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FINANCIAL MARKETS AND ECONOMIC DEVELOPMENT[‡]

Informal Risk Sharing, Index Insurance, and Risk Taking in Developing Countries[†]

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The penetration of formal insurance markets is puzzlingly low in agrarian areas of developing countries, although agriculture is highly susceptible to fluctuations in weather. And, despite the fact that most rural households participate in informal risk sharing, farmers appear to sacrifice profitability to lower their risk. To understand the complex interactions between informal risk sharing, formal insurance, and risk taking, we have randomized offers of rainfall insurance contracts to a set of households living in Indian villages for which we had preexisting census data that permits a rich characterization of the nature and extent of informal risk sharing within readily identifiable, exogenously formed networks: the subcaste, or *jati*. This article describes preliminary findings from three studies undertaken or under way (Mobarak and Rosenzweig 2012, 2013a, 2013b) that use the resulting experimental and nonexperimental data.

We first examine whether and how caste-based risk sharing affects the demand for formal insurance. Next we compare the effects of index insurance provision and informal risk sharing on farmers' willingness to invest in risky production methods and technologies. Finally, we assess the general-equilibrium effects of offering insurance to cultivators and to agricultural laborers on wage levels and volatility by estimating labor supply and labor demand effects.

Four distinct features of the research design allow us to empirically identify these relationships. First, we use the listing data from the 2007/2008 round of the national NCAER Rural Economic Development Survey (REDS) as the sampling frame for the experiment, which allows us to stratify the randomization across and within caste-based risk-sharing groups identified in REDS, as well as within and across villages. *Jatis* are clearly the relevant risk-sharing network: the data indicate that the majority of loans and transfers to households are from fellow caste members, and the majority of informal loans and financial transfers to households from family and from fellow caste members originate outside the village.[1] *Jati* networks span villages and districts in India, and the spatial correlation in rainfall falls sharply as distance increases (Mobarak and Rosenzweig 2012). *Jatis* therefore have the potential to indemnify aggregate (village-level) rainfall risk in addition to household-specific idiosyncratic risk.

Jati-based risk-sharing may directly substitute for formal insurance, but the relationship is actually more complex because informal networks can potentially help mitigate an imperfection of index insurance called "basis risk"—the imperfect correlation between rainfall measured at the weather stations and farmers' actual losses. A second feature of our project design is that we randomly place weather stations in

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[1] Transfers are remittances and "assistance received at the time of difficulty" from individuals and households excluding gifts for festivals and marriage. Only 9.2 percent of informal "assistance" transfers originated in the village, and outside-village remittances outnumbered inside-village remittances by 2 to 1.

some of the project villages. This allows us to explore whether basis risk deters index insurance purchase, and the extent to which informal risk sharing that indemnifies household-specific losses mitigates this effect.

A third key feature of the experimental design is that we offer the insurance product to both cultivators and landless households in which the head's primary occupation is agricultural laborer. We know of no governmental or private insurance agency in India that offers weather insurance to agricultural laborers. Yet, clearly the incomes of such workers are heavily dependent on weather outcomes. By offering the insurance product to landless agricultural workers we can assess to what extent their behavior and welfare is directly affected when protected against rainfall variation.

A fourth feature of our project design is that we can identify general-equilibrium effects at the village level. To the extent that the provision of insurance to farmers alters their input decisions and risk-taking behavior, as theory suggests and we confirm, such insurance will also affect the demand for and risk facing agricultural laborers. Because the REDS listing data describes the occupations and landholdings of all households in villages, our design enables us to characterize the general-equilibrium spillover effects of insurance provision to cultivators on the insurance take-up, incomes, and risk-mitigating behavior of agricultural laborers.

