WEATHER RISKS AND INSURANCE OPPORTUNITIES FOR THE RURAL POOR

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INTRODUCTION

As climate variability gains prominence in the international policy agenda, public and private sectors alike are increasingly considering strategies to cope with its economic and social consequences. In turn, the general public—faced with a growing number of extreme weather events and natural hazards—is beginning to demand concrete action. One sector where climate variability and its associated risk have the most damaging impact is the rural economy,[1] in particular smallholder farmers. This brief outlines some of the adverse effects that climate variability has on the rural economy and describes how different insurance mechanisms can contribute to reducing vulnerability and increasing resilience to weather risks.

WEATHER AND THE RURAL SECTOR

Agricultural production and its associated value chains are at the center of rural economies. In both developed and developing countries, agricultural production is directly tied to weather variables such as rainfall, temperature, humidity, and wind. When extreme weather conditions occur, agricultural production typically suffers and in some cases may be lost completely.

Year after year, unexpected weather extremes are a constant in several regions of the globe, with devastating effects on agricultural production and rural livelihoods. Prolonged droughts in the Horn of Africa and US Midwest, extensive floods in the Philippines and North India, abnormally low temperatures in Japan and the United States, and heat waves in Australia and Europe are recent examples. In addition, some extreme weather events allow pests and diseases to flourish, potentially crippling agricultural production over vast regions.

Negative weather events constitute a major source of risk[2] for agricultural producers, who may experience income reduction due to crop and animal losses. These effects are often transmitted to other actors in the agricultural value chain (traders, wholesalers, processors, suppliers), with linkages to financial markets (through loan defaults, illiquidity, and so on). Furthermore, spillovers from large weather shocks impact the nonfarming sector through depressed local demand, dampened economic activity, and price increases due to a lower local food supply. Finally, extreme weather events may destroy local infrastructure (roads, bridges, warehouses, schools, health facilities), causing additional damage to the rural economy.

WEATHER AND THE RURAL POOR

While weather extremes and climate variability negatively impact many rural actors, the rural poor are the most vulnerable group. In developing countries, the livelihoods of the rural poor depend largely on small-scale, subsistence farming activities. In addition, large weather shocks can depress rural nonfarm activities that represent an important income source for the landless and a fallback alternative for farmers. Thus, weather risks can have a disproportionate negative impact on the incomes and well-being of the rural poor, an impact compounded by their limited capacity to cope with these risks. Faced with a reduction in current income due to a transitory weather extreme, and lacking proper financial instruments to smooth this shock (insurance, savings, or credit), the poor often must resort to costly and limited coping strategies. Thus a temporary weather shock might turn into a long-lasting—or even permanent—wealth shock that may push households into a poverty trap. For instance, they may be forced to choose between liquidating a fraction of their productive assets (such as livestock, tools, or land)—compromising their future growth potential—or reducing current consumption—putting the burden on future human capital development, particularly that of young children in the household.[3]

TRADITIONAL RISK-COPING STRATEGIES

In this context, rural households have traditionally resorted to a number of informal risk-coping mechanisms. Examples of these include holding savings (either in cash, in kind, or through semiliquid assets), borrowing from informal sources, income transfers within a social or family network, and income diversification—both by diversifying agricultural activities and by mixing agricultural and nonagricultural labor. Most of these strategies, however, are costly and have limited risk-mitigation potential. For instance, loans or gifts from other households have the potential to protect from idiosyncratic shocks (that is, unexpected losses that affect a reduced number of households within a locality or social network) but are ill suited to protect against systemic (or common) shocks, which affect most households in a given region and thus undermine their capacity to support each other. Informal savings are perhaps too costly for a population that likely should invest its resources in assuring adequate food intake for household members, in human capital improvements, and in productive opportunities. In addition, diversification strategies may come at an efficiency cost—that is, they may impede rural farmers from capturing the full range of benefits from specialization or keep them from investing in risky capital and technology with higher expected incomes.

