the simple neoclassical model of borrowing constraints, Ginè et al. (2011) find that wealthier households are more likely to purchase insurance and that binding credit constraints lower the demand for insurance contract. Other studies have explored behavioral constraints to insurance take-up, including mistrust in the insurance policy and insufficient understanding of the product itself (Gaugav et al., 2011; Cole et al., forthcoming). Limited financial literacy of farmers, who may not be familiar with the concept of insurance, is another important barrier to higher demand (Karlan et al., 2012; Cole et al., forthcoming). Having previous experience with insurance, knowing the insurance vendor or having received a payout in the past are also important determinants of the decision to purchase WII contract (Karlan et al., 2012; Cole et al., 2012). Finally, basis risk—defined as imperfect correlation between rainfall index and yields at the individual plots—is an important factor hampering widespread adoption of WII, especially in remote rural areas where the weather station infrastructure is limited (Karlan et al., 2012; Mobarak & Rosenzweig, 2012).3

In a series of studies based on a field experiment in three states in India, Mobarak and Rosenzweig (2012; 2013a; 2013b) take the discussion one step further to explore the complex interaction between rainfall insurance, informal risk-sharing, basis risk and risk-taking behavior. A long-standing hypothesis explaining low demand for formal insurance in rural areas is pre-existing informal risk-sharing arrangements based on reciprocal transfers, prevalent in many developing countries, and particularly in India (Ravallion & Dearden, 1988; Rosenzweig, 1988; Rosenzweig & Stark, 1989; Townsend, 1994).

The studies rely on experimental and comprehensive non-experimental data to examine how the market for formal insurance is mediated by informal risk-sharing networks. Rainfall insurance contracts were offered as part of the randomized controlled experiment at the discounted prices (determined via a lottery) to a set households living in 42 villages in three Indian states (Andhra Pradesh, Uttar Pradesh and Tamil Nadu) (detailed information on the research design and insurance product is available in Mobarak & Rosenzweig, 2012). The sampling frame for the RCT component was based on the comprehensive pre-existing census data from the national NCAER Rural Economic Development Survey that permit a rich characterization of the informal risk-sharing

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3 There are three types of basis risks: (i) due to (limited) pure idiosyncratic risk, or weather contributors to low yields; (ii) due to potentially weak correlation between individual losses and the index based on geographic distance from the weather station; (iii) due to index prediction errors (Carter, 2012). The second type of basis risk is the most common, owing to low density of automated weather stations in remote rural areas and lack of historical rainfall records. Recent innovations in satellite imagery can substantially reduce basis risk and improve the design of insurance contracts.
networks that were exogenously formed based on sub-castes, called *jatis*. Rich data on *jati*-based informal insurance, combined with natural variation in the fraction of village members (and caste-members) who received insurance offer, permits examining the interaction between informal protection and formal insurance product. Construction of automatic weather stations in randomly selected villages in Uttar Pradesh (where no automatic weather stations were previously available) is another salient feature of the field experiment, allowing for rigorous exploration of the role of basis risk.

The take-up rate of the rainfall insurance product was substantial across the three states: approximately 40% of households purchased index insurance, and more contracts were purchased at lower prices (see Figure 3). Mobarak and Rosenzweig (2012) document several important results. First, in line with prior research, the study finds that rainfall insurance allows the farmers to increase risk-taking and their agricultural returns: they shift away from drought-resistant but low-yield rice varieties towards higher-yield but more risky varieties. Second, informal risk-sharing at the sub-caste level is effective in mitigating risk, but it comes at a substantial cost – significantly lower risk-taking with lower average returns (Mobarak and Rosenzweig, 2013b). On average, more informal risk-sharing reduces the demand for formal index insurance.

