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Capital Market Innovations and Cooperatives: A New Risk-Sharing Strategy for Agriculture (Joseph W. Glauber, presiding)

Opportunities for Improved Efficiency in Risk Sharing Using Capital Markets

Jerry R. Skees

This article reviews many of the recent risk-sharing innovations, including use of equity-based instruments for catastrophe risks and the new weather markets. The article discusses why the new innovations create more opportunities for using area yield and weather markets to share agricultural crop risk. In the companion papers that follow, Zeuli and Black, Barnett, and Hu demonstrate how these type of instruments can be used to share both throughput risks and create new opportunities for pooling individual risk for the particular case of a farmer-owned cooperative.

Changes in markets for sharing natural-disaster and environmental risks give new promise for creativity in risk sharing for the agricultural sector. Many of these innovations occurred after hurricane Andrew shocked the insurance world by creating financial losses beyond any level that was previously estimated. While the traditional markets have been insurance and reinsurance, there are new arrangements that may improve efficiency in pricing risk transfers. These new arrangements have potential applications in sharing crop yield risk, as these risks are correlated in nature just as hurricanes and earthquakes. The transaction costs associated with organizing reinsurance for correlated risks are high. High transaction costs create inefficiencies that result in incomplete markets for sharing certain catastrophe risks. Society should gain from new market-based risk-sharing arrangements that will complete these markets (Arrow).

If the new market instruments reduce the transaction costs and help stabilize catastrophe risk markets, then new opportunities for sharing crop yield risk may emerge. In the current policy environment, some may argue that such instruments are not needed for crop yields. After all, the government currently provides subsidized crop insurance to farmers via private companies that also have access to subsidized reinsurance. Clearly these interventions are inefficient (Skees). In addition, subsidized crop insurance is offered only to farmers. Agri-businesses also suffer financial losses when there is a widespread crop failure. Thus, the innovations reviewed here have broad implications for improving the efficiency of risk sharing in the agricultural sector.

Different Types of Risk Require Different Risk-Sharing Instruments

For some time markets have used two classes of contingent claims contracts for sharing risk: insurance contracts and futures exchange contracts (Miranda and Glauber). In both cases, a payment is made contingent upon the occurrence of some event that is expected to create financial losses for those holding the contracts. Insurance contracts work best when the risks being insured are independent, which means only a few insureds suffer a loss at any given time. For example, private insurance contracts work well for life, automobile, and home insurance. Pooling independent risk actually creates a lower expected risk than the

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mean of the independent risk (Priest). The problem of highly correlated risk has led to the evolution of well-functioning futures contracts. These markets have allowed participants to protect common and correlated risks such as changing commodity prices, interest rates, and exchange rates.

There are numerous risks that are neither independent nor highly correlated. These risks include those created by natural disasters. For example, when a hurricane or an earthquake occurs, not everyone has a total loss. Still, many losses do occur at the same time. Crop losses have similar characteristics. Although events such as too little rain, too much rain, or widespread frost create widespread crop losses, not every farm experiences the same loss. In the last two decades, economic losses from drought and excess heat in the United States have exceeded both hurricane and earthquake losses. The challenge for those insuring losses from hurricanes, earthquakes, and crop disasters is to have access to adequate capital to cover worst-case scenarios. Again, the $18 billion loss for the insurance industry due to hurricane Andrew, created tremendous stress in the international reinsurance community. Capacity to reinsure wind losses on the East Coast was very limited and expensive in the following year. The Midwest floods were in the year following Andrew. Next came the Northridge earthquake (Barnett). Each of these disasters precipitated new thinking about how to share catastrophe risk.

Traditional Methods for Sharing Catastrophe Risk

Since catastrophe risks are not independent and in the classic sense are uninsurable, how can markets share these risks most efficiently? The traditional mechanism is to share catastrophe risk with another insurance entity by what is called reinsurance. Reinsurance can take many forms. The two most common reinsurance arrangements are quota share and stop loss. A quota share is an arrangement in which the primary insurance company shares premium and risk in some proportion with a reinsurance company. A stop loss can be thought of as another insurance contract in which the primary insurer pays a premium to the reinsurer who agrees to pay for all losses beyond a certain threshold.