I. Experimental Design

The research design requires us to construct average *jati* characteristics with statistical precision, and our experiment and analysis therefore focuses on *jati*s with at least 50 households in this sample of populous castes. The 63 REDS villages in our sample villages contained 118 unique *jatis* meeting this size criterion in the REDS listing. We first randomly selected 42 (of the 63) sampled REDS villages to receive insurance marketing. To ensure that we retained a "pure control" group of households whose fellow caste members (or villagers) do not receive any insurance treatment, we first stratified the randomization by caste, so that members of 25 (of the 118) castes are randomly selected to not receive any insurance offers. Next we stratified by occupation, so that almost all insurance offers were made to agricultural households, with half the offers going to "cultivators" (those who make planting decisions) and the other half going to households engaged purely in agricultural labor work. Two thirds of the cultivators and agricultural laborers in the 93 treatment castes, totaling about 4,667 households, ultimately received insurance offers. Ninety-eight percent of these households had no prior exposure to formal insurance.

Stratification of random assignment by caste creates natural variation in the number and fraction of farming households in each village receiving insurance offers depending on the distribution of caste groups across villages. About 26 percent (33 percent) of all cultivators (laborers) receive insurance marketing in the average treatment village, but this fraction varies from 0 percent to 56 percent (0 percent to 80 percent). This variation, induced by the stratified randomization, is useful for studying the labor market spillover effects of insurance offers to cultivators or laborers.

We designed and marketed a "Delayed Monsoon Onset" insurance product. The product we offered, in collaboration with Agricultural Insurance Company of India Lombard (AICI), provided a cash payment to purchasers if rainfall were delayed beyond an expected monsoon onset date, which was determined by AICI based on the historical rainfall data. The AICI price of a unit of insurance varied from Rs. 80 to Rs. 200 (US$ 1.6-4), but discounts from these prices, ranging to 0 percent, 10 percent, 50 percent, or 75 percent, were randomized across households. Overall, roughly 40 percent of all households purchased some insurance. Interestingly, the take-up differential between agricultural laborers and cultivators was less than 4 percent. Finally, as there were no pre-existing weather stations in the 19 REDS villages in the state of Uttar Pradesh, we randomly placed the weather station in 12 of those villages, with the rest placed outside the villages as in other states.

II. Informal Risk Sharing, Basis Risk and the Demand for Weather Insurance

Mobarak and Rosenzweig (2012) embeds a model of index insurance with basis risk in Arnott and Stiglitz (1991)'s cooperative risk-sharing model to show that: (a) basis risk, or the imperfect correlation between losses and insurance payouts due in part to the remote location of

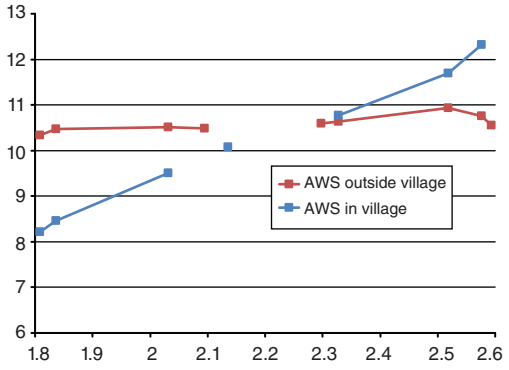

FIGURE 1. LOWESS-SMOOTHED RELATIONSHIP BETWEEN LOG OUTPUT VALUE PER ACRE AND LOG RAIN PER DAY IN THE *KHARIF* SEASON, BY PLACEMENT OF RAIN STATION (*UP villages*)

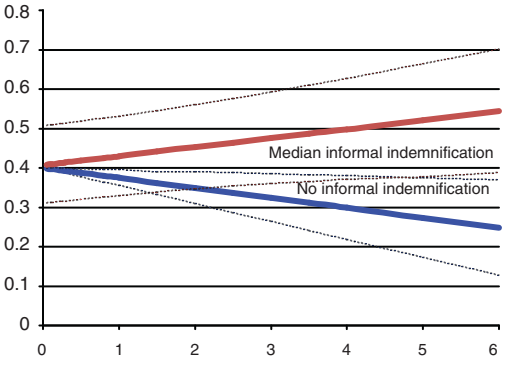

FIGURE 2. RELATIONSHIP BETWEEN DISTANCE (*kilometers*) TO THE NEAREST AWS AND THE PROBABILITY OF INDEX INSURANCE TAKE-UP, BY LEVEL OF INFORMAL RISK SHARING

the rainfall gauges, lowers the take-up of index insurance; (b) when the insurance contract carries no basis risk, demand for index insurance is independent of the extent of informal coverage of idiosyncratic (household-specific) losses; (c) informal risk sharing and index insurance can be complements when there is basis risk, because the *jati* network will cover household losses precisely when the index contract fails.

To test these predictions, we first use REDS survey data on interhousehold transfers in response to village-level rainfall shocks and household-specific adverse shocks to construct indices of informal risk sharing that measure how well each caste in our RCT sample indemnifies against idiosyncratic losses, and against aggregate shocks.[2] We proxy for basis risk using the farmer's (randomized) distance from the weather station used to measure rainfall on which insurance payouts are based. We estimate an insurance demand equation for the RCT sample to whom offers of insurance were made at randomly varying prices. Basis risk is interacted with informal indemnification of idiosyncratic losses, as implied by the model.

[2] To compute the nature and extent of informal risk sharing, net transfers are regressed on the rainfall and household-specific shocks interacted with a set of average caste characteristics computed from the 118,000 sample REDS listing, controlling for caste fixed effects. Mobarak and Rosenzweig (2012) discuss identification issues.

It is important to first establish that basis risk exists in these insurance contracts, and that distance to the rainfall station is a reasonable proxy for it. Figure 1 shows the lowess-smoothed relationship between farm output per acre in our follow-up data and the realization of rainfall during the *Kharif* season in the Uttar Pradesh villages where we randomized in which villages we would place a weather station. There is a clear positive relationship when rainfall is measured in the village, but the slope is considerably attenuated when rainfall is measured farther away. Basis risk therefore is an important potential concern, and induced variation in rainfall station placement enables us to assess how the level of basis risk affects weather insurance take-up.

Figure 2 summarizes the key results from the insurance demand estimation. When the insurance contract does not carry any basis risk (a value of zero on the *x*-axis, i.e., when rainfall gauges are placed in the village), there is no difference in index insurance demand between castes who do not indemnify any idiosyncratic risk and castes that demonstrate the sample median level of informal risk sharing. However, as basis risk increases along the *x*-axis, members of castes that share idiosyncratic risk become much more likely to purchase index insurance than do members of castes that do not share risk. At the mean distance to the nearest rainfall gauge used to calculate payouts (4 km), there is a 20 percentage point difference in insurance demand.

III. Informal Risk Sharing, Rainfall Insurance and Risk Taking

Mobarak and Rosenzweig (2013a) shows that the modified Arnott-Stiglitz model determining jointly the levels of informal insurance and risk-taking within the community predicts that higher informal coverage may be associated with less risk taking. To assess whether and how variations in informal indemnification of household losses affect risk taking empirically, we exploit the idea that among farmers who take more risk, crop output, input use, and profits should be more sensitive to rainfall. From the REDS data we use variation in village-level monthly rainfall over eight years to compute that part of rainfall that is unexpected during the survey year to assess the relationship between informal insurance coverage and farmer risk taking. We find that in *jatis* with higher indemnification of individual losses, per-acre profits are less sensitive to rainfall, while in *jatis* in which indemnification depends more strongly on weather shocks, profits were more sensitive to rainfall variation.

We also use the random variation in the offer of weather insurance and the indices of *jati*-level loss indemnification interacted with variation in rainfall to assess the effects of rainfall insurance and informal loss indemnification on risk taking from the RCT survey data. We find the exact same relationships as in the REDS data. Per-acre output was much more sensitive to rainfall among farmers offered the insurance product, while the sensitivity of output to rainfall was significantly lower the higher was *jati*-level loss indemnification.

Figure 3 shows the lowess-smoothed relationships between log village daily rainfall and log per-acre output value in the *Kharif* season among cultivators (i) by whether or not the farmer had been offered the insurance product and, among farmers not offered rainfall insurance, (ii) by whether or not the farmer was in a *jati* with below or above the median of *jati*-specific loss indemnification. Farm output rises steeply with rainfall for farmers randomly offered weather insurance. For farmers in the high-indemnification *jatis* without rainfall insurance, however, the rainfall-output relationship is almost flat, and perhaps downward sloping, consistent with such farmers selecting crops or technologies less sensitive to rainfall. Even among those farmers in the low-indemnification *jatis*, per-acre output is lower than among farmers offered rainfall insurance at high levels of rainfall. Thus, while caste groups in India are evidently successful in mitigating risk, it appears to come at a substantial cost: more risk-averse production, with lower average returns. Rainfall insurance, however, allows farmers to increase risk taking.

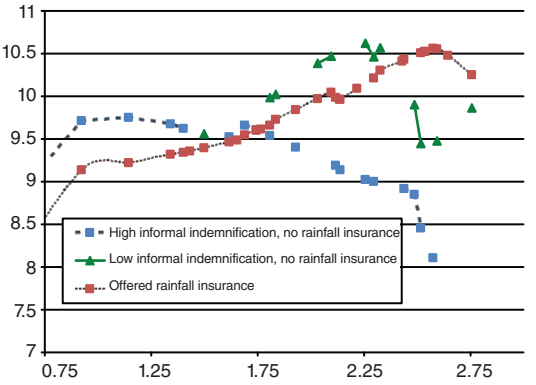

Figure 3. Lowess-Smoothed Relationship between log Per-Acre Output Value and log Rain per Day in the *Kharif* Season, by Insurance Type and Level

IV. Weather Insurance and Landless Agricultural Workers

The exclusive target of weather insurance programs is farmers, and we have seen that weather insurance induces farmers to take on more risk. Providing weather insurance to cultivators could therefore increase the wage risk borne by the large proportion of the (landless) population that is reliant on agricultural wage work.[3] Mobarak and Rosenzweig (2013b) studies the general-equilibrium effects of providing rainfall insurance to both cultivator and landless agricultural wage-worker households.

Jayachandran (2006) examined in the context of a general-equilibrium model how the provision of financial services to landless households that enabled them to smooth incomes affected their labor supply, and thereby the risk faced by cultivator households. If landless households cannot borrow, they can only smooth incomes

[3] In 28.5 percent of households in our sample villages the primary occupation of the head is agricultural wage work.

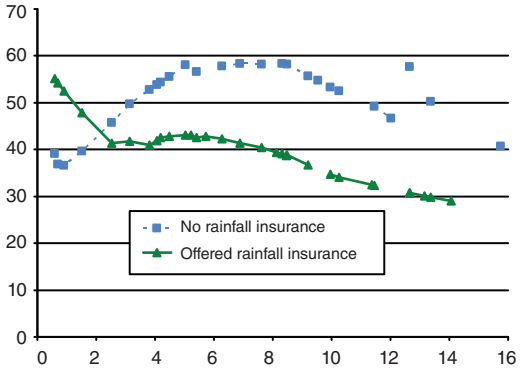

FIGURE 4. LOWESS-SMOOTHED RELATIONSHIP DAYS WORKED FOR AGRICULTURAL WAGES AND RAIN PER DAY IN THE *KHARIF* SEASON AMONG THE LANDLESS, BY INSURANCE OFFER

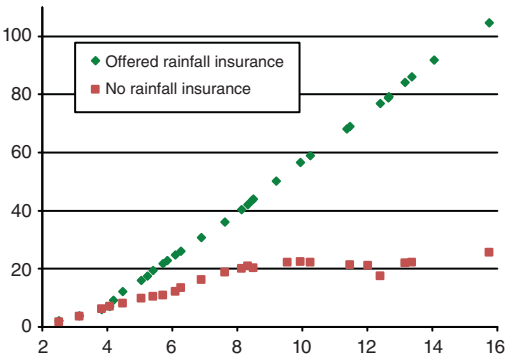

FIGURE 5. LOWESS-SMOOTHED RELATIONSHIP BETWEEN HIRED MALE HARVEST LABOR USE AND RAIN PER DAY IN THE *KHARIF* SEASON AMONG FARMERS, BY INSURANCE OFFER

over time by working more when rainfall is low and taking more leisure when rain is plentiful, thereby lowering equilibrium wage rates in bad times and raising them in good times. This increases the income volatility of wage workers but decreases the volatility of profits for farmers.

Our study examines the effects of rainfall insurance on both the supply of and the demand for agricultural labor in a general-equilibrium context in which landless households supplying agricultural labor are unable to smooth. We first examined effects on the supply of agricultural labor. A standard model of labor leisure choice would suggest that, with borrowing constraints, at low levels of rainfall labor supply will be strongly positively related to rainfall—income is low and the substitution effect dominates. At high levels of rainfall, however, the income effect may dominate, and labor supply will be less rain-elastic and perhaps even backward bending. In contrast, for landless households with weather insurance, labor supply will be relatively inelastic to rainfall at low levels of rainfall, when there are insurance payouts.

Figure 4 displays the lowess-smoothed relationship between *Kharif*-season rainfall per day and total days of labor supplied among the landless agricultural households by whether or not they were offered the insurance product. We see the inverted u-shape relationship for the uninsured households, with labor supply steeply upward-sloped at low rain levels and then a negative relationship at high levels. For households offered insurance, however, labor supply is lower overall and much less sensitive to rainfall, especially at low rainfall levels as expected. Preliminary estimates indicate that for rainfall at the bottom twenty-fifth percentile of the rainfall distribution, households offered insurance work 28.3 percent fewer days than the uninsured.

Temporary migration is an increasingly pervasive option as a means of smoothing incomes ex post. We find similar relationships for migration, with the probability of migration increasing with rainfall and then falling as rainfall increases for the uninsured, with the strength of these rainfall effects significantly attenuated for laborers offered the contract. Point estimates indicate that at the twenty-fifth percentile of the rainfall distribution, the probability of a male migrating is 35 percent lower in households offered insurance compared with uninsured households.

To assess the labor-market spillover effects of offering insurance to the landless on cultivator incomes, through these labor supply and migration effects, and the effects of offering insurance to cultivators on the first and second moments of the incomes of the landless, we estimated the determinants of the amounts of hired male harvest labor in the *Kharif* season by cultivating households. Figure 5 displays the lowess-smoothed relationship between rain per day and per-acre days of male harvest labor hired in the *Kharif* season by whether or not farmers were offered the insurance product. The substantially shallower labor-rain slope among uninsured cultivators is readily apparent, consistent with the finding that per-acre output is less responsive to rainfall in the control group. For rainfall above

very minimal levels, farmers offered insurance hire more male harvest labor at every level of rainfall. Moreover, we also find that, for given rainfall, more hired labor is employed by cultivators the higher the proportion of the landless offered insurance in the village, suggesting that of the two labor supply effects induced by offering weather insurance to the landless the reduced-migration effect dominates.

The relationships in Figure 5 imply that the increased risk taking of insured farmers will increase wage levels but also labor demand volatility, and thus increase the wage risk of the landless. This suggests that, if landless households are aware of the impact of insurance on wage risk and levels, such households will be more receptive to purchasing weather insurance when farmers also take on insurance. Consistent with this, our preliminary estimates indicated that at the sample proportion of cultivating households (0.45), landless households are 12 percentage points (31.5 percent) more likely to purchase the insurance product if (all) cultivator households are offered weather insurance compared with having no cultivators in the index insurance program.

V. Concluding Remarks

By combining an RCT with preexisting census and survey data we have been able to examine the complex interrelationships among informal insurance arrangements, basis risk, the demand for formal weather insurance, ex ante risk taking and ex post risk mitigation among both cultivator and landless labor households in a setting in which community risk sharing is pervasive. In future work we will exploit the caste-based stratification of our design to explore potential spillover effects of formal insurance availability within and across caste boundaries.

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