FORMAL WEATHER INSURANCE MECHANISMS

Formal risk-sharing mechanisms take advantage of the fact that in a large enough population, only a *fraction* of individuals may suffer a negative risk shock. For example, in a given year only a small fraction of drivers are involved in car accidents. By pooling risks within a large population, formal insurance programs can provide an efficient risk-sharing mechanism in which all contribute with premiums but only those who experience a loss get compensated. Furthermore, because insurance markets can pool risks across a broad scope of activities and large geographic areas, they can lower the costs of dealing with systemic risks through diversification. The most common type of insurance is known as indemnity insurance, whereby compensations rely on identifying specific losses and indemnifying the individual against them.

While in theory the same principles should be applied to weather risks and rural populations, the reality is that most countries lack standard indemnity agricultural insurance markets (with the exception of certain developed countries or large subsidized systems in a few developing ones, usually involving considerable public intervention). Multiple-peril crop insurance, for example, which can protect against any source of risk affecting yields, has been unsuccessful commercially without large subsidies. Single-peril crop insurance, which covers against a specific factor affecting the crop (such as hail or wind), has had more success, though it has been developed only at modest scales.[4]

There are a number of reasons why agricultural indemnity insurance has failed to expand successfully in developing countries. Possibly the most important is that among small farmers the costs of loss verification, which typically requires a site visit, can be considerable relative to the sum being insured, especially if rural infrastructure is inadequate. Moreover, the lack of formal financial service networks and legal records may add to the cost of premium collection and compensation disbursement. Second, indemnity insurance is prone to significant information asymmetry problems such as adverse selection (whereby only the most at-risk farmers purchase insurance) and moral hazard (whereby an insured farmer may not exert optimal effort to reduce risk or mitigate its impact).[5] Both of these problems generally result in an increased cost.

INDEX-BASED INSURANCE, A FORMAL INSURANCE OPPORTUNITY FOR THE RURAL POOR

As a result of these market failures, an increasing trend has been to explore an alternative type of weather insurance product for smallholder farmers.[6] Under weather *index* insurance, a somewhat recent innovation that is possibly more suitable for rural areas in developing countries, farmers get a prespecified compensation according to the value of a particular weather variable (the index).[7] For instance, an index insurance product against drought would pay farmers when rainfall (as measured at a specific weather station or by satellite) is below a certain predefined "trigger," generally with higher payments for lower rainfall. The key assumption is that by carefully selecting a weather index one should be able to estimate agricultural losses with a sufficient level of confidence.

Some regard index-based insurance as having great potential to reach smallholder farmers in developing countries because (1) payouts are based only on publicly observed data (the index), drastically reducing loss verification costs; (2) adverse selection and moral hazard problems are minimized;[8] and (3) compensations can be automatically determined and thus disbursed quickly to farmers. This makes insurance easier and cheaper to administer, and thus potentially more affordable for the rural poor. These characteristics of index insurance have attracted donors and governments alike. In the past 15 years many international organizations, researchers, and microfinance institutions have conducted pilots in developing countries to demonstrate index insurance advantages and learn best implementation practices, with the hope that private insurers would eventually scale these pilots up.[9]

There have been a number of seemingly successful implementations of index insurance. In India alone, more than nine million farmers purchase these hedging products to insure against weather risk,[10] although this can be partly explained by the fact that agricultural insurance is mandatory in order to gain access to agricultural loans subsidized by the government. In the United States, a large federal index-based insurance program protects farmers against a variety of weather risks, although the system is highly subsidized. Other examples include the R4 / Horn of Africa Risk Transfer for Adaptation program in Ethiopia and Senegal, and Kilimo Salama in Kenya and Rwanda, with relatively more modest yet significant take-up rates.

More generally, however, index insurance pilots in developing countries have repeatedly experienced low take-up, perhaps due to lack of trust in the insurance company, lack of understanding of the product, liquidity constraints, or crowding out of insurance by implicit public guarantees (governments' providing emergency relief in the case of an adverse weather event).[11] While all of these mechanisms are also applicable to traditional indemnity insurance, index insurance suffers from one disadvantage: basis risk. This risk arises due to an index's inadequacy to perfectly capture the individual losses of an insured farmer, which can be related to a number of factors. First, the index is generally measured at a local weather station (or through not-fully-accurate satellite imagery) and not at the farmer's plot. Second, a simple weather index cannot capture the interplay of weather variables (temperature, rainfall, humidity, evapotranspiration, winds, and the like), nor can it account for variability in crop variety, soil quality, and farming practices. Third, other, nonweather events may impact crop growth, such as pests and diseases. Hence, there is a chance that a farmer, after having paid the premium, will not get a compensation even after experiencing a loss. On the other hand, it is also possible that without experiencing a loss a farmer may get a compensation.

