
Policies on Managing Risk in Agricultural Markets

Donald F. Larson • Jock R. Anderson • Panos Varangis

Over the past dozen years, policymakers have largely abandoned long-standing popular approaches for addressing risk in agriculture without fully resolving the question of how best to manage the negative consequences of volatile agricultural markets. The article reviews the transition from past policies and describes current approaches that distinguish between the trade-related fiscal consequences of commodity market volatility and the consequences of price and production risks for vulnerable rural households and communities. Current policies rely more heavily on markets, even though markets for risk are incomplete in numerous ways. The benefits and limitations of market-based instruments are examined in the context of risk management strategies, and innovative approaches to extend the reach of risk markets are discussed.

For decades governments have intervened to reduce risk in markets for internationally traded commodities. Over the past dozen years, however, many of the policies and supporting institutions used for that purpose were reevaluated and found to be not only ineffective and unsustainable but impediments to growth. Most of these approaches have now been abandoned, but governments and policymakers still seek to understand how best to manage the negative consequences of volatile commodity markets because traded commodities remain an important source of export earnings for many developing economies and an important component of income and consumption for the poor.

This article reviews the historical relationship between the work of applied economists and policymakers and the commodity and risk market instruments introduced in the 1980s. It explores how a growing body of analytical work contributed to a change in thinking that moved the emphasis of policy from stabilization to management of risks, and it surveys current thinking on managing rural risks.

Efforts Aimed at Stabilization

By the 1980s unilateral and multilateral interventions in commodity markets to achieve macroeconomic and commodity market stabilization were common. International commodity organizations employed buffer stocks or managed trade, trying to bring order to unstable commodity markets. The United States used support prices and inventories to manage domestic prices. The European Union had a similar scheme and also operated a set of commodity-specific exchange rates—“green rates”—for trade among EU members. Marketing boards and stabilization stocks and funds were common in both developed and developing economies. For developing economies, lines of credit were available at the International Monetary Fund (IMF) and elsewhere to support these operations.

Both historical and practical considerations led to such interventions (Larson and others 1998; Akiyama and others 2001), but a great many of the interventions—especially the multilateral interventions—were also motivated by prevailing economic thought.

At the close of World War II, policymakers focused on ways to prevent short-term trade shocks from turning into the widespread economic decline that characterized the Great Depression years. In an age of gold-standard fixed currencies, central banks were often challenged to manage shocks in export earnings. At Bretton Woods, Keynes (1943) proposed a world currency based on a price index of the 30 most traded commodities. With currencies linked to the index, commodity prices and price-related swings in trade earnings would be stabilized largely automatically. Although Keynes's ideas were not incorporated into the charters of the Bretton Woods institutions, an alternative approach of linking lending to commodity volatility emerged. A succession of internationally backed compensatory financing schemes were proposed in the years following the Bretton Woods conference, including the 1953 Olano Proposal for a Mutual Insurance Scheme, the 1961 Development Insurance Fund, the 1962 Organization of American States Proposal, and the 1963 Swedish and Brazilian proposals at the Committee for International Commodity Trade meetings and the French Proposal for Market Organizations.

Also in 1963 the IMF began to offer compensatory financing to countries experiencing unexpected temporary declines in export earnings. The program is based on net export earnings, rather than a single set of commodities, thus taking advantage of any natural portfolio effect that might arise from diversified exports and imports. With modifications, this program remains the primary instrument among the Bretton Woods institutions for handling the effects of volatile commodity trade. Later, as part of the first Lomé Agreement in 1975, the European Union offered its own compensatory financing schemes, STABEX and SYSMIN, to the African, Caribbean, and Pacific group of states.

In 1950 Prebisch (1950) and Singer (1950) independently offered the hypothesis that the prices of primary commodity exports would fall relative to those of

manufactured imports because of differing elasticities of income and demand. Consequently, the net barter terms of trade for commodity-producing developing economies would decline. This contradicted the long-standing notion of increasing scarcity put forward by Malthus, Ricardo, and Hotelling. Soon thereafter, the two ideas became entwined so that the “commodity dependency” problem was characterized by declining terms of trade and volatile export earnings.¹ Generally, economists argued that instability of export earnings limited development through adverse effects on income, inflation, savings, and investment. As a consequence, international efforts were extended to key commodity markets as well. Later, Massell (1969, 1970) integrated these ideas in a model for estimating the benefits of stabilizing commodity markets. More than a decade after that, Newbery and Stiglitz (1981, p. 18) commented:

The predictions of the (Massell 1969) model are readily derived . . . and are quite precise: (i) producers gain and consumers lose from price stabilization if the source of instability lies on the supply side; (ii) consumers gain and producers lose from price stabilization if the source of instability lies on the demand side; (iii) in both cases, gainers could afford to over-compensate the losers, so there are net benefits from price stabilization.

Policies of the era were motivated by macroeconomic considerations, and analysis was largely sectoral. Price levels, price stability, and spatial price differences were the principal policy targets. The macroeconomic focus derived in part from the belief that the domestic income effects or trade effects associated with volatile agricultural and other commodity markets were an impediment to economic growth. The focus was conditioned as well by the dominant view that agriculture’s role in development was as a supplier of “surplus” labor (Lewis 1955). The emphasis on price emerged in part from the empirical observation that commodity prices were the primary source of commodity income volatility (Johnson 1947; Massell 1969). There were practical considerations as well, especially for developing economies, where few alternative instruments are available for redirecting resources (Timmer 1989). For traded commodities governments could frequently gain some measure of control by imposing quotas or tariffs while allowing domestic markets to function with fewer interventions. Moreover, information gathering is simpler for prices than for supply, allowing government managers to react more quickly.