Although reinsurance markets are extremely effective and have grown in recent years, there are significant limitations. First, price discovery is difficult. There is no price transparency. The international reinsurance market is a classic thin market with few buyers and sellers. Second, transaction costs are high. Reinsurance contracts can be unique, requiring costly legal fees to tailor the contract to the special circumstances. Monitoring must also occur to reduce the likelihood of moral hazard. Third, the prices that must be charged for reinsurance may simply not match the willingness to pay. In addition to covering the transaction costs, prices are to build reserves and account for the ambiguity of catastrophe risk (Jaffee and Russell, Skees and Barnett). A lack of understanding about the risks and events being insured may cause insurers and reinsurers to set premiums too high (Camerer and Kunreuther, Hogarth, and Kunreuther).

Froot develops four explanations for the high price and low use of catastrophe reinsurance: (*a*) reinsurers have market power, (*b*) the corporate form for reinsurance is inefficient, (*c*) frictional costs of reinsurance are high, and (*d*) moral hazard and adverse selection at the insurer level are high. Most of the analytical review provided by Froot boils down to items that increase the transaction costs of getting reinsurance for catastrophes. Froot goes on to point to how insurance regulations increase the transaction costs even further and how free government-disaster assistance crowds out development of reinsurance markets. Finally, he discusses how decision makers may underestimate or simply not consider the very low likelihood of payment from reinsurance. Kunreuther et al. also reviews these cognitive failure problems in insurance and reinsurance markets.

New Market Instruments for Sharing Catastrophe Risk

New innovations are emerging to address the limits of reinsurance (Cole and Chiarenza, Doherty, Lamm). Many of these innovations are being called insurance securitization. Insurance securitization involves the creation of a marketable security that is financed by premiums flowing from a contingent claims transaction—generally the traditional insurance and reinsurance transactions. The concept is simple: If the risk can be standardized in some fashion and packaged into a market security, then many investors can participate in the risk sharing. Since capital markets trade

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many times the value of the entire reinsurance capacity, this access to additional capital with lower transaction costs should compensate for many of the limitations in the reinsurance markets. Despite significant growth in the volume of insurance securities, they remain a small percentage of the overall reinsurance market (roughly 5%). Still these markets hold promise, and there is considerable excitement in the industry about their potential (Elliott).

Two classes of equity instruments are being used to securitize insurance risk: exchange-traded indexes (e.g., the catastrophe or CAT contract on the Chicago Board of Trade [CBOT]), and risk-linked securities such as catastrophe bonds. Both provide a mechanism of risk transfer from a primary insurer to a large group of investors/speculators. As such, they serve as another type of reinsurance. The actual arrangement for these equity instruments can take many forms. In some cases, they will look very similar to reinsurance and protect against excess losses of the primary insurer. In other cases, they may simply be structured as an index product with an event-triggered risk (explained below). Beyond the security instruments that have emerged, event-triggered risks are being traded in other ways. The most significant event-triggered risk trades are in the new weather market, where both temperature and rainfall are being traded.

Exchange-Traded Indexes

Exchange-traded indexes offer the opportunity to receive payments based on the occurrence of some event. Sandor, Berg, and Cole write about the attributes needed for successful futures and options contracts on indexes. "First, the underlying index must be standardized and uniform. Second, the index formula must be well understood and verifiable. Third, the prices underlying the index and the index itself must be disseminated frequently and widely. Fourth, the index inputs should be competitively determined and not subject to manipulation. Finally, the market must perceive that the index accurately reflects value" (p. 6).

When an index contract is properly constructed, it is largely free of moral hazard because an individual who uses the index contract should be unable to influence the outcome that determines payments from the contract. Monitoring needs are reduced, lowering transaction costs. The payment is solely based on the index, not on what happens to the insured's individual losses. And while this may lower the price as it controls moral hazard and lowers transaction costs, it does mean that the insured faces a basis risk; that is, they can have a loss even when the index does not trigger a payment. The trade-off between increased basis risk and lower moral hazard is key. Because incentives are more properly ordered with an index contract, one can expect that there are opportunities for more price transparency and increased liquidity. Ultimately, secondary markets may also emerge, where individuals who purchase index contracts to protect against their risk exposure can sell the contracts as conditions change and they become more valuable to someone else who is at risk.

The PCS catastrophe (CAT) options that trade on the CBOT are the first exchange-traded indices. Property Claim Services (PCS) is an industry authority that has provided estimates of catastrophic property damage since 1949. PCS provides the data needed to trade and settle PCS CAT options. There are nine indexes (one national, five regional, and three state indexes) that track the PCS estimates for insurance losses resulting from catastrophes in each defined region for a specified loss period. The loss period is the time during which the catastrophe must occur; the most common loss period is set for quarterly losses. Thus purchasing a call option at some specified loss level will give a form of reinsurance when losses during a three-month period exceed the strike-loss level. The options are European, meaning they can only be exercised at the end of the contract. Cummins and Geman developed the economics of how to use and price the CAT contracts.

When the CAT contracts were first introduced (1992), there were fewer regions and they were larger in size. Restructuring the contracts and breaking the regions into smaller sizes helped the trading considerably. For all of the CAT contracts on the CBOT, the open interest exceeded 20,000 contracts in April and May of 1998 (Bouriaux and Himick). Since that time, open interest has declined as the entire reinsurance market has become softer.

In the spring of 1995, the CBOT introduced Crop Yield Insurance and Futures Options for corn. Sandor, Berg, and Cole were leaders in writing about what was needed and how such a contract might be designed. In the first year,

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there was considerable interest. Open interest exceeded 2,000. Iowa corn was the most active contract. The U.S. Department of Agriculture (USDA) estimates of harvested corn yield per acre is the basis for the index. One advantage of these contracts is that they could be traded throughout the season. This offers opportunities to offset risk positions at any time. There are a number of reasons why the crop yield contracts have not been successful. Government subsidized reinsurance offered to crop insurance companies and constraints in the regulatory environment are likely major reasons.

The concept of area yield contracts in the United States was introduced when the USDA began a pilot program on area yields indexed at the county level in 1993. Numerous articles have been written about area yield insurance (Mahul; Miranda; Skees, Black and Barnett).

Risk-Linked Securities

CAT bonds are the most common risk-linked security. CAT bonds, just like corporate bonds, are debt instruments providing capital contingent upon the triggering of a certain event. CAT bonds are used to provide reinsurance protection. Over thirty such bonds providing over $10 billion of synthetic reinsurance have been sold since 1994. In exchange for taking the risk, those purchasing CAT bonds receive a relatively high rate of return if there are no catastrophes. However, they may lose some or all of their investment or earnings on their investment if a catastrophe does occur. Because catastrophes should be independent of the general economic trends, fund managers may use CAT bonds to diversify their portfolios with an equity that has zero correlation to traditional equity markets.

CAT bonds can be written to replace insurance losses from a single event such as an earthquake or a hurricane, or they can be written to cover risk of aggregate losses for a portfolio of risk. In both cases, the likely trigger would be some high level of loss, thus, making them work just like a stop loss in reinsurance or as a call option on losses beyond some level. Primary insurers and reinsurers have used CAT bonds. Capital is captured with CAT bonds. For this reason, regulators like this tool because it eliminates the likelihood that a reinsurer will default. With a traditional reinsurer, defaults are more likely because reinsurers do not have to guarantee their ability to pay future losses.

Numerous risk-modeling firms have emerged to both model catastrophes and educate potential purchases of catastrophes. The more complex the risks, the higher the transaction costs associated with defining terms, modeling, and developing the unique characteristics needed to develop the contract. Although most of the CAT bonds issued to date have transferred catastrophe reinsurance risk, there are many other potential uses. Any risks where a well-defined trigger can be identified could be packaged into a CAT bond. An easily defined trigger will reduce transaction costs since no one has to worry about moral hazard or how well the business at risk is underwriting their risks. In these cases, the parametric features (the full probability distribution function) can be estimated. Such contracts are known as parametric reinsurance. For example, at least two Richter-scale CAT bonds have been developed in recent years. Payments are triggered by a certain value on the Richter-scale at a certain location. These CAT bonds have been as large as $100 million. Agriculture has many risks that can be parameterized: weather risk, area crop yields, some environmental risk, and others. Any of these risks could be packaged into a CAT bond, possibly with very low transaction costs.

Markets for Weather-Based Securities

Weather indexes began trading in 1996 as the U.S. power industry was deregulated. Some people lose and others win when certain weather events occur. When the same event has different impacts on different parties, a trade is possible. When the power industry was deregulated, revenues became more volatile. Extreme low and high temperatures create peak-load problems for the electricity industry. When the local company cannot generate enough electricity, they must buy power on the open market to meet the additional demand. By using index contracts that pay when the temperature is either too cold or too hot, the company can hedge against this added cost. In some cases, power companies may also want to protect against normal temperatures since benign weather creates low demand.

Dischel reports that three principal market makers (Koch industries, Enron Corporation,

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and Aquila Energy) have been involved in "almost all of the estimated six hundred deals that have been done." These markets are growing very fast. Several companies are also involved in writing rainfall index contracts. The World Bank has been investigating the use of rainfall index contracts as a means of supplying crop insurance in developing countries (Skees, Hazell, and Miranda).

As information systems improve and we learn more about the relationships between weather and crop yields and crop quality, it may soon be more useful to have a portfolio of weather contracts that meet particular needs. Farmers or agri-businesses may find such contracts more dynamic than traditional crop insurance. For example, different weather events will have varying influence depending on the cumulative weather events that create a unique growing season. If the crop starts slow due to a cold, wet spring, the timing of the weather may influence yields differently than a season with a quick start. Further, new varieties may be expected to respond differently to weather events than old varieties. This knowledge may be used to tailor the rainfall contracts to the new varieties rather than using historic yield records. Improvements in information systems will continue. Credible and inexpensive ways of measuring weather events will make these markets even more attractive when they are coupled with computer models that link weather events to yields or other variables that drive incomes.

Conclusion and Implications

Using markets that are more transparent should improve price discovery for catastrophe risks. Each of the new innovations discussed in this article—CAT bonds, exchange-traded instruments, and weather derivatives—should have more transparency than some traditional means of protecting against catastrophe risk. To the extent that these innovations are used to facilitate price discovery, they can also improve the reinsurance markets by making them more efficient and by reducing the reinsurance cycles that cause serious problems for sharing catastrophe risk. As Elliott argues, insurance securitization also has the potential to increase the capacity of available reinsurance with more stable prices. His beliefs lie in the fact that insurance securitization will improve the liquidity and price transparency of both insurance/reinsurance markets. With dynamic capital markets, investors can easily and swiftly change risk positions. If a secondary market develops to trade risk-linked securities, the capital markets for sharing catastrophe risk will become even more efficient.

There has been a steady growth in the use of CAT bonds and the CBOT CAT contract. Both are becoming more affordable. While these equity instruments may never comprise a large percentage of the total capital at risk from catastrophes, they will likely serve as a catalyst in making traditional reinsurance more transparent and liquid.

In conclusion, the new developments in capital markets offer significant potential to make risk sharing for weather events and area yields more efficient and available. This opens many new possibilities in the agricultural sector. Some of these opportunities can now be exploited more as discussed in the companion papers (Zeuli; Black, Barnett, and Hu).

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