Potential Role for Insurance in Managing Catastrophic Risks in Developing Countries

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The Problem

Droughts, floods and other natural disasters lead to severe income losses for rural people, especially farmers and poor people. Given their limited ability to offset these losses, many rural people suffer extreme hardship, lose assets and default on their debts in disaster years.

The prevalence of natural disasters is not new and farmers, rural institutions and lenders have, over generations, developed ways of reducing and coping with risk (e.g. crop diversification, transhumant livestock systems, kin support networks, storage and asset accumulation). Although the virtues of these traditional risk management mechanisms are widely recognized (see, for example, Hazell, Pomareda, and Valdes), they also have their limitations. They can be costly in terms of the income opportunities that rural people forego (e.g. crop diversification is typically less profitable than specialization). They can discourage investments and technological changes that, while risky, enhance long-term productivity growth. And they have limited capacity to spread covariate risks like droughts that affect most people in a region at the same time. In theory, these limitations would not exist if capital and insurance markets were perfect and could pool risks more widely, but the reality for many risky agricultural regions in developing countries is quite the opposite; relevant capital and insurance markets are poorly developed and they are weakly linked across regions and with urban areas.

Arrow and Debreu long ago addressed the value of risk sharing markets for society. Failures in insurance markets provide a rationale for governmental intervention, but only if governments can fix the problem at lower cost than the social benefits derived. And governments of all hue and color around the world have intervened with a range of risk management programs for rural people (e.g. crop insurance, livestock feed subsidies, herd restocking). Such programs have often proved an expensive drain on the public purse, and there is little evidence to show that these interventions have generated any sizeable social benefits, or that the benefits exceed their costs on average (Hazell, Pomareda and Valdes).

Given these failings, many governments must rely on various forms of direct disaster assistance to relieve the problems of stricken areas. For many small countries, such government assistance can be extremely costly and may represent a high percentage of GNP when the disaster is large. This cost may escalate in the future as more people live in vulnerable areas and as global

climate change increases the frequency and severity of many natural disasters. Moreoever, once disaster assistance has been institutionalized and people know they can count on it, then it has many of the longer term effects of an insurance subsidy that inadvertently worsens future problems by encouraging people to increase their exposure to potential losses. For example, compensation for flood or hurricane damage to homes can lead to the building of more houses in flood and hurricane prone areas. Similarly, compensation for crop losses in drought prone areas encourages farmers to grow more of the compensated crops even when they are more vulnerable to drought than alternative crops or land uses.

What are needed are more effective mechanisms for enabling rural people to better manage their own catastrophic risks. While some disaster assistance should never be ruled out, the burden on government might be substantially reduced.

New Approaches to Insurance: Using Index and Area-Based Contracts to Insure Natural Disasters

What is needed is a system of insurance that meets the following requirements:

1. It is affordable and accessible to all kinds of rural people, including the poor.

2. It compensates for catastrophic income losses to protect consumption and debt repayment capacity.

3. It is practical to implement given the limited kinds of data available in most developing countries.

4. It can be provided by the private sector with little or no government subsidies.

5. It avoids the moral hazard and adverse selection problems that have bedeviled most agricultural insurance programs.

Area-based index contracts, such as regional rainfall (and other weather) insurance could meet all these requirements.

The essential principle of area-based index insurance is that contracts are written against specific perils or events (e.g. area yield loss, drought, or flood) defined and recorded at a regional level (e.g. at a county or district level in the case of yields, or at the local weather station in the case of insured weather events). Insurance is sold in standard units (e.g. $10 or $100), with a standard contract (certificate) for each unit purchased called a Standard Unit Contract (SUC). The premium rate for a SUC is the same for all buyers who buy the same contract in a given region, and all buyers receive the same indemnity per SUC if the insured event occurs. Buyers are free to purchase as many units of the insurance as they wish.

A simple example is drought insurance. Insurance contracts are written against severe rainfall shortfalls (say 30 percent or more below norm) measured at a regional weather station. The insurance is sold in standard units and all buyers pay the same premium and receive the same indemnity payment per unit of insurance. Similar kinds of insurance contracts can be written against other natural disasters, including flood, hurricane and hail losses.