A series of international interventions were structured for dealing with price volatility, a concern for both developed and developing economies. Under UN auspices, five international commodity agreements were signed by producing and consuming countries: the International Sugar Agreement (1954), the Tin Agreement (1954), the Coffee Agreement (1962), the Cocoa Agreement (1972), and the Natural Rubber Agreement (1980). A 1968 UN Conference on Trade and Development proposal resulted in a 1975 resolution calling for an Integrated Program for Commodities

covering 10 core commodities. The Common Fund for Commodities was established to provide liquidity for the integrated program. Moving more rapidly, the IMF established its Buffer Stock Financing Facility on June 25, 1969.

Governments began to run unilateral domestic stabilization programs as well. The European Union, Japan, and the United States all operated systems that combined minimum price guarantees with government-controlled inventories. Developing economies took up a variety of stabilization efforts as well (Knudsen and Nash 1990). These included buffer stock schemes (Bangladesh, India, Indonesia, Republic of Korea, Mexico, the Philippines), buffer funds (Côte d'Ivoire, Republic of Korea, Papua New Guinea), marketing boards with monopolies on trade (Ecuador, India, Malaysia, most of Africa), and variable tariff schemes (Chile, Malaysia, Venezuela). Although price stabilization was a common objective, multiple, often competing objectives emerged as well, complicating administration of the programs and speeding their demise.

In Asia and Africa policymakers faced additional challenges. Following a series of devastating famines between 1967 and 1975 in Biafra (Nigeria), Bangladesh, Ethiopia, and throughout the Sahel, self-sufficiency and food security became driving concerns for many developing economies. Controls on trade or domestic supply were modified to meet multiple objectives. Large state enterprises, such as Conasupo in Mexico, the Bulog in Indonesia, and grain boards throughout Africa, were charged with managing domestic inventories of food.

Challenges to Stabilization Approaches

Although the argument that volatility reduced investment and subsequently led to lower rates of growth in commodity-dependent countries was appealing, economists found only weak empirical evidence of a direct link. Using data on Malaysian rubber plantations, Caine (1954) challenged the negative link between revenue instability and investment. Later, MacBean (1966) also challenged the findings using cross-country data, as did Knudsen and Parnes (1975). Deaton (1992) found for Africa overall that the expansions in investments and income during periods of increasing export prices were greater than the contractions during periods of falling prices. Dawe (1996) calculated instability indices for a cross-section of countries based on shares of exports and found that export instability was negatively associated with growth and investment.

Increasingly, economists began to wonder whether the link between low growth and volatile commodity markets had more to do with government mismanagement than with private investment. Bourguignon and Gelb (1988) found evidence for this view for Venezuela, as did Bevan and others (1990) for Nigeria and Indonesia. Hausmann and Gavin (1996) argued that uncertainty over commodity-dependent

government revenues (and fiscal management) had a cascading negative effect on the economies of Latin America. Rodrik (1998) argued that the link between short-term economic shocks and growth was determined by the ability of domestic institutions to manage the political strife that such shocks initiate.

Some economists also argued that the benefits of stabilization were overstated. Friedman (1954) stressed the importance of private savings rather than public stabilization schemes in solving the “producer income problem.” Newbery and Stiglitz (1981) argued that the Massell model was flawed in ways that exaggerated the benefits of stabilization. An important and frequent finding is that the welfare gains that are possible from price stabilization are small (Anderson and others 1981; Myers and Oehmke 1988; Wright 1988; Kannapiran 2000). Moreover, the practical implementation of stabilization schemes raises many thorny problems for program administrators (Anderson and others 1977b).

Early on, Bauer and Parish (1952) noted that the stabilization objectives of most marketing boards were ill defined and potentially a guise for taxation. Quiggin and Anderson (1979, 1981) discussed the limits of price bands and buffer funds. Wright and Williams (1990) noted the widespread failure of domestic stabilization schemes of all sorts and linked the failure to the nature of commodity prices and underlying models of storage. Examining the time-series properties of commodity prices, Deaton and Laroque (1992) argued that the series tended to be mean-reverting—a condition for a successful stabilization fund—but that the reversion took place over years; consequently, successful stabilization funds needed impractically large lines of credit. Townsend (1977) and Larson and Coleman (1993) discussed the likelihood of bankruptcy for stabilization schemes, even when hedging markets are used.

As the poor performance of stabilization schemes became more evident, analysts began to emphasize the distinction between policies to change the distribution of prices internationally or domestically and policies to manage uncertainty using markets for price risk. McKinnon (1967) explored futures markets as an alternative to buffer stocks. Later, Gilbert (1985) demonstrated that hedging on forward markets could achieve some of the welfare gains normally associated with buffer stocks. Gemmill (1985) argued that futures markets for cocoa, coffee, and sugar were an attractive mechanism for hedging export earnings risks and that forward contracts could be substantially cheaper than buffer stock operations. O’Hara (1984) looked at the use of commodity bonds to stabilize consumption. Rolfo (1980) investigated the use of futures for cocoa producer prices and calculated the optimal hedge ratio when there was both production (output) and price volatility. Overdahl (1987) demonstrated the benefits of oil futures markets for oil-producing states.