Importantly, basis risk – or the imperfect correlation between losses experienced by the farmer and the weather index that the insurance payouts are based on - is a significant impediment to the take-up of formal insurance. Take-up is lower the further is the farmer’s distance to the weather station. Every extra kilometer of distance lowers take-up by 6 percent. The data indicate that distance is a relevant and important component of the basis risk faced by farmers. Figure x shows the relationship between farm output per acre ex-post and the realization of rainfall during Kharif season. There is positive relationship between output and rain measured in the village (using random subset of stations placed in villages), but the slope is significantly attenuated when the rainfall stations is located outside of the village.
Not only is basis risk important for explaining low take-up rate of WII, but its interaction with the demand for formal and informal insurance is an important dimension of the analysis. Specifically, the research finds that without any basis risk (when rainfall stations are randomly located in the villages), there is no difference in WII demand between castes that do not indemnify idiosyncratic risk and casts that have a median level of informal risk sharing. When the basis risk is high, formal and informal insurance are complements: informal coverage of losses from the jati members protects the household from the basis risk, increasing the demand for formal insurance (Mobarak and Rosenzweig 2012). This is because informal risk sharing networks can help precisely when the index insurance contract fails due to basis risk – i.e. when friends and risk sharing partners can observe that an individual requires help due to some idiosyncratic losses that are ignored by the weather insurance contract.
In a closely related study, Mobarak and Rosenzweig (2013b) explore the general equilibrium responses of insurance offers on agricultural labor markets. A unique feature of the rainfall insurance field experiment is that the contracts were marketed not only to cultivators, but also to landless agricultural wage workers who have traditionally been excluded from the insurance market. Landless laborers, who constitute the poorest segment of the rural population and arguably find it even more difficult to manage risk, exhibit substantial demand for rainfall insurance. This finding underscores an important advantage of index-based insurance (over crop insurance, for instance) related to equity considerations, because rainfall insurance can potentially benefit a larger number of people by offering a risk-coping strategy that is not tied to landholdings (or any particular asset in a specific location). The study also finds that when cultivators take more risk following insurance offers, some of the risk gets transmitted over to landless wage laborers, as labor demand during harvest becomes more susceptible to rainfall conditions. This suggests that offering insurance only to cultivators, and rationing landless laborers out of the market potentially makes laborers even worse off, as they bear even larger uninsured risks. On the other hand, the empirical results from this study indicate that when offered insurance, landless laborers are less likely to migrate in search of work. With insurance, they become less likely to use seasonal migration as an ex-post risk management tool.

In summary, evidence from the small but rapidly evolving literature on index-based insurance reveals a policy-relevant insight: in addition to capital constraints, *risk constraints* can hinder
productive investments among low-income agrarian households. Mounting evidence shows that uncertainty due to weather fluctuations discourages profitable investment in agriculture, even when the marginal returns on such investments are high. Hence offering households protection against weather-related risk through rainfall-based insurance product can generate substantial benefits for low-income households (Barnett et al., 2008; Carter, 2009; Dercon & Christiaensen, 2011).

But there is ample ground for future research. For instance, there is limited understanding of how certain features of product design and marketing techniques affect take up; how substantial are the spillover effects of formal insurance; and how familiarity with the insurance product can affect future demand. The prospect of bundling insurance with other microfinance products such as agricultural production loans or inputs is operationally appealing but more research is necessary. There are substantial evidence gaps in the literature on the impact of financial literacy and consumer education on developing demand for financial products such as insurance. Possible negative consequences of WII adoption—such as focus on monoculture and weaker incentive to invest in R&D of drought resistant seeds or other agricultural technologies such as irrigation—require further investigation (Fuchs and Wolff, 2011).

2.6. Mobile Phone Technology

Agricultural markets in the developing countries are characterized by many frictions, high transportation costs and information asymmetries. Information is critical for efficient functioning of markets, yet for millions of agrarian households timely and accurate information about prices and agricultural market conditions is often not readily available, cannot be trusted, or is prohibitively expensive. In reality, information is often costly and incomplete, and price dispersion is a common feature across markets in the developing countries (Stigler, 1961). Intermediaries who purchase farmers’ produce often take advantage of the farmers’ lack of sufficient information about the prevailing market conditions and of their limited access to other markets (Goyal 2011). This in turn lowers farmers’ profits and has an adverse effect on quality or productivity enhancing investments. Technological innovations such as information dissemination through mobile phones and text

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4 Giné and Yang (2009) find that when maize and groundnut farmers in Malawi were randomly offered a credit package bundled with a weather insurance policy, the take-up rate was 13 percentage points lower relative to the farmers who were only offered credit. The interpretation of this finding is not straightforward: on the one hand, as the authors suggest, credit may be a “limited-liability” contract since repayment under extreme circumstances are not enforced; hence, the lower take-up of the bundled product may be due to the fact that the credit contract already partially insured the farmers. However, it may also be that case that farmers simply do not value the insurance product offered for a number of reasons – due to basis risk, complexity of the contract, or price. The experiment did not separately market an un-bundled insurance product, making it difficult to distinguish between the various possibilities.
messages has the potential to bring about swift and dramatic changes to risk-management practices with respect to agricultural price volatility.

In the last few decades the rapid growth of mobile phone technology in the emerging markets, especially in Sub-Saharan Africa, drastically reduced the transaction costs and information asymmetries. In 2010 mobile phone owners in developing world accounted for nearly two-thirds of the world’s 4.77 billion users (Pickens, 2011). Application of mobile phone technology has quickly evolved from the simple communication device to useful tool for improving agricultural and labor market efficiency.