Importantly, index-based products require data infrastructure as a precondition to their development. Sufficiently long historical time series are needed to estimate the probabilities of the weather index with an acceptable degree of confidence, and to assess the plausibility and appropriateness of a specific weather index. But data availability is a crucial problem in developing countries, where index insurance may hold the largest development potential—a problem that can be seen as a historical failure to provide a public good. While some data limitations can be increasingly ameliorated with remote sensing innovations via satellites (with an increasing number of satellite products spanning more than three decades of consistent data), indirect measurement of weather variables is inevitably imperfect, and its appropriateness relies on a number of factors specific to each intended application.[12]

RECENT INNOVATIONS AND FUTURE ACTIONS

Index insurance has potential as a formal and efficient risk management tool for farmers in developing countries, but its limitations have to be addressed. To reduce its complexity and to adjust better to farmers with different risk profiles, a team at the International Food Policy Research Institute has proposed a novel approach. The idea is to offer an array of products ("weather securities"), each with a simple payout structure: fixed compensation linked to a single trigger for the index. Under this approach, a farmer could create a portfolio of products (with different triggers, calibrated to protect against weather events of various intensities, and for different coverage periods) to suit his or her individual crop risk profile. Evidence from pilots suggests that farmers may value this simplicity and flexibility.[13]

To minimize basis-risk problems, focus could shift from insuring individual farmers to insuring so-called aggregators, such as farmer associations or pregroups[14] and microfinance institutions. For instance, an institution holding a significant portfolio of agricultural loans may be interested in insuring it against severe systemic shocks that may otherwise result in large loan write-offs. An advantage of such a system would be that individual (idiosyncratic) negative and positive basis risks could be largely offset by each other in the aggregate portfolio. Another proposal to minimize basis risk is to add "gap insurance" as a second tier of *indemnity* insurance—which would kick in only if the broader index product had not triggered. A related idea is "multi-scale area yield insurance,"[15] under which a product would combine two area-yield indexes measured at different geographic levels: a broader geographic index with a higher trigger and a local index with a lower trigger. Payouts would happen when both indexes are below their corresponding triggers. Finally, the increasing affordability of automatic weather stations and the expanding technologies (satellites) for remote sensing of weather variables and crops' growth have the potential to result in products with reduced basis risk in the near future.

Another line of action is related to the state's traditional role as a risk absorber of last resort. As mentioned above, once a major weather shock hits, it is fairly common for national, regional, or local governments to give in to the pressure for emergency assistance. Therefore, it seems natural to insure these agencies against weather risks. Upon the occurrence of an extreme weather event, then, an insured agency or local government would receive a direct payout to implement emergency relief and food safety programs. Such arrangements are already being implemented in developed countries and expanding into developing countries, particularly those prone to natural catastrophes.[16]

In sum, formal weather index insurance holds the potential to directly contribute to the resilience of the rural poor in developing countries by protecting them against increasingly probable weather extremes. Evidence from several insurance pilot programs shows that while this potential is real, additional work and innovations are needed to produce a sustainable expansion of efficient agricultural insurance markets in developing countries. Now there is great body of expertise and professionals from both public and private institutions who are actively engaged in bringing in innovations, improving index products, and finding effective ways to scale up insurance programs. By supporting the implementation of innovative weather insurance pilot programs aimed at addressing past challenges, policymakers can actively contribute to the resilience of the rural poor facing weather extremes and provide them with much-needed opportunities to escape poverty.

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NOTES

[1] For quantitative estimates of the impact of climate change on agriculture, see G. C. Nelson, H. Valin, R. D. Sands, P. Havlík, H. Ahammad, D. Deryng, J. Elliott, S. Fujimori, T. Hasegawa, E. Heyhoe, P. Kyle, M. Von Lampe, H. Lotze-Campen, D. Mason d'Croz, H. van Meijl, D. van der Mensbrugghe, C. Müller, A. Popp, R. Robertson, S. Robinson, E. Schmid, C. Schmitz, A. Tabeau, and D. Willenbockel. 2013. "Climate Change Effects on Agriculture: Economic Responses to Biophysical Shocks." *Proceedings of the National Academy of Sciences.* Published electronically December 16. doi:10.1073/pnas.1222465110.

[2] While irrigation, improved seeds, and enhanced farming practices can be used to reduce the dependence of crop and animal production on local weather realizations, a considerable fraction of residual risk remains.

[3] S. Dercon and J. Hoddinott. 2004. "Health, Shocks, and Poverty Persistence." In *Insurance against Poverty*, edited by S. Dercon, 123–136. Oxford, UK: Oxford University Press; C. Barrett and J. McPeak. 2006. "Poverty Traps and Safety Nets." In *Poverty, Inequality and Development: Essays in Honor of Erik Thorbecke,* edited by A. de Janvry and R. Kanbur, 131–154. New York: Springer.

[4] V. H. Smith and B. K. Goodwin. 2010. "Private and Public Roles in Providing Agricultural Insurance in the United States." In *Public Insurance and Private Markets*, edited by J. R. Brown, 173–210. Washington, DC: American Enterprise Institute.

[5] P. Hazell, C. Pomareda, and A. Valdes. 1986. *Crop Insurance for Agricultural Development*. Baltimore: Johns Hopkins University Press.

[6] P. Hazell, J. Anderson, N. Balzer, A. Hastrup Clemmensen, U. Hess, and F. Rispoli. 2010. *The Potential for Scale and Sustainability in Weather Index Insurance for Agriculture and Rural Livelihoods*. Rome: International Fund for Agricultural Development.

[7] A slightly different type of index insurance, area-yield insurance, does not rely on a weather variable as its index but instead focuses on whether the average yield over a specified area is above or below a threshold.

[8] Since losses are not assessed directly but only through the value of an objective index, the farmer's effort does not affect the probability of a payout—thus moral hazard considerations are dealt with. Additionally, because the probability of a payout is assessed objectively from the historical values for the index, the insurance company should not be concerned about which type of farmer buys this insurance—thus adverse selection is dealt with.

[9] Hazell et al. 2010.

[10] D. Clarke, O. Mahul, K. N. Rao, and N. Verma. 2012. *Weather-Based Crop Insurance in India*. Policy Research Working Paper 5985. Washington, DC: World Bank.

[11] M. Matul, A. Dalal, O. De Bock, and W. Gelade. 2013. *Why People Do Not Buy Microinsurance and What We Can Do About It*. Briefing Note 17. Geneva: Microinsurance Innovation Facility.

[12] For an example of alternative methods to estimate rainfall, see R. I. Maidment, D. I. F. Grimes, R. P. Allan, H. Greatrex, O. Rojas, and O. Leo. 2013. "Evaluation of Satellite-Based and Model Re-analysis Rainfall Estimates for Uganda." *Meteorological Applications* 20 (3): 308–317. For an insurance application, see S. Chantarat, A. G. Mude, C. B. Barrett, and M. R. Carter. 2013. "Designing Index-Based Livestock Insurance for Managing Asset Risk in Northern Kenya." *Journal of Risk and Insurance* 80 (1): 205–237.

[13] A pilot application of this approach in India can be found in R. V. Hill, L. M. Robles, and F. Ceballos. 2013. *Demand for Weather Hedges in India: An Empirical Exploration of Theoretical Predictions*. Discussion Paper 01280. Washington, DC: International Food Policy Research Institute.

[14] See A. de Janvry, V. Dequiedt, and E. Sadoulet. 2014. "The Demand for Insurance against Common Shocks." *Journal of Development Economics* 106:227–238; and S. Dercon, R. V. Hill, D. Clarke, I. Outes-Leon, and A. S. Taffesse. 2014. "Offering Rainfall Insurance to Informal Insurance Groups: Evidence from a Field Experiment in Ethiopia." *Journal of Development Economics* 106:132–143.

[15] G. Elabed, M. F. Bellemare, M. R. Carter, and C. Guirkinger. 2013. "Managing Basis Risk with Multi-scale Index Insurance." *Agricultural Economics* 44:419–431.

[16] Hazell et al. 2010.

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