The volume edited by Priovolos and Duncan (1991) brought together much of the new thinking on the use of market instruments to manage government debt. Myers and Thompson (1991) presented a model of external debt management that included commodity-linked bonds. Claessens (1991) pointed out that commodity

bonds can be used to hedge debt management problems associated with volatile export earnings. Wright and Newbery (1991) proposed commodity-linked financial instruments to smooth commodity export revenue, and Anderson and others (1991) looked at the role of partial guarantees and commodity contingency. A related volume, edited by Claessens and Duncan (1993), presented case studies showing how markets could be used to achieve many of the sectoral stabilization objectives of existing programs in a sustainable way.

About the same time, evidence was mounting that many of the interventions intended to facilitate growth had instead become impediments. Many stabilization policies limited competition and misdirected resources. But more important, many policies had inconsistent objectives. The same governments that sought to protect producers from the negative consequences of volatile commodity markets also taxed their producers directly or indirectly to spur industrialization and favor urban interests. Influential studies by Krueger and others (1991) and Mundlak and others (1993) documented the negative consequences of these policies and recommended sweeping reforms.

Most telling was the growing evidence that the interventions failed to have their intended effect, most often because they could not be sustained. Growing expenditures on stabilization and support programs led to a lessening of support in the European Union, Japan, and the United States, whereas untargeted efforts to subsidize consumers or producers proved expensive for developing economies (Akiyama and others 2001). The international commodity agreements were unable to adapt to changes in the market, and by 1996 their economic clauses had all lapsed or failed (Gilbert 1987, 1996), victims of politics and economics (table 1). Funds dedicated to buffer stock management at the Common Fund have never been used for that purpose. The IMF eliminated its Buffer Stock Financing Facility in February 2000. Signaling an end to the era of international commodity market interventions, STABEX and SYSMIN were abolished with the Cotonou Agreement in June 2000.

By the 1990s domestic regimes were being reformed as well in response to the changing view of government's role in commodity markets; a series of political changes, market events, and crises; and the urging of multilateral lenders such as

Table 1. Life Cycles of Recent International Commodity Agreements

<i>Item</i>	<i>Sugar</i>	<i>Coffee</i>	<i>Cocoa</i>	<i>Rubber</i>
Initial agreement date	1954	1962	1972	1980
Status of economic clauses	Lapsed in 1963 and 1983	Suspended in 1989	Suspended in 1988	Suspended in 1996; revived in 1997; suspended in 1999
Number of treaties	4	4	4	4

Source: Gilbert (1995) and Varangis and Larson (1996), updated by the authors.

the World Bank (Meerman 1997). How quickly reforms were undertaken and how well they succeeded depended greatly on the timing and initial conditions. Some reforms came as a result of fiscal crises, spurred in part by events in international markets, and were implemented with little planning. Some reforms yielded quick results, with smallholders' incomes rising rapidly as interventions came to an end. The extent of reforms differed greatly by commodity as well, with reforms common in coffee markets and rare in sugar markets (Akiyama and others 2003). But as domestic and international institutions charged with stabilizing commodity prices were systematically dismantled, policymakers became concerned that reforms had exacerbated volatility problems.² New approaches were sought.

Thus from the time of the Bretton Woods Conference through the structural reform period of the 1990s, policymakers and development economists seeking to manage the risks associated with commodity markets focused first on macroeconomic issues of stability and growth and later on the efficacy and sustainability of stabilization policies. There was frequently a tendency to blur the distinctions between two sets of problems related to commodity risks: the inability of some governments to prudently manage volatile revenues and expenditures and the limited capacity of vulnerable rural households to diminish the consequences of risks and the high costs of trying to do so.

Though earlier approaches relied on sectoral instruments (such as buffer stocks or trade interventions) for both problems, current approaches advocate separate treatment. This is not to dismiss the link between macroeconomic stabilization policies and rural incomes. Macroeconomic policy associated with stabilization still significantly affects rural incomes through rural–urban terms of trade, remittances from urban and overseas workers with links to rural communities, and government financing of rural development projects and safety nets. But agricultural commodities today are less frequently a source of macroeconomic instability than they were two decades ago because of greater diversification and declining international prices. Dependence on agricultural commodities is more common for households, communities, and regions than for national economies. Exceptions, where export earnings for agricultural commodities remain an important component of national income, are concentrated among the poorest countries, where aid flows and debt muddle the links between commodity stabilization and macroeconomic stabilization (Collier 2002).

Toward Rural Risk Management Strategies

Helping make the conceptual distinction between the problems of macroeconomic stabilization and rural risk management was ongoing work on the role of risk in farming households and communities. Early examples include Schultz (1945), Johnson (1950), and Heady (1952) on the United States. Risk also began to receive

explicit treatment in agricultural modeling exercises (Freund 1956) and early theoretical models of preference (Pratt 1964; Arrow 1965). Dillon (1971), Anderson and others (1977a), and Musser and Patrick (2002) survey the literature. Similar themes were addressed, first by anthropologists and later by economists, in the context of how traditional peasant societies managed risk (Schultz 1964; Stern 1989). Related work examined sharecropping arrangements (Cheung 1969).

Concurrently, household-focused studies provided additional empirical information about the relationship between risk and behavior. This research was made practical by newly available village and household surveys, especially a series undertaken by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). From that research came strong evidence that farmers in poor rural communities are risk-averse and take reasonable actions that result in lower but more stable incomes. Researchers began to distinguish between planning strategies and coping strategies. They also distinguished among price, production, and income risks; between idiosyncratic and systemic risk; and between rare natural disaster risk and more frequent risks. Researchers also explored the capacity of households to self-insure and both formal and informal arrangements for sharing risks within communities. Early examples are Moscardi and de Janvry (1977), Dillon and Scandizzo (1978), Binswanger (1980), Hazell (1982), and Antle (1989). Fafchamps (1999) and Dercon (2002) review informal mechanisms, and Moschini and Hennessy (2001) review agricultural risk studies in the context of formal and incomplete markets.