Figure 5. Mobile-cellular subscriptions, by level of development, per 100 inhabitants

There are several mechanisms through which mobile phone technology can improve household risk management, increase household welfare and improve market efficiency. First, at the very basic level, mobile phones improve cohesiveness of social groups and networks by drastically reducing communication costs. As information is shared more freely and cheaply, members of the social networks may be able to respond faster to the income shocks of other members. Mobile phones can also play an important role in the diffusion of knowledge via social learning and peer effects (Conley & Udry, 2010). Weather updates and early warnings can allow household to make better-informed decisions or assist in disaster preparedness (Aker & Mbiti, 2010). Second, mobile phone technology can reduce information asymmetries and reduce price uncertainties faced by agrarian households (Aker, 2011). Lower information asymmetries and improved coordination

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5 We discuss these issues in broad outlines, and Aker and Mbiti, 2010 provides a more thorough review.
among market actors lead to increased producer surplus and enhanced market efficiency. In addition, matching between job-seekers and employers can be significantly improved. Mobile phones have an overwhelming advantage over traditional methods of gathering and sharing information: despite a high initial fixed cost, the variable cost of using a mobile phone is low. Information can be obtained almost immediately and regularly from a variety of sources, and the technology is user-friendly and accessible (Aker & Mbiti, 2010; Radcliffe & Voorhies, 2012). Finally, mobile banking offers opportunities for financial inclusion of the poor, making financial transactions safer and more efficient.

There is a very rich literature exploring the role of mobile technology in reducing information asymmetries relevant to agricultural decisions. According to the law of one price, widespread adoption of mobile phones should lead to lower price dispersion and improved allocation of goods in the markets. Precisely how the welfare gains are shared between consumers and producers is theoretically ambiguous (Baye et al., 2007). An emerging body of literature investigates the implications of the rapid mobile phone rollout on market performance and on consumer welfare in several developing countries, and especially in Sub-Saharan Africa (Overa, 2006; Jensen, 2007; Muto & Yamano, 2009; Aker, 2010). The key methodological issue in these studies is to disintegrate economic factors responsible for the spread and usage of mobile phones from factors explaining changes in output prices and other outcomes of interest. In a seminal paper, Jensen (2007) examines the economic effects of rapid expansion of mobile phone coverage in Kerala, India on the local fish markets. In line with the predictions of the law of one price, the study finds that price dispersion across local fish markets was drastically reduced following the introduction of mobile phones. Moreover, the fish markets became more efficient, and less wasteful. Increased arbitrage among fishermen produced significant welfare gains: they earned higher profits and consumers paid lower price for the fish. In summary, the environment became less risky for most market participants.

Similarly, Aker (2010) finds that introduction of mobile phones in Niger resulted in substantial reduction in grain price differences across markets, especially in remote areas. Using panel data on banana and maize farmers in Uganda, Muto and Yamano (2009) find that mobile phone technology induced market participation of farmers in remote areas who produce relatively more perishable crops (bananas). Goyal (2011) examines the impact of an innovative technological initiative which provided daily wholesale prices to soy farmers in the Indian state of Madhya Pradesh through village-based internet kiosks. In addition, kiosks offered farming tips and weather updates in
local languages. The second dimension of the intervention offered farmers an opportunity to sell their produce directly to the private soy processing company, circumventing intermediaries. Using differential timing of kiosk and warehouse installation across districts, the study finds a significant increase in monthly prices as a result of the introduction of internet kiosks. Importantly, farmers increased the area under soy cultivation due to intervention—expected (higher) earnings, lower price dispersion and access to an alternative outside market option influenced their planting decisions and improved the functioning of the rural soy markets.

Recent advent of mobile financial applications known as “mobile money” or “mobile banking” has allowed millions of people in countries as diverse as Kenya, the Philippines, South Africa, Afghanistan, Sudan, Ghana, as well as in Latin American countries, to engage in financial transactions more cheaply and securely (Demirguc-Kunt & Klapper, 2012). M-PESA, Kenya’s mobile money service, is the most widely adopted mobile financial service around the world. Adoption rates do not appear to be a problem in this setting, and mobile money services reached 14 million users by early 2011 (Suri & Jack, forthcoming), which is close to 70 percent of adult population of Kenya.