Area-based crop yield insurance is a good example of such a scheme. In this case the insurance is written against the average yield for a region (e.g. a county or district), and a payment is made whenever the measured yield for the region falls below some pre-defined limit (say 80 percent of normal). Such schemes already exist in the US, India, Sweden, and the Canadian province of Quebec (Miranda; Mishra; Skees, Black, and Barnett).

Area-based yield insurance requires long and reliable series of area-yield data, and this kind of data is not available in most developing countries. Hence alternative weather indices may be more attractive, such as area rainfall or temperature, for which there are available time series data that is collected on a regular basis.

Area-based index insurance has a number of attractive features:

- Because buyers in a region pay the same premium and receive the same indemnity per SUC, it avoids all adverse selection problems. Moreover, the insured's management decisions after planting a crop will not be influenced by the index contract, eliminating moral hazard. A farmer with rainfall insurance, for example, possesses the same economic incentives to produce a profitable a crop as the uninsured farmer.

- It could be very inexpensive to administer, since there are no individual contracts to write, no on-farm inspections, and no individual loss assessments. It uses only data on a single regional index, and this can be based on data that is available and generally reliable. It is also easy to market; SUCs could be sold rather like travelers' checks or lottery tickets, and presentation of the certificate would be sufficient to claim a payment when one is due. In fact existing lotteries could be modified to include additional payments ("prizes") that would be payable to all buyers in the event that an insured event occurred.

- The insurance can be sold to anyone. Purchasers need not be farmers, nor even have to live or work in the region. The insurance should be attractive to anybody whose income is correlated with the insured event, including agricultural traders and processors, input suppliers, banks, shopkeepers, and laborers. Defining SUCs in small denominations would raise their appeal to

poor people. Insurance could also be built into credit and into the purchase price of key inputs like fertilizer.

- It would be easy for the private sector to run, and might even provide an entry point for private insurers to develop other kinds of insurance products for rural people. For example, once an area-based index removes much of the co-variate risk, an insurer can wrap individual coverage around such a policy to handle independent risk (i.e., certain situations where the individual has a loss and does not receive a payment from the area-based index).

- As long as the insurance is voluntary and unsubsidized, it will only be purchased when it is a less expensive or more effective alternative to existing risk management strategies.

- A secondary market for insurance certificates could emerge that would enable people to cash in the tradable value of a SUC at any time.

- Recent developments in micro-finance also make area-based index insurance an increasingly viable proposition for helping poor people better manage risk. The same borrowing groups established for micro-finance could be used as a conduit for selling index insurance, either to the group as a whole, or to individuals who might wish to insure their loans

A key question is whether the insurance would prove attractive to individuals. An index product should be more affordable than individual insurance, particularly if government does not subsidize either. Moreover, by offering an index contract that removes most of the systemic, correlated risk that an individual faces, he/she only faces independent risks that may more easily be insured through conventional insurance or credit markets.

However, a problem with index contracts is that an individual can suffer a loss and not be paid because the major event trigging a payment has not occurred. For example, a farmer with rainfall insurance could lose his/her crop to drought at a micro-location, but not receive an indemnity if the rainfall at the region's weather station remains above the trigger point. With index contracts it is also possible for an individual to be paid when they suffer no losses. In futures markets, this type of risk is referred to as basis risk. Index contracts essentially tradeoff basis risks for transaction costs, and the insurance will not be attractive if the basis risk becomes too high.

For a rainfall index, the degree of correlation between net receipts from the index and farm income will play a large role in the effectiveness of the risk protection offered to a farmer. With higher correlation there will be less basis risk. Understanding income-rainfall correlation requires crop yield modeling. Further, it is possible that a set of rainfall indexes may fit best for different farming systems. Farm income risks for certain crops may be most sensitive to rainfall

shortfalls at different times during the season (e.g. planting and blooming). Income may also be at risk during harvest if there is excess rain. The specific design of the index contract will also have a bearing.

Constraints to Area Index Insurance

In principle, one might expect the private sector to take the initiative in developing area-based index insurance, but there are several setup problems that might require a public intervention to jump start activity in many developing countries. Setting up the basic infrastructure to get started may be an important government activity. Start up activities include a) the research costs of identifying key catastrophic weather events that correlate strongly with agricultural production and income in different types of rainfed agricultural regions; b) educating rural people about the value of weather insurance; c) ensuring secure rainfall stations; d) establishing an appropriate legal and regulatory framework for weather insurance; and e) underwriting the insurance in some way (perhaps through contingent loans) until a sufficient volume of business has been established that international reinsurers or banks are willing to come in and assume the underwriting role for themselves. These roles need not be costly but could prove crucial in launching weather insurance. But it is also important not to launch the insurance on a heavily subsidized basis, so as not to distort incentives for private insurers or farmers.

Despite the promise of area-based index insurance, there are significant issues that must be resolved. These are a) the need for secure rainfall measurements, b) the actuarial challenges that are present due to the El Nino Southern Oscillation (ENSO), and c) the covariate risk problem for the insurer.

Secure Rainfall Measures

The proposed insurance depends on the existence of tamper proof weather stations to ensure reliable readings on insured events. This problem can be resolved through new hardware systems that eliminate any direct human involvement in the recording process. Readings can also be verified with remote sensing data taken from satellite images (e.g. soil moisture content as a check on low rainfall readings).

Secure and reliable rainfall measures are critical for all parties. New technologies hold significant promise. One company in the US offers a rain gauge operated by a battery with a five-year life. Tiny buckets trip the measuring device so that rainfall at .01 of an inch can be recorded, but no rain is actually collected and stored. By using a data jack with windows based software, a worker simply plugs into the rainfall-measuring device and downloads the data. It is not necessary to take frequent readings; in fact intervals of up to a month are adequate. A complete system of 50 such gauges, software and data jack cost about $240 each. This is affordable and offers the opportunity to densely populate a region

with rain gauges. Such coverage would permit readings from several adjacent gauges to be averaged to provide more reliable point estimates for a region. It would also reduce the danger of disorted readings should an individual tamper with a single gauge. Security can be enhanced by placing the rain gauges on telephone poles with shields around them from below.

El Nino Southern Oscillation

The actuarial soundness of the insurance could be undermined by the ENSO phenomenon that changes the probability of the insured events. It may be necessary to adjust the cost of the insurance when an ENSO event is confirmed, although this would require sufficient lead-time between knowledge of the pending event and the time of selling insurance. The most troublesome aspect of ENSO events in some parts of the world is that they extend across multiple crop seasons. It might be necessary to sell contracts a few years into the future before anyone has knowledge of the ENSO. For example, contracts that cover individual years for three years into the future may need to be sold as a package.

Finding Efficient and Affordable Mechanisms to Share Covariate Risk

The insurer faces high risk because of the covariate nature of the insured risk. When a payment is due, then all those who have purchased insurance against the same weather station must be paid at the same time. Moreover, if the insured risks at different rainfall stations are highly correlated, then the insurer faces the possibility of having to make huge payments in the same year. To hedge against this risk, the insurer can either diversify regionally by selecting weather stations and risks that are not highly (positively) correlated, or sell part of the risk to the international reinsurance and financial markets.

The prospects of diversifying risks across regions is feasible within some large countries, but is unlikely to be sufficient for most developing countries. International reinsurance is already available for some kinds of natural disaster risk. The simplest form of reinsurance is a stop loss where the primary insurer pays a premium to get protection if their losses exceed certain levels. Other forms of reinsurance are also common. Quota-share arrangements involve simply sharing both premiums and indemnities.

Despite significant growth in the international reinsurance markets in recent years, reinsurance markets are still thin with few large international firms and limited capacity. Kunreuther, Stipp, and Froot review some of the problems with reinsurance markets. Reinsurers have short memories, and after a major catastrophe reinsurance prices increase greatly or the reinsurer simply pulls out of the market. This happened in Florida after Hurricane Andrew and in California after the Northridge earthquake. State reinsurance pools were created in both Florida and California to offset these problems (Noonan; Jaffee and Russell).

Similar problems have arisen since the terrorist attacks in the US of September 11, 2001.

As an alternative to formal reinsurance, recent developments in global financial markets are making it increasingly feasible to use new financial instruments to spread covariate risks, like regional rainfall, more widely (Cole and Chiarenza; Doherty; Lamm; Skees 1999b; Skees and Barnett). For example, "catastrophe" bonds offer innovative ways of packaging the risks assumed by a rainfall insurer to sell in the international financial markets. "Catastrophe" bonds issued against rainfall events in developing countries could be very appealing to international investment bankers because their risk would be uncorrelated with the risks of most other financial investments.

There is also some promise that exchange markets can be used as risk-sharing institutions for disasters. The Chicago Board of Trade (CBOT) already trades a Catastrophic Insurance Options Contract (CAT) that allows those at risk from large property and causality losses due to hurricanes or earthquakes to share some of that risk with a larger community of traders in an exchange market. The contract has grown a good deal in recent years but still comprises only about two percent of the total market.

Skees and Barnett go further by proposing that governments could offer some very low-level index contracts to reinsurers to assure that adequate capital is forthcoming. Lewis and Murdock make a similar proposal for the US government to offer excess of loss contracts to the private sector. Since the insurer will likely load for events that have not happened yet, this may be important. One way to facilitate this would be to have the government offer options on rainfall that is at the lowest level experienced in recent decades. Primary insurers and reinsures would determine how many and what mix of such contracts to purchase from the government. These contracts could be simply rated at the historical break-even rate, or they could be auctioned to the highest bidder. The World Bank, IDB or others in the capital markets could back up these contracts with a contingency loan so that the government would have sufficient capital to pay all losses if the bad year came before an adequate reserve had been built up. In effect, the capital markets would be offering a stop-loss type contract to the government.

Conclusions

A market-based, risk-sharing insurance alternative for natural disasters has many potential advantages. By making insurance available, the government may not have to provide free disaster aid. Other efficiency gains should be expected as well as farmers may be more flexible in taking advantage of the benefits of specialization. To the extent that market-based insurance can serve the risk management needs of the rural poor, it can also help redress important food security problems.

Unlike traditional agricultural insurance, properly designed area-yield or weather index insurance contracts require less monitoring to control adverse selection and moral hazard. In addition, administrative costs should be low. A variety of rural people could purchase area-index insurance contracts in addition to small-scale farmers. They could also be sold in small units that might appeal to poor people. Finally, creative forces within financial markets should be able to use index insurance contracts to handle covariate risk. Wrap-around products that cover some additional risk are possible. Microfinance entities could use the contracts to handle major risk and offer better terms of credit. Many possibilities exist for using this type of insurance to further develop markets for sharing risk

Despite the promise of index insurance contracts, some key issues must be addressed. All parties must be confident that the measurement of what will trigger payments is secure and accurate. There must also be confidence and transparency in the procedures used to develop premium rates. Great care must be used in designing contracts that match what is at risk for most people. Marketing plans must be developed that address how, when, and where index contracts are to be sold. Also, the government and other involved institutions must consider whether to facilitate and regulate secondary markets of exchange for the contracts. Finally, reinsurance or effective and efficient use of other financial markets will be critical for sharing the covariate risk represented in index contracts. These risks must be spread around the world to obtain the best pricing.

Once properly constructed index contracts are in place, it should be possible to obtain efficient pricing in the international markets. Governments can build the infrastructure for measuring the index and monitoring the information to add credibility. Governments may also become involved in selling very low options on the index in order to improve the pricing. These options could be secured by contingency loans with an international bank (e.g., the Inter-American Development Bank or the World Bank). Again, there are many possible evolutions in the market once an effective index contract is trading. These developments should be oriented toward market-based insurance. Governments should not engage in attempting to protect farmers from independent risk. This effort should be left to the private sector.

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