At the same time, development institutions and policymakers began to search for ways to measure the microeconomic effects of macroeconomic and sectoral policies meant to spur economic growth. This required finding better ways to measure poverty and analyze its causes. This new approach led to several institutional changes by development organizations. Examples from the World Bank include the treatment of uncertainty in project appraisal, *World Development Report 1990: Poverty and subsequent related research*, the rise in lending for targeted safety nets, and the sponsorship of household surveys and related analytical tools.³

From these developments emerged a more systemic view of risk and risk management that involves multiple strategies (prevention, mitigation, coping, management) and arrangements (informal, market-based, public) for dealing with risk and instruments that take account of the sources and characteristics of rural risk (Robison and Barry 1987; Anderson and Dillon 1992; McConnell and Dillon 1997; Hardaker and others 2004). The theme was featured in the 2001 updating of the World Bank rural development strategy (Anderson 2001) and social protection strategy (World Bank 2001).

Because the type and severity of the risks confronting farmers and others vary greatly with farming systems, climate, infrastructure, policy, and institutional settings, there is a certain boundlessness to the issues and few general prescriptions about

strategies to manage risk are possible. Rather, the sections that follow discuss some of the formal and informal mechanisms for managing rural risk.

Although the relevance of these mechanisms depends on local circumstances, there are some typical characteristics of development that affect the availability of these instruments and the demand for them. Keeping key differences among countries in mind is especially important when drawing generalizations from research based on specific household surveys, particularly those in India, Ethiopia, and Thailand.

Generally, as countries develop, rural communities become more diversified in their sources of income, the share of the population engaged in agriculture shrinks (Lanjouw and Lanjouw 1995; Larson and Mundlak 1997), and farmers become more commercialized and specialized. Formal markets of all sorts—for inputs, credit, insurance, information, and outputs—are more likely to arise and mature as countries develop. In part all this comes about because governments are better able to safeguard the security of persons and property and to enforce contracts (North 1994). Finally, the most obvious differences are in accumulations—of wealth, infrastructure, human capital—that affect the vulnerability of rural households and communities and the role of policy in managing agricultural risks. This means that the hurdles to accessing risk markets are higher in countries and communities where there is less capacity to self-insure.

Vulnerability, Ex Ante Choices, and Ex Post Adjustments

The consequences of risk for rural households are related both to the types of risks associated with specific income-earning activities and to the capacity of households to absorb losses. Because all economic activity entails some measure of risk, the efficacy of risk management efforts by the household can be judged in the aggregate by examining how well households are able to maintain consistent levels of consumption over time.⁴ Households can achieve this in several ways. They can prepare for times of need by saving, holding inventories, and accumulating productive assets that can be sold in times of need. Because risks are likely to affect different activities in different ways, diversification of activities—especially the diversified use of land and labor—can lessen the consequence of any particular risk. Thus for farming activities, for example, choices about production technologies can affect the consequences of weather-related risks. Because there are separate risks associated with markets, decisions concerning self-sufficiency and market participation affect income risks as well.

A growing applied literature on these topics has frequently found shocks related to crop and livestock yields, prices, health, and labor markets. Fafchamps (1999) and Dercon (2002) survey studies characterizing the sources of rural risks in poor

countries. Wolpin (1982), Paxson (1993), and Rosenzweig (2001) examine consumption smoothing in low-income countries. Dercon (1996), Larson and Plessmann (2002), and Morduch (2002) find evidence that farmers choose to diversify into less profitable crops or choose less productive technology.

These strategies and their outcomes act in reinforcing ways. Greater wealth allows households to diversify their income sources by starting nonagricultural businesses or entering into more profitable agricultural activities (Reardon and others 1988; Dercon 1998). Greater wealth can also allow farmers to make investments that can limit the consequences of risks (Rosenzweig and Binswanger 1993). The consequences of rural risk can also reverse the accumulations of human and physical capital that contribute to income and wealth. Households may attempt to supply more labor (Kochar 1995; Rose 2001), and parents may choose to have their children work rather than attend school (Jacoby and Skoufias 1997). In difficult times households may liquidate productive assets (Binswanger and McIntire 1987).

Not all risk management strategies rely exclusively on household resources. Arrangements for risk sharing and mutual insurance are a common feature of rural communities in low-income countries. Most arrangements are informal—they rarely involve written contracts and are not enforced by governing institutions. Alderman and Paxson (1992) and Morduch (1998) provide useful surveys of informal insurance mechanisms. The ubiquity of risk-sharing arrangements among the rural poor in low-income countries is consistent with studies that find rural risks in low-income countries to be largely idiosyncratic (Udry 1991; Townsend 1995; Jalan and Ravallion 1999). The nature of risk may be partly an outcome of diversification strategies. Systemic risk is more significant in developed economies' agriculture, where greater specialization is evident (Miranda and Glauber 1997).

When risks are idiosyncratic, there is scope for mutual insurance arrangements. In turn, the practical distinction between what constitutes systemic or idiosyncratic risks depends on how risks are pooled. Risks that affect all household members may not affect all households in a community. Risks that affect communities may not affect the entire region, state, or country. For agriculture, underlying risks associated with production stem from the interplay between climate-related events and natural endowments. Consequently, geographically diverse pools of agricultural risk exhibit less systemic risk. At the same time, performance risks related to contract enforcement in low-income countries limit the scope for mutual insurance arrangements that extend beyond families, tribes, or villages.

The personal relationships that characterize mutual insurance arrangements are also a dominant feature of other forms of exchange in poor rural areas (Fafchamps and Minten 2001). Where low-cost enforcement mechanisms are absent, performance risks associated with all forms of contracts can be high.⁵ However, the scope for pooling and sharing risks of all kinds is dramatically reduced for forms of exchange and insurance based on personal relationships. Storage markets, liquid

markets for output and for assets, financial markets for savings and credit, and formal insurance markets all depend on impersonal trade accounts to varying degrees.

It is not surprising then that constrained household and community insurance mechanisms are only partly effective (Dercon 2002). Moreover, the poorest appear to benefit the least from informal insurance (Reardon and others 1988; Jalan and Ravallion 1999; Goldstein and others 2002). For all participants, informal insurance schemes in rural areas work least well when they are needed most for several reasons. First, the most severe agricultural shocks tend to be systemic, so that all farmers in the community are less able to afford transfers. This is exacerbated when, as is frequently the case, nonfarm income can be covariate with systemic shocks to agriculture (Czukas and others 1998). Because of illiquid markets, shortfalls in food supply can cause food prices to rise rapidly while prices for livestock or other productive assets fall (Rhamato 1991). In situations where household and community risk strategies fail completely, households lack the ability to command food supplies, and famines result (Sen 1981; Ravallion 1997).

Extending Formal Markets for Risk

Though varied, comprehensive in types of risks addressed, and able to solve information problems related to transaction costs and moral hazard, informal mechanisms for managing rural risks also reduce the scope for pooling risks outside of communities.⁶ They are unable to take advantage of the potentially beneficial portfolio effects of including individuals who face uncorrelated or negatively correlated natural risks or who have different capacities or willingness to assume risk.

There have been many recent efforts to extend the reach of rural risk markets in developing economies to supplement informal systems. The focus here is on instruments that address agricultural production and price risks, rather than on credit and income risks, for which there is also an extensive literature (for surveys, see Bell 1988 and Besley 1994; for policy issues see Yaron and others 1997; and for lessons on informal systems, see Udry 1995 and Eboh 2000). The primary markets that uniquely address agricultural risks are futures and options markets, which can be used to hedge against price movements, and crop insurance markets, which focus on yield shortfalls.

Risk Markets, Households, and Small Businesses

Small-scale farmers and other small businesses in developing economies rarely use market-based risk instruments. For one thing, the very poor lack assets insurable by crop insurance, price insurance, or similar products. For another, most agricultural risk markets are incomplete in many aspects—time, space, and type of commodity.

Nonetheless, there is some scope for making use of such markets in poor rural areas (Rolfo 1980; Myers 1988; Lapan and Moschini 1996).

There are at least three types of potential benefits of using risk markets. One relates to the indirect effects of insuring individuals. Poverty can be transient and often market related (Jalan and Ravallion 1998). As a result, market-related price and output insurance, delivered directly or indirectly to community households and businesses, may have direct income effects for the insured and economic multiplier effects in the community. In addition, both effects may help fund informal risk systems. There is some related evidence from food aid programs, discussed later.

A second type of benefit relates to funding formal public safety nets and services. During periods of systemic risk, when informal systems are most likely to fail, governments are often called on to provide relief and to step up related services. In some instances governments are unable to fully afford to do so, particularly provincial or local governments that may be obliged to share in the cost of relief. Thus risk markets have a potential role when governments do not have the resources to self-insure.

A third potential benefit is that extending the reach of formal risk markets can help extend the temporal and spatial aspects of related markets for output, storage, inputs, and credit. This is important because it is the emergence from self-sufficiency and the opportunity to participate in markets that marks the earliest stages of development in rural areas.⁷

Price Risk

The most transparent markets for price risk are futures and options contracts traded on organized exchanges. Contracts for coffee, cocoa, maize, soybeans and soybean products, sugar, wheat, and some livestock are traded on an international basis. Most volume is traded in Japan, the United States, and the United Kingdom, but there are long-standing exchanges in Argentina, Brazil, and India, as well as emerging commodity exchanges in China, Hungary, Poland, and Russia.⁸ There are also active over-the-counter markets for options on traded agricultural products, including rice and palm oil. Significant barriers stand between these risk markets and the risks faced by farmers, however, including issues of scale, basis risk, information, and enforcement mechanisms (Frechette 2000).⁹ Moreover, options are short-term instruments, rarely exceeding nine months, and they are inappropriate for hedging annual income fluctuations (Gardner 1989). However, some mechanisms have emerged to extend price risk markets.

Using inventories. In some countries, warehouses and grain elevators are delivery points for price risk instruments. In the simplest form grain elevators post schedules of forward purchase prices. Elevator companies then hedge their net exposure on

commodity exchanges or related price risk markets. Harwood and others (1999, p. 75) provide an example from the United States.

Contractual arrangements can also be used to link price hedging, inventories, and credit. For rural communities the chief benefit is lowering transaction costs. In warehouse receipt or inventory financing systems, inventory owners place their crops in certified warehouses and enter into a repurchase agreement with the warehouse company, which then offers a loan based on the value of their inventories. When price futures, options, or related markets are available, warehouse companies can use the markets to hedge the value of the inventory collateral.

Such arrangements are frequently accorded special treatment in the law, allowing warehouse managers to quickly liquidate inventories when loan payments are due. In the United States, for instance, certified warehouses can issue transferable receipts (Budd 1991). In Latin America two documents perform the same economic function: the *certificado de deposito* (certificate of deposit), a claim stating the quantity and quality of goods stored, and the *bono de prenda* (product bond), used to assign ownership. Although this institutional arrangement has a long history in Latin America, efforts to establish warehouse receipts are more recent in countries where inventories were long managed by government agencies or state enterprises. Coulter and Onumah (2002) provide examples from Africa; Martin and Bryde (1999) discuss warehouse receipt systems in transition economies.

Aggregating demand. Several characteristics of price risk markets create obstacles to access by small-scale farmers. The contracts themselves are associated with large underlying volumes, and futures and options trading involves large fixed costs. Several efforts have been made to provide access to price risk markets by aggregating local demand. Varangis and Larson (1996) report on Mexico's Agricultural Products Options Program (Programa de Cobertura de Precios de Productos Agrícolas), which offers subsidized dollar-denominated futures options to maize, cotton, sorghum, and soybean farmers. Guatemala's national coffee association, Asociación Nacional de Café, facilitates price-hedged credit for smallholder producers.

Though the mechanisms of such programs are understood, there has been little analysis of their effects on household decisions and outcomes. To further investigation of this type of risk management program, the World Bank, the European Union, the Netherlands, and Switzerland convened an International Task Force on Commodity Risk Management in Developing Countries (1999) to study the benefits of facilitating access by farmers and small businesses in developing economies to price risk-management instruments. The program focuses on finding local intermediaries, mostly producer cooperatives, to aggregate demand, pay option premia, and disseminate payouts. Ten case studies are available on the program's Web site (www.itf-commrisk.org/itf.asp?page=104).

Yield Risks

In addition to price risks, farmers face yield risks, due to adverse weather, pests, and diseases. Roumasset and others (1989) review studies on the sources of yield risk for grains.

Crop insurance. Formal agricultural insurance institutions are better suited to address yield risks than are informal mutual insurance mechanisms, which have limited reach. Ray (1967) has an early discussion. However, moral hazard and adverse selection problems plague traditional crop insurance schemes. Moral hazard arises when farmers are able to take actions that affect insurance payouts. Inspection and monitoring can limit the problem, but they boost costs—especially in the context of smallholder production in developing economies. Adverse selection results when those purchasing insurance have better information about risks than the insurance provider. As a consequence, unless insurance is compulsory, the self-selected pool of insurance participants will have above-average risks. The adverse selection problem has both spatial and temporal aspects. For example, farmers may choose to insure only crops grown on inferior land (spatial) or participate only when preseason rainfall is low (temporal). In practice, because moral hazard and adverse selection problems both stem from asymmetric information, both types of problems will emerge (Quiggin and others 1993).

Information problems related to crop insurance are well studied in part because efforts to provide comprehensive crop insurance on a commercial basis have so consistently failed (Valgren 1922; Krammer 1983).¹⁰ Thus crop insurance relies heavily on government subsidies. Pomareda (1986), Hazell (1992), and Wright and Hewitt (1994) compare crop insurance in developed and developing economies. Detailed histories of crop insurance and related policies are provided by Lopes and Dias (1986) for Brazil, Yamauchi (1986) for Japan, and Glauber and Collins (2002) for the United States.

The combination of moral hazard, adverse selection, and public subsidy has welfare consequences related to how farmers allocate resources, how natural resources are used, and how public support is allocated. There is an extensive theoretical and applied literature, much of it related to North American experiences. Knight and Coble (1997) and Moschini and Hennessy (2001) survey the literature, and Skees (2000) provides lessons based on U.S. experiences.

Index insurance. Because of the high costs associated with administering traditional crop insurance, interest has grown in alternative instruments for insuring a portion of farm yield risks. These products look to contain administrative costs by eliminating moral hazard and reducing adverse selection and thereby the associated monitoring costs (Skees and others 1999). They do so by using an insurance trigger

linked to farm losses that cannot be manipulated by the insured. Contracts and indemnity payments are the same for all buyers per unit of insurance, so the problems of moral hazard and adverse selection associated with traditional crop insurance are lessened. These features can significantly reduce administrative costs because contracts can be standardized and on-site inspections and damage assessments are avoided.

Conceptually, these products are similar to exchange-linked price insurance for price takers. These products address risks that are systemic to the insured group but leave idiosyncratic risks uninsured, much as basis risks remain with price insurance. In addressing systemic risk only, these products are less appealing to farmers but more attractive to a broad range of people and institutions whose incomes are also affected by the insured events, including banks, agribusinesses, rural financial institutions, agricultural traders, and transport industries. Banks and rural finance institutions could purchase such insurance to protect their portfolios against defaults caused by severe weather events, thereby addressing an important constraint on rural credit.

Area-yield and weather-based insurance are two of the better known examples of index insurance, although other products have also been studied. Skees and Enkh-Amgalan (2002) examine a proposed index-based insurance for livestock in Mongolia. Area-yield crop insurance is a contingent contract that pays out when average yield for a group, usually defined geographically, falls below a specified trigger. Payouts are based on probabilities of the event occurring, which are usually based on historical data. If the pool that defines the trigger is sufficiently large, decisions to enroll or actions on the farm will not affect outcomes, resolving moral hazard and most types of adverse selection problems.