M-money can facilitate more efficient consumption-smoothing via remittances or reciprocal gifts among members of social networks. In 2011 alone, more than $350 billion remittance payments were sent around the world (Demirguc-Kunt & Klapper, 2012). Mobile technology has a potential transform the remittance industry in the developing world by drastically reducing the costs of sending and receiving remittances. Aycinena et al. (2010) show that lower transaction fees significantly increase remittance flows. Electronic money transfers are much cheaper and safer than cash transfers. According to recent data from the Global Financial Inclusion Database, in Sub-Saharan Africa 16 percent of adults—and 31 percent of those with a formal account—report having used a mobile phone in the past 12 months to pay bills or send or receive money (Demirguc-Kunt & Klapper, 2012).

Business models underlying m-money can take a variety of forms. Formal banks can offer m-money service to their customers, but so can mobile network operators without requesting a formal banking account. Partnerships between banks and mobile operators are also common.6 Older forms of mobile money rely on the pre-paid mobile-airtime minutes as de facto currency that

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6 Some believe that India’s government attempt to regulate the sector by requiring the mobile money providers to operate through commercial banks explains the slow growth of mobile money in India (Demirguc-Kunt & Klapper, 2012).
can be transferred between phones, exchanged for cash or for goods and services. In case of M-PESA, the system relies on a wide network of retail agents, typically small business owners, who provide deposit and withdrawals services to M-PESA users. The agents, dispersed densely through the country, can exchange cash for “electronic money” (or e-money) and vice versa. A user can transfer e-money via SMS to another recipient (even if the recipient is not registered with M-PESA). No interest is earned on e-money balances, creating an incentive to keep smaller sums of money in M-PESA accounts (Suri & Jack, forthcoming).

Despite much enthusiasm regarding potential welfare implications of mobile technology, empirical evidence on its effects is still very limited. Using a difference-in-differences strategy, Jack and Suri (forthcoming) explore the impact of reduction in transaction costs due to rapid expansion of M-Pesa in Kenya on household consumption-smoothing. Specifically, they examine how two-year changes in household consumption respond to various exogenous shocks among M-Pesa users and non-users. By including household fixed effects, the authors allow for household-specific unobservables to be correlated with the decision to use M-Pesa. The key identifying assumption is that the same unobservable characteristics are uncorrelated with household ability to respond to exogenous shocks. The authors document several interesting findings: non-users of M-PESA who experienced a negative unexpected shock reduce per capita consumption by 7 percent, while consumption of M-Pesa users is unaffected. The authors suggest that these effects reflect improved risk-sharing, and specifically due to the increase in remittance transfers among M-Pesa users.

Mobile phones offer many potential uses and a wide range of benefits for communication above and beyond its risk sharing and risk mitigation characteristics. As a general, the penetration of the technology has been both quick and widespread, and low demand does not appear to be an issue. However, offering financial services to remote rural areas of developing countries using the mobile platform is technically complicated. The more binding constraint impeding the widespread use of this technology for risk management purposes is therefore likely on the supply side. Mobile technology has the potential to improve agricultural productivity and mitigate risks by reducing information asymmetries and transaction uncertainties. However, much remains to be learnt about the necessary regulatory and enabling environment to ensure security of branchless banking, and whether it is well-suited for serving diverse financial needs of the poor. More research is required on the financial needs of the poor, and how the new technology will affect their financial behavior.
III. Explaining low demand for other risk-management technologies, products and behaviors

The discussion in section II suggests that the poor are often reluctant to invest in products like insurance, or behaviors like seasonal migration, which have the potential to reduce their exposure to risk and improve their welfare.\(^7\) There are many other such examples of relatively inexpensive technologies and products with high (potential) net benefits, which also suffer from low demand. They include a range of risk-mitigating technologies such as preventative health products, improved agricultural inputs such as fertilizers and hybrid seeds, education opportunities, and financial services like savings (Meredith et al. 2011; Dupas 2010; Brune et al., 2011; Duflo et al., 2011; Dupas & Robinson, 2011; Duflo, Kremer and Robinson 2010). Even more surprisingly, the demand for such products is low even at highly subsidized prices. Understanding the key constraints to adoption for this broader class of products may teach us about the low penetration of risk mitigation and management technologies and behaviors. In addition, such analysis helps us devise strategies to counteract the constraints to adoption and to improve product design to better serve the needs of the poor. In this section, we will broaden the scope of our discussion, and will draw on recent experimental evidence to explore several leading hypotheses that seek to explain low adoption of seemingly profitable technologies.

An important distinguishing feature about low-income individuals is that they often have narrower margins of error in their decision-making: certain actions or decisions – particularly those that carry high risk of uncertain negative outcome – can manifest themselves in more pronounced and devastating ways (Bertrand, Mullainathan & Shafir, 2009). The circumstances, in which the poor function, often lack support systems designed to mitigate potential negative outcomes of risk-taking behavior. For instance, insurance markets are very thin and self-insurance through savings is not easily available. In contrast, in developed countries, in addition to the traditional financial instruments that help household to manage risk, there are other support systems, including various services of consultants and professional advice, automatic reminders, incentives, automatic deposits, to name a few.

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\(^7\) Some believe that the poor choose not invest in productive technologies and behaviors because the return to such investments is much smaller than suggested by economic theories. While this may be true of many specific technologies and contexts, the broader notion is often rebuked due to overwhelming empirical evidence of positive and non-negligible returns from both experimental and non-experimental literature (see Banerjee & Duflo, 2005 for a review).
3.1. Credit and savings constraints

The poor may not be able to invest in new risk-mitigating products and technologies because they are liquidity constrained. However, this line of reasoning leads to a puzzle: if the returns to using certain products are sufficiently high, why the poor do not borrow money or use their savings to purchase and use such products?

Traditional commercial lending is very limited across the developing world. Commercial banks have faced numerous obstacles to profitably provide financial services to the poor: Lack of collateral among the poor, not enforceable property rights, high transaction costs, adverse selection, moral hazard, and information asymmetries are some of the common factors contributing to dearth of commercial banking (Karlan & Morduch, 2009). Access to credit through informal channels—from moneylenders, traders, landlords, friends and family – is often prohibitively expensive. Aleem (1990) using a survey of 14 moneylenders in rural Pakistan finds that exorbitantly high informal sector interest rates in his sample are not due to high default rates but can be explained by high costs of lending, driven by screening costs (establishing who is creditworthy), monitoring (observing ability to pay), and enforcing (collecting money). The rapid expansion of microcredit, primarily in Southeast Asia, can potentially offer a solution. However, the terms of microcredit loans are not well-suited for financing investment in products or behaviors with uncertain future returns because they rely on and require quick and regular repayments.

A closely related question is why low-income households do not gradually accumulate usefully large sums of money to invest in improved and profitable technologies, health products or education. The view that the poor are unable to save because they do not have sufficient cash on hand has been rebuked by overwhelming evidence to the contrary. For example, using data from thousands of households in 13 developing countries, Banerjee and Duflo (2007) show that even those living on less than $1 a day manage to spend on what appears to be non-food items, such as social and religious expenditures, tobacco and alcohol. At the very low levels of consumption, poor household face a very high opportunity costs of savings: it may too difficult to save if one has to skip a meal. Pre-existing system of risk-sharing based on reciprocal transfers among members of the social network can also interfere with individual ability to save because of social pressure to share one’s income with friends, relatives and other members of one’s social network (Jakiela & Ozier, 2012).

The rate of formal savings is low in the developing world and gaps in formal financial access are vivid (see Figure 6). There are both demand and supply factors that restrict savings in the
developing countries. From the supply-side, providing formal savings in rural areas is not financially sustainable because of high administrative costs required to collect tiny sums of cash at frequent intervals. Whenever access to formal savings is available, there are numerous barriers preventing the poor from utilizing them: account openings fees, minimum balance and identification requirements, high transportation costs, and other constraints make it difficult, expensive and inconvenient for the poor to save formally (Beck, Demirguc-Kunt & Peria, 2006).

The poor do appear to have a strong demand for safe and flexible ways to save. In fact, low-income individuals are often willing to pay a high price to have access to savings. Well-known examples of such informal savings are zero interest-rate Rotating Saving and Credit Associations (ROSCAs) and revolving deposit collectors, such as susus in West Africa, who charge money to hold on to people’s savings (Collins et al., 2009). In a randomized controlled trial in Kenya, Dupas and Robinson (2013) find that the demand for savings accounts is substantial even with the negative nominal returns on savings. Having a formal savings account is desirable for a number of reasons. Not only does it provide a safer, more reliable way to save but it also potentially offers a better control over one’s savings by making savings more discrete and hence by reducing social pressures for intra- (Anderson & Baland, 2002) and inter-household transfers (Platteau, 2000).

Behavioral biases may prevent low-income individuals from accumulating usefully large sums of cash. Behavioral literature emphasizes various psychological barriers to saving such as time-inconsistent preferences, problems of self-control problems and loss aversion (Datta & Mullainathan, 2012). A decision to save can be viewed as a tradeoff between lower consumption at present and some (uncertain) payoff in the future. Individuals with present-biased preferences may find it particularly difficult to give up present consumption in return for future consumption. In fact, evidence shows that individuals are acutely aware of their temptation to use savings on day-to-day activities. Ample evidence shows that the poor are often willing to restrict their own ability to use their savings and demand savings products with features specifically designed to help overcome these psychological barriers. Research in the both the developed and developing countries has repeatedly confirmed that commitment-products can help overcome these self-control problems (Thaler & Benartzi, 2004; Ashraf et al., 2006). Individuals may also explicitly or implicitly engage in ‘mental accounting’—they may be more motivated to save for a specific purpose such as health emergencies, school fees, or business expansion, rather than for an ambiguous reason (Dupas & Robinson, 2011). Innovations in product design such as labeling of a savings account may be a cost-
effective strategy to increase savings via mental-accounting and to overcome loss aversion (Karlan & Morduch, 2009).

Figure 6. Global savings from the Global Financial Inclusion Indicators

3.2 Willingness to pay versus liquidity constraints

Price is the key determinant of adoption of many risk-management products that reduce household exposure to health and other types of shocks. Yet studies across many countries show that charging even a small fee can dramatically reduce access to important products, trumping other determinants of adoption (J-PAL Bulletin 2011). For instance, Figure 7 shows that in case of insecticide-treated bed nets, the demand drops sharply when the price is increased from free to 40-60 Kenyan shillings. Furthermore, this steeply sloped demand curve is not responsive to framing, verbal commitment or gender-targeting.
There are two possible explanations for a high price-sensitivity that the poor exhibit for risk-mitigating products: either the utility from using these products is low (which may also be due to lack of information about the potential benefits) or individuals are liquidity-constrained. The optimal policy responses may be very different depending on which explanation is correct. Appropriate pricing strategy in the presence of positive externalities that commonly characterize such products is a controversial topic among researchers, policymakers and development practitioners. Proponents of a free distribution point out that, with positive externalities and learning spillovers, subsidies are necessary to ensure optimal level of adoption of certain risk-reducing products. Moreover, they argue that the poor who cannot afford to invest in such a product or service are the ones with the greatest need for it. Charging small fees will raise little revenue at the cost of dramatically reducing access to the poorest. On the other hand, opponents claim that low-income households will not value the free product as much as they would if they had to pay for it (sunk cost effect). In addition, they posit that market prices play an important screening role by selecting people who need the product the most (selection/screening effect) (Ashraf et al., 2010). A related concern is that one-time cost-sharing may not be a viable strategy to encourage long-term adoption because consumers may anchor their demand to the subsidized price and will be reluctant to pay a higher positive price in the future.
Several methodological approaches allow distinguishing willingness to pay from the ability to pay. Contingent valuation exercises allow us to infer willingness to pay using in hypothetical situations in surveys. As Null et al. point out (2012), the main concern with contingent valuation is that the actual purchasing decisions may deviate from the ones observed in hypothetical situations, and discrete choice studies may be biased by unobserved characteristics that influence the demand decisions. Other approaches to estimating willingness to pay include discrete choice models and price randomizations that induce purchase.

There is an extensive experimental literature on willingness to pay focusing primarily on products in Asia and Africa that reduce such health risks as water-borne diseases in children, malaria, indoor air pollution, and malnutrition. Several important lessons have emerged from this literature, although one should be cautious about generalizations. First, as already established, field experiments uncover high price elasticity for a wide variety of products that can mitigate risks to human health, such as clean water technologies (Null et al., 2012); anti-malarial insecticide-treated bed nets (ITNs) (Cohen & Dupas, 2010); and improved cookstoves to reduce harmful indoor air pollution (Mobarak et al., 2012). Charging even a small fee can drastically reduce adoption. Generally, the screening hypothesis is not supported empirically: there is no conclusive evidence suggesting that positive prices help identify individuals with the greatest need for the product (Kremer et al., 2009; Ashraf et al., 2010; Cohen & Dupas, 2010; J-PAL Bulletin 2011). Third, there is no evidence to suggest that free distribution is associated with lower valuation of the product and increased waste (Cohen & Dupas, 2010; J-PAL, 2011).

In order to establish the importance of liquidity constraints in hindering widespread adoption of welfare-enhancing and risk-reducing technologies, experimental studies examine expenditure patterns of households that were randomly assigned to receive or qualify for cash transfers. In a series of experiments, Meredith et al. (2011) provided households in Kenya a randomly determined amount of cash to purchase children’s rubber shoes that prevent hookworm infections among small children. Not surprisingly, the study finds that liquidity constraints and prices are the most important factors determining the purchasing decisions, while education campaign and peer effects have negligible impact. Similar results are obtained in three small-scale studies in Guatemala, India, and Uganda where soap and multivitamins were marketed.

A closely related strand of literature explores the effects of conditional and unconditional cash transfers on decisions to invest in health or education. Both types of investment can have long-run implications for future productivity and for individual ability to respond to risk. Conditioning
the receipt of cash on a certain type of expenditure objective is a popular social policy, with a substantial political backing. Progresa, renamed to Oportunidades in Mexico is perhaps one of the most well-recognized conditional cash transfers (CCT) program. Unconditional Cash Transfer programs (UCT) are less common, although in recent years the importance of “conditioning” has come under scrutiny. Empirical evidence, primarily from Latin America, overwhelmingly suggests that CCTs are effective for overcoming underinvestment in human capital (Schady & Araujo, 2008; Fiszbein & Schady, 2009; de Brauw & Hoddinott, 2011). A recent experimental study by Baird et al. (2011) featuring both CCT and UCT interventions in a sample of adolescent girls in Malawi support this conclusion: while UCT had a modest effect on school enrollment, the effect of CCT was twice as large. In addition, they find that school attendance and learning also improved in the CCT arm, and no such effect was detectable in the UCT intervention.

A different approach to the problem of underinvestment in education considers the economic returns to this behavior—after all, if there is substantial uncertainty about future returns to education and if there is a risk of the returns being lower than expected, then such an investment may not be justifiable at present (Banerjee & Duflo, 2011). Proponents of supply-side explanations of underinvestment, on the other hand, emphasize the need to provide necessary infrastructure and tools necessary for success; in case of education, such tools include textbooks, uniforms or better-trained teachers.

Disentangling supply and demand-side factors empirically is challenging. On recent piece of evidence comes from a study of garment workers in Bangladesh. In this study, Heath and Mobarak (2012) exploit a large-scale supply-side schooling intervention designed to subsidize schooling in Bangladesh and the coincidental increase in returns to education due to unprecedented growth in the garments sector. Using triple difference estimator, the study finds a significant increase in school enrollment among girls of appropriate school age living close to the garment factories, relative to boys, and a negligible effect of the female stipend program. Atkin (2011) similarly uncovers heterogeneous effects across age as a result of rapid growth in the manufacturing sector in Mexico. These results corroborate findings from a study by Jensen (2012), suggesting that learning about employment opportunities and providing information about returns to education may be a very cost-effective strategy for influencing schooling decisions.
3.4 Behavioral Explanations and Learning

Behavioral biases can prevent low-income households in the developing countries from taking advantage of various risk-reducing and income-generating technologies, or at the same time, they can encourage certain behavior. Insights from behavioral economics, psychology and other disciplines reveal that people’s behavior is shaped by habits, inclinations, and frequent disagreements between intentions and actions. Analysis of individual decision-making that is grounded in psychology and behavioral economics offers a different lens through which one can analyze successes and failures of development programs. This approach also provides an opportunity to improve product design and cost-effectiveness of development programs (Datta & Mullainathan, 2012).

Evidence has shown that loss aversion—a stronger dislike of a monetary loss than the pleasure of an equal-sized gain— and mental accounting—ways in which individuals and households categorize and evaluate their financial transactions—play an important role in financial decision-making (Thaler, 1999). As we have already pointed out, present-biased preferences and self-control problems help explain why it may be difficult to save (Ashraf et al., 2006) or engage in potentially profitable activities such using fertilizer (Duflo et al., 2011). Labeling savings accounts and commitment-to-save savings accounts are just some examples of how subtle changes in program design can address issues of present-biased preferences and lack self-control (Ashraf et al., 2006).

Lack of knowledge or information about the potential benefits of using risk-mitigating technologies is often cited as a primary obstacle to higher take-up rates and use. A critical determinant of adoption of a new technology is the learning process through which information is absorbed, disseminated, and applied. Information campaigns, free trial periods, physical demonstration of improved agricultural practices and learning from one’s peers, reputable community members and other trusted contacts in social networks can reveal the (net) benefit of using a new technology, peeling off layers of uncertainty (Dupas 2012; Conley & Udry, 2010; Foster and Rosenzweig 1995; BenYishay & Mobarak 2012; Adhvaryu 2012; Miller and Mobarak 2013).

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8 However, benefits to improved technology do not occur across the board. Suri (2011) points out the benefits as well as costs of using improved technology (hybrid maize seeds) may be heterogeneous. In her study of Kenyan farmers she constructs a panel data on net rather than gross returns to technology use. She finds that farmers with highest estimated gross returns do not choose not to adopt because they also have highest costs of acquiring this technology due to poor infrastructure. On the other hand, farmers with lower returns adopt, while the marginal farmer is indifferent to adoption because his returns are zero on average.
Providing information alone, via demonstration or through other means, may not be sufficient to ensure success. A case in point is a field experiment by Duflo, Kremer and Robinson (2010) that encouraged farmers in Kenya to use fertilizer via demonstration plots. The study finds that a significant share of farmers in Kenya who attended the demonstration plots to learn about improved fertilizer wanted to use fertilizer in the following growing season. However, many of them postponed purchasing fertilizer at the time when they had cash, leading to a much lower take-up rate (Figure 8). The solution to the problem of procrastination takes into account present-biased preferences of farmers. Small time-limited reductions in the cost of fertilizer right after the harvest when farmers have more cash on hand can result in dramatic increases in fertilizer use. This simple lesson can be applied for adoption of other risky technologies in rural areas where incomes are seasonal.

Adopting and using new technologies and behaviors often requires formation of new habits, and existing habits can interact or limit the effectiveness of interventions (Verplanken & Wood, 2006). Marketing techniques and product design features that take into account cognitive biases can have surprisingly strong effect on demand. For instance, simple reminders to save via text messages have shown to be surprisingly effective in increasing savings in Peru, Bolivia and the Philippines (Karlan et al., 2010). In the randomized control study of credit in South Africa, Bertrand et al. (Bertrand et al., 2010) find that limiting the number of loan options, not suggesting a particular use for the loan, and including a photo of an attractive woman increases loan demand by almost as much as a 25% reduction in the interest rate.

![Figure 8. Intention versus action](image)

Intra-household externality in decision-making – or inability of a household member, who has control over purchasing decisions, to take into account potential benefits accruing to other family members from using a certain product – is another explanation for low demand for improved technologies and risk-management strategies. A case in point is a recent field experiment in rural Bangladesh which offered a technological solution to a widespread problem of indoor air pollution: improved cookstoves. Unlike traditional cookstove, improved cookstoves are more fuel-efficient and most importantly drastically reduce respiratory problems. Miller and Mobarak (2013) offer improved cookstoves at randomly assigned prices. In some randomly selected households, the stoves were marketed to women, while in others males received the offer. The study finds that women who bear disproportionate cooking costs and who can benefit the most from improved technology lack the ability to purchase them because they are not in charge of household financial decision-making. Intra-household differences in preferences and the bargaining constraints faced by women deter the adoption of superior technology.

3. Conclusion

Low-income households in developing countries manage a myriad of risks and engage in consumption smoothing (Morduch 1995). But in doing so, they often forgo higher-earning opportunities in return for safer investments. For instance, farmers choose to plant low-risk, low-yield crops instead of investing in more profitable but riskier inputs (Rosenzweig & Binswanger, 1993). Individuals in rural Bangladesh are reluctant to seasonally migrate due to uncertainty of the economic outcomes, despite expected high returns (Bryan et al., 2013). 

Risk constraints appear to hinder productive investments in developing countries, stymieing economic development and exacerbating income inequality (Dercon & Christiaensen, 2011; Karlan et al., 2012). Understanding the underlying constraints to adoption is crucial for addressing the underlying causes of poverty and for designing better policy responses.

Many highly-efficacious technologies already exist, or have been recently designed to mitigate these risks but paradoxically their adoption and use rates are low across the developing world. In this paper, we focus our discussion on a few select examples of such welfare-improving products and technologies that help households manage different types of risks, including index-based rainfall insurance, seasonal migration and mobile phone technology. We draw attention to the latest state-of-the-art literature based on randomized controlled trials that identifies tangible benefits
from using or adopting these technologies. Although weak demand is the primary explanation for low adoption, supply-side challenges also exist.

The problem of underinvestment permeates other sectors, and next we broaden our discussion to highlight challenges of investing in a host of other risk-management products and technologies that include preventative healthcare products (insecticide-treated bed nets, clean water technologies, vitamins), agricultural inputs (high-yield corps and fertilizer), investment in education, and savings.

We shed light on leading explanations for low adoption rates of these risk-mitigating products and behaviors. Hypotheses we highlight include liquidity- and credit-constraints; price sensitivity; risk aversion and low levels of experimentation; behavioral biases; lack of adequate information about potential benefits and misaligned incentives. Although price sensitivity stands out as the most prominent explanation of low adoption, other constraints to adoption are also important and are context-specific.

We navigate through the vast literature on underinvestment in promising risk-management tools developing countries to understand the underlying reasons for successful adoption or failure. We also discuss a few proven and potential solutions to the problems of weak demand. An emerging lesson from this evolving research is that multi-pronged approach that addresses several constraints simultaneously may be the most effective strategy in encouraging widespread adoption. Recent pieces of evidence based on rigorous methods offer promising innovative solutions to longstanding challenges of underinvestment in profitable and relatively inexpensive technologies, but the chain of evidence is still too short.
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