Public-Private Partnerships for Agricultural Risk Management through Risk Layering

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Public and Private Risk Management

AGRICULTURAL SHOCKS come in a variety of shapes and sizes. Catastrophic droughts and floods can destroy productive assets and reduce yields to a tiny fraction of normal levels. Absent rapid disaster assistance, such events can decimate savings and force poor families deeper into poverty from which some will not escape. (For an analysis of catastrophes in Ethiopia and Honduras, see Carter et al., 2007).

Yet catastrophes are not the only risk faced by farmers. Less devastating, but more frequent, weather events also buffet the agricultural sector. Yields that decline to “only” 60% or 70% of normal levels may not threaten family survival, but they do destroy the working capital of the small farmer and threaten her future viability as a commercial producer. Anticipation of such losses forces small farmers into conservative production strategies that limit their growth and income even as they keep risk exposure at manageable levels.

While the anatomies of catastrophic and commercial shocks are different, they are ultimately driven by the vagaries of the same uncertain events, rainfall, insect invasions, etc. And while the public sector often takes responsibility for disaster relief in time of catastrophe, and private individuals manage their own commercial risks, both public and private actors can benefit from a single high quality data system that can make the risk management efforts of each more effective and affordable. In other words, it is time to investigate a public-private partnership around the information system needed to employ insurance (also known as risk transfer) contracts to manage both commercial and catastrophic risks.

Increasingly governments are stepping into disaster relief in times of catastrophes. For example, a government may judge that when yields drop below 50% a catastrophe has occurred and may provide relief. If there is accurate yield information, the assistance can be targeted and proportional to the disaster. The financial burden of relief is substantial, though less costly than a delayed reaction, and governments are increasingly turning to international financial mechanisms, such as insurance, to build fiscally responsible relief programs.

Meanwhile the private sector is turning to index insurance, a market-driven product that empowers farmers to financially prepare for years with poor harvests. Index insurance is a low-cost product relying on a validated data source, such as weather readings, area yield information or satellite imagery of ground cover, to create an index correlated with yields (Carter 2011 discusses alternative indexes in more detail). In years when harvests are poor, for example between 50-80% of average, farmers receive a payout that covers farm investment costs and gives them the chance to re-engage in productive activities the subsequent year, protecting their commercial viability.

The crucial element for innovative insurance products is reliable data on weather or area yields, which is the same information a government needs for effective disaster response activities. Forming partnerships between the public and private sectors by unifying information systems will enable...
governments to provide fiscally responsible catastrophe protection while individuals can purchase insurance products to protect their livelihoods. This brief will examine the parallel but currently separate efforts by the public and private sectors and demonstrate how combining efforts could lead to important synergies and advantages for both sectors. What are the different levels of weather risk faced by farmers? To what extent could information systems allow for more targeted disaster response? How could these public information systems create accurate and lower cost private risk transfer tools? How could collaboration create synergies? This brief will explore these questions in the context of Ecuador.

**Risk Layers and Insurance**

Rural households engage in agriculture knowing that weather fluctuations will cause bountiful harvests in some years and poor harvests in others. Figure 1 illustrates how a single index based on area yield can be used to design contracts to deal with commercial and catastrophic risk. The dashed line in Figure 1 represents the simulated yields for an individual rice farmer from the Palenque region of coastal Ecuador. The solid line is the simulated area yield (i.e. average yield across farms within the contract region). For purposes of this figure, the contract region is a UPM (Unidad Primaria de Muestreo), a geographic sampling unit of 500 hectares used in the Ecuadorian government’s yield survey. National yield survey data were used to estimate the distribution of area yield in the UPM. Random draws from the estimated distribution were used to generate both individual and area yields, which then accurately represents the kind of risks a farmer might face over the next 20 years.

As can be seen, average yields in this area are just over 4000 pounds per-hectare. When yields are at this level or above, farmers are able to pay off their debts, meet the family’s consumption needs and preserve or expand their productive asset base. The first risk layer, which we refer to as the Risk Retention Layer, corresponds to yields between 3200 and 4000 pounds (80% to 100% of the historical average). While farmers make little if any money in these years, most can, by drawing down savings or seeking supplements from family and friends, repay debts, meet family consumption needs and maintain their commercial viability for the next season.

The second risk layer—the *Commercial Risk Layer*—corresponds to yields between 2000 and 3200 pounds (50% to 80% of the historical average). In Ecuador, we expect yields to dip to these levels once every five years or so. At these levels, local risk coping strategies become overwhelmed and farmers struggle to repay debts and maintain the level of working capital required to enable a return to high yielding production in future years. The use of insurance contracts to transfer this commercial risk out of the community can be highly advantageous, as we discuss below.

The third and final risk layer, the *Catastrophic Risk Layer*, corresponds to yields that are less than half of their normal level. For Ecuadorian rice farmers, yields are expected to collapse to these levels once every 10 or 15 years. In these catastrophic circumstances, farmers and their communities need external resources if they are to avoid long-term and irreversible consequences to their farming businesses and to the well-being of their children and other family members. While governments have long responded to catastrophic disasters with various forms of assistance, several countries in Latin America, including Ecuador, Mexico and Peru have recently explored the use of insurance contracts to provide the needed resources when yields fall to these catastrophic levels.

While the layers of risk managed by private individuals and the public sector are different, both can potentially benefit from insurance or risk transfer contracts that are triggered by the same area yield index (or some other measure, such as rainfall, that reliably predicts local yields). An area yield index measures average yields within a specific geographic locality, such as a municipality, and if well designed
can provide reliable quantitative information on the timing, severity or breadth of the disaster, allowing disaster assistance to be properly targeted to the areas in greatest need. The unpredictability of weather makes it difficult for governments to include resources for relief activities in annual government budgets. Index insurance offers a fiscally sound solutions, as governments would pay relatively small premiums each year and in return would receive large indemnity payments. These payments can then be transferred to households, allowing them to repay debts while maintaining sufficient asset levels to avoid falling into a poverty trap.

An area yield index can also be used to manage the commercial risk layer. Recall the dashed line in Figure 1 simulates yields for an individual farmer for a 20 year period. An index insurance contract for this farmer would offer indemnity payments every time the area yield index (represented by the solid line in the figure) falls below a trigger level of 3200 pounds (or 80% of historic average yields). Note that this insurance is not perfect. For example, in year 2016 of the simulation, the farmer's individual yield is less than 3200 pounds, while the area yield index remains above its trigger level, meaning that the farmer would receive no payment even though she suffered losses. Despite these imperfections, which can be minimized through careful contract design, individual and area yields tend to track each other relatively well and the insurance usually pays off when warranted.

While index insurance is not perfect, as long as area yield information is available it is relatively low cost to administer because it eliminates the need for on-farm verification of losses, and it reduces moral hazard and adverse selection. These latter three problems tend to cripple the operation of conventional insurance, especially for the small farm sectors where such costs are high relatively to the modest amounts of insurance coverage that small farmers require.

While there is still much to learn about the effectiveness of index insurance for small farmers, the benefits are potentially large. In bad years, farmers who insure the commercial risk layer receive indemnity payments that allow them to preserve working capital, repay loans and sustain their commercial viability. In addition to this direct risk reduction, farmers may indirectly benefit by improved terms of access to credit. If farmers are insured, lenders would face lower default risk and thus may lower interest rates and expand credit supply. Taking the direct and indirect effects together, index insurance may crowd-in credit supply and increase the use of productivity enhancing agricultural inputs and generate an expansion of area planted to more remunerative commercial crops (see Carter 2011 for more discussion).

In summary, with the right information infrastructure in place, a single yield index can allow the creation of risk transfer contracts for both the commercial and catastrophic risk layers. Before turning to a discussion about what that infrastructure might require, the next section will use the Ecuadorian data to illustrate a concrete layered risk transfer strategy that could be employed by public and private actors.

A Unified Risk Transfer Contract

Using the concrete case of Ecuadorian rice farming, Figure 2 illustrates how a single underlying index, in this case area yield, can be used to design one contract that insures farmers against both commercial and catastrophic risk. Alternatively, the single index could be used to design separate contracts; one for commercial and one for catastrophic risk, thereby allowing flexibility in the balance between the state and the private sector in facilitating risk management for small farmers.

While a variety of payoff structures are possible, we illustrate the case when farmers receive a single fixed payment of $200 per-hectare when area yields fall between 2000 and 3200 pounds per hectare, which is between 50% and 80% of their historic average. A payment of this amount would roughly allow farmers to recover their working capital, preserve creditworthiness and continue production next year. The red bar in Figure 2 (Box B) illustrates this first step of the payout function, corresponding to protection against commercial risk. Also illustrated in Figure 2 is the estimated probability function for the UPM-level, area yield index (shown as the solid curve). The combination of the payoff function plus the probability function will allow us to price the contract. The blue bar in Figure 2 corresponds to the second step of the payout function and shows that a farmer would receive a payment of $500 per hectare in the event of a catastrophic yield loss, i.e. when area yield
falls below 2000 pounds per hectare, which is 50% of the historic average.

How much would this insurance cost? In insurance analysis, it is typical to begin with the “actuarially fair” or pure premium, which is equal to the value of expected payouts. The full market price of an insurance contract is some mark-up over the pure premium. In US crop insurance, the mark-up is about 20% for index insurance contracts, with this extra charge used to cover administration and other costs of the insurance company.

In the Ecuadorian case, the pure premium for commercial coverage (represented by Box B) would be $12/hectare. The market price (with a 20% markup) would be $15/hectare. The pure premium for the catastrophic layer (represented by Boxes A and C) would be $20/hectare, with a market price of about $24/hectare. The integrated contract offering both commercial and catastrophic protection would have a pure (market) premium of $32 ($39) per-hectare.

Under one scenario, the public sector could pay the full price for the catastrophic risk layer ($24/hectare) and the farmer could pay for the commercial risk layer ($15). Alternatively, the farmer could pay for the full cost of the first $200 in coverage (Boxes B and C) while the public sector could pay for the additional $300 indemnity that is paid when yields are catastrophically low (Box A). In this case, the farmer’s share of the market premium would be $24/hectare and the public’s social protection share would be $15.

This example of a unified risk transfer contract is meant to illustrate the range of possibilities that might exist. From an economic perspective, the public’s share of the unified premium is less a subsidy and more a way of public budgeting for social protection as part of an overall development policy. From the farmer’s perspective (and that of the agricultural finance system), the transfer of commercial risk should pay for itself in terms of reduced credit costs and increased average farmer incomes.

A Unified Information System for Risk Transfer

Designing contracts requires accurate information systems. In this example, reliable time series data on area yield is required to design the contract. Other indices requiring alternative information sources can be used, such as rainfall, temperature, satellite imagery of ground cover or hybrids of these. The key to an index, and the information underlying it, is that is highly correlated with actual output. It should also optimally weigh the tradeoff between reducing basis risk verses higher operational costs. Basis risk is the risk that an individual farmer suffers a yield loss but does not receive an insurance payout because the index (i.e. area yield) was high. Basis risk has three causes: pure idiosyncratic risk, lack of accuracy caused by the geographic scale of the index, and lack of accuracy caused by index prediction errors.

Lack of accuracy due to either geographic scale or index prediction errors are together referred to as design effects because these can be minimized by choosing an appropriate index and intelligent contract design. Mitigating idiosyncratic risk is more challenging as, by definition, this type of risk is unrelated to factors such as drought that cause widespread highly correlated losses. Imagine, for example, highly localized hail that damages only a few fields. If this type of risk dominates an agricultural region, index insurance may not be the most effective risk transfer tool. If instead most crop losses are due to covariate risks such as drought, well designed index contracts can significantly reduce basis risk.

The challenge lies in the tradeoff between reducing basis risk versus higher costs. A contract based on directly measured area yield in a small, homogeneous region will have relatively low basis risk. This reduction in basis risk would of course need to be weighed against the potentially higher operational costs which result from on the one hand the need to directly measure area yields (for example via crop cuttings or farmer surveys) and on the other hand the
need to design a larger number of contracts to cover a given area. To reduce costs, the design can be modified by increasing geographic scale or selecting a new information source, one that aims to predict, rather than directly measure, yields. In regions with distinct microclimates, such as the Sahel region of Africa or mountainous regions of the Andes, expanding the geographic scope of an index may increase basis risk to the extent that a contract would offer only minimal risk protection. The second way to reduce costs is by predicting yields, for example by measuring rainfall and modeling the effect rainfall has on yields or by remotely sensing vegetative cover and modeling the effect pasture “greenness” has on livestock mortality.

As a final stage in contract design, ground truthing multiple contracts by comparing how close each contract tracks actual losses is a crucial step in contract selection. It is important to remember that basis risk will exist in any index insurance product. However given its potential to effectively mitigate correlated risk at relatively low cost and potentially allow for agricultural credit expansion, index insurance may go a long way towards enhancing the efficiency of and providing social protection to the small farm sector.

Whichever index is ultimately deemed optimal, it is clear that a single information system can serve to transfer risk from both the commercial and catastrophic risk layers. Index insurance contracts, be they for the commercial or catastrophic risk layer, rely upon information systems for their creation and monitoring. Governments are establishing catastrophic assistance programs but are limited by a lack of information, which impedes delivery and reduces the effectiveness of social protection programs. Meanwhile the private sector is hindered in creating effective contracts by the limited scope of data available and the low quality of existing data. The potential synergies created by coordinating these parallel efforts and investing in a unified information system are enormous. Bringing together public and private sector efforts would benefit both sectors and facilitate economic growth and stability.

reduce rural poverty and overall inequality in Latin America. Governments throughout the region have begun to recognize that helping the small farm sector manage risks can be a key to helping integrate small holders into existing value chains, allowing the agricultural sector to realize its important role in economic development.

While conventional multi-peril insurance contracts (which can be tailored to individual needs) may seem tempting, their high operating costs and their susceptibility to moral hazard and adverse selection make it unlikely that they offer a sustainable risk management option for small farmers in the region. Given recent advances in index insurance globally and the renewed interest of governments in the region to provide social protection against catastrophic events, it is an opportune moment to explore the viability of index insurance as a more holistic option.

Instead of expensive premiums of conventional insurance contracts, governments have a chance to invest in improving information systems, and thus provide a key public good which would both allow the private sector more easily design low cost insurance policies and the government to effectively tailor disaster assistance. In Mexico, the government has invested in agricultural information systems and developed an index-based catastrophic insurance policy for small holders. Initial evidence (Fuchs 2011) suggests that this reduction in risk has led to significant yield gains.

Information systems are the key to low cost and effective risk management tools. Only together do the public and private sectors have the resources and expertise to establish information systems and develop insurance products to protect farmers against both commercial and catastrophic risk. Index insurance may hold the key to unlocking agricultural growth, empower smallholder farmers and deepen rural financial markets, ensuring that gains in development are sustainable. 14

Moving Forward in Latin America

As argued in the 2008 World Development Report, Agriculture for Development, enhancing small farmers’ participation in the modern agricultural sector will
Further reading