Halcrow (1949), Industries Assistance Commission (1978), and more recently Miranda (1991) discuss proposals for area-yield insurance. Much of the literature is devoted to optimal contract design, including discussions by Miranda (1991), Smith and Baquet (1996), Skees and others (1997), Mahul (1999), and Vercammen (2000). Chambers and Quiggin (2002) consider the influence of area-yield insurance on producer decisions. Miranda (1991) and Skees and others (1997) describe area-yield programs in Canada, Sweden, and the United States. Mishra (1996) describes area-yield insurance in India.

Experience with area-yield products has been mixed for several reasons. Product coverage, based on county or other administrative boundaries, may not correspond to the spatial outcomes of climatological risk (Wang 2000). There is a natural tension in the optimal size of the pool of farmers included in the trigger. Large pools are needed to preclude moral hazard and help offset the fixed costs of offering an insurance product, but large pools may increase the basis risk associated with the insurance trigger. Detailed data are needed to construct the underlying probabilities, and such data may not be available in many developing economies. Experience with

area-yield programs comes primarily from developed economies, especially the United States, where government policies may crowd out market-based products and introduce policy-related risks that market-based products cannot address (Gardner 2002).

A relatively new insurance instrument is weather-based index insurance, with payouts based on the occurrence of a weather event rather than on actual crop losses (Lee 1953; Bardsley and others 1984; Quiggin 1986; Skees 1999; Turvey 2001). Thus insurance contracts could be written against severe rainfall shortfalls (say, 30 percent or more below a defined norm) measured at agreed regional weather stations. The insurance would be sold in standard units, and all buyers would pay the same premium and receive the same indemnity payment per unit of insurance if a shortfall occurs.

Although the theoretical aspects of contract design have been explored, and climate-related risks are well understood in developing economies, less is known about whether farmers are willing or able to pay for such insurance. What little evidence is available suggests that a residual unmet demand for insurance against weather risks remains despite the myriad risk management mechanisms employed by households (Gautam and others 1994; Sakurai and Reardon 1997). Additionally, survey evidence suggests that farmers are willing to pay for certain contract designs based on reasonable premia assumptions (McCarthy 2003).

Still, there are certain challenges in creating weather insurance instruments, particularly in developing economies. First, reliable historic data are needed to allow accurate pricing of the insurance. Though such data are generally available in most developing economies, coverage can be limited. Second, secure weather stations are needed to increase the confidence of those providing the insurance. Automated weather stations and increasingly remote sensing could reduce the risk of tampering with weather observations at local weather stations. Third, farmers may face basis risk if rainfall at the weather station is not highly correlated with rainfall at the individual farm. This is more of a problem for farmers in regions with diverse microclimates than for banks purchasing insurance to protect their regional portfolio or for agribusinesses that have weather exposure over a wider area. Skees and others (2002) discuss examples from Mexico.

There have been few agricultural applications of weather-based index insurance in the world. Weather indices are used for agricultural insurance in Ontario and Alberta, Canada. In Mexico AGROASEMEX, the agricultural reinsurance company, recently used weather derivatives to protect part of its crop reinsurance portfolio exposed to weather risks. In Argentina a rainfall insurance contract is used by a milk-producing cooperative (there is positive correlation between rainfall and milk yields). In 2001 the International Finance Corporation, the private-sector lending arm of the World Bank Group, joined with private investors to create an \$80 million facility to reinsure weather risks in developing areas. Agriculture, however, is only

one of several industries affected by weather risks. Markets in North American and Europe have developed primarily to hedge energy-related risks (Muller and Grandi 2000). Consequently, weather markets may prove more liquid than markets for area-yield insurance.¹¹

Revenue insurance. There has been considerable discussion about how incomplete markets limit the ability of farmers to hedge income risks (Rolfo 1980; Anderson and Danthine 1983; Lapan and Moschini 1994). Several studies have assessed the potential for revenue insurance, primarily in North America (Miranda and Glauber 1991; Turvey 1992; Babcock and Hennessy 1996; Hart and others 2001).

Conceptually, revenue insurance is a combination of price and traditional crop insurance—although area-yield variations have been considered. A U.S. pilot program uses the average February price of a December settlement corn futures and historical yields to price an insurance product. Payouts are based on a combination of assessed yields and the average price of the December settlement in November. Because of this construction, high prices can compensate for low yields, lessening the contract payout. Application to developing economies is limited because the insurance requires both price and yield risk markets.

Contractual Arrangements and Market Instruments

Pre-export financing. Where domestic credit systems are expensive or function poorly, exporters frequently enter into pre-export financing arrangements to share performance, price, and exchange risks. These arrangements, which combine aspects of formal and informal markets, typically include a local domestic agent and an international trading company.

The two parties enter into a contract for a specific purchase—so many tons of coffee, for example, for a fixed fee. The cost of credit is implicit in the fee. The international company deposits dollar-denominated funds in a domestic bank, and the domestic agent purchases domestic crops and prepares them for export. The international company approves the release of funds to the domestic agent based on certification by a local warehouse or inspection company. Although the contracts usually cover very short periods, they are often repeated when performance has been good.

The parties rely on economic incentives (off-shore credit is typically less expensive) and the prospects of repeated future business, a feature also associated with informal personal transactions. Price risks are shared; the agent takes on price and exchange risks during the purchasing period (because local purchases will be in local currencies), whereas the international company takes on the price risks from the time it acquires supplies in country until the goods reach their eventual market.

The international company may enter into additional risk management arrangements by hedging the good or entering into forward contracts.

Producer clubs. Even though contract enforcement is often difficult in developing economies, sharecropping and labor-sharing arrangements are commonplace in many rural communities. Robertson (1987) provides many examples from Africa. Where production takes place near a processing center, contracts are sometimes structured so that processors provide smallholders inputs on credit in exchange for future product deliveries. Such contracts are common in the sugar and palm oil industries, where crop characteristics create a binding relationship between producer and processor.

More sophisticated arrangements can also be found for specialized products that include types of risk management. For example, in Mexico starch companies will enter into arrangements with producer groups for high-starch maize. Group members are jointly obligated to meet contract requirements. In return, the starch company offers a forward purchase agreement for the maize at a fixed price and partly prefinances inputs and technical advice. The company also partially prefinances crop insurance, so that farmers are not penalized when crops fail. By addressing both price and yield risk, the arrangement allows farmers to adopt newer technologies more readily.

Governments, Insurance, and Rare Events

Some events can overwhelm the actions taken by individuals, families, and communities to manage risks. When the scale of loss of life and property is large, governments step in to limit further loss and help compensate victims. One area where such intervention is important is in providing assistance to prepare for and recover from natural or human-caused disasters, when human and economic losses can be large. Developing economies suffer the greatest costs from disasters: More than 95 percent of all deaths caused by disasters occur in developing economies, and losses due to natural disasters are 20 times greater (as a proportion of gross domestic product) in developing economies than in industrial countries. Poorly planned development can turn a recurring natural phenomenon into human and economic devastation with irreversible effects.¹²

But along with such cases there has been a tendency for public outcry to drive governments to intervene in ways that are demonstrably ineffective and that distort individual incentives to plan more carefully for occasional inevitable bad outcomes, including through selective purchase of insurance contracts. If governments rush to bail people out of the effects of insurable natural disaster risks whenever there is political clamor to do so, commercial insurance markets will be stunted. Such “free”

but unreliable public insurance entices some to take up risky activities with incomplete safeguards and without full consideration of the public and private costs of doing so (for an example related to drought management in Australia, see Drought Policy Review Task Force 1990). Often, when political factors (including the availability of donor assistance) trigger disaster-relief programs, the timing and level of relief is uncertain (Shaw 2002) and relief may be poorly targeted.

Public policy research has long considered questions about the role of governments in sharing responsibilities for insurance and insurance markets (for example, Kunreuther 1978). A potentially good policy would swing into action as needed, without requiring (or allowing) political largesse or creating disincentives for producers to plan for and manage their own natural disaster risks (Anderson and Dillon 1988).

Food Programs and Informal Insurance

Food programs are a special type of public insurance. In wealthy countries, food assistance is part of a general safety net, provided continuously and not only as part of natural disaster relief efforts. Not so in poor countries, where food assistance generally is a response to acute shortages. Natural disasters are often a triggering event, but their consequences are heavily influenced by previous private and public investments and policy. When food shortages occur in their most acute form, as famine, they are almost always associated with a combination of natural disasters and bad policy. Ravallion (1997) reviews public action failures related to famine, from inadequate government responses to food shortages—sometimes deliberately so—to market interventions that have made households more vulnerable to famine.

There is an extensive body of literature on programs that provide food in response to disaster-related shortages, with surveys by Maxwell and Singer (1979), Clay (1986), and Barrett (2001). In addition to the nutritional impact of such programs, researchers have addressed problems of moral hazard and adverse selection, including disincentives for households to produce food and to work. Food deliveries can also displace food and storage markets (Schultz 1960; Sen 1960; Fisher 1963; Barrett 2001). The disincentive effects are intensified by the tendency for some program food supplies to go to unintended recipients, which also reduces the efficiency of the programs. Considerable effort has gone into finding appropriate methods of targeting food assistance to avoid these problems (Besley and Kanbur 1990; Ravallion 1991; von Braun 1995; Alderman and Lindert 1998).

More recently, researchers have considered the relationship between informal insurance systems and food programs. Attanasio and Rios-Rull (2000) provide a numerical analysis drawing on data related to Mexico's PROGRESA program, and Dercon and Krishnan (2003) offer econometric evidence based on surveys from Ethiopia. Both

studies suggest that formal food assistance can crowd out informal insurance, because food assistance changes the consequences of not participating in mutual insurance arrangements. This tension between informal insurance incentives and food assistance prompted Dercon and Krishnan to suggest that food assistance programs use village mutual insurance systems to target assistance.

Nevertheless, informal systems fail when risks are systemic—for example, when extensive or sequential multiple crop failures occur—and formal aid may have limited effects on decisions to participate in informal systems that address idiosyncratic risks. Even when systemic natural events are the cause of food shortages, other types of moral hazard problems related to the frequency of the events remain. When shortages and food aid occur frequently, households' choices may be affected in ways that create a continuing dependency on aid—for example, households may continue to work marginal lands. Alternatively, when shortages are infrequent, aid interventions can provide immeasurable benefits without affecting long-term choices, because households will view the possible risk and the subsequent food aid as rare.

From this Skees and others (2002) argue that food aid policies should be designed around the frequency and systemic nature of disaster events. They suggest establishing objective measures for triggering the prompt release of food aid in response to relatively rare and systemic events, such as droughts or earthquakes, to minimize moral hazard. The use of objective measures also opens up the possibility of finding insurance-based methods to fund such relief. Analogous relationships exists between disaster relief and crop insurance, discussed next.

Disaster Relief and Private Insurance

Natural disasters can have devastating effects for farmers and spawn cascading effects throughout the local economy as agricultural workers and those employed in support services lose jobs and income. The farm income losses associated with the failed crops can sometimes be privately insured. When parametric insurance is considered, such as temperature or area-yield policies, the distinction between disaster relief and insurance as compensating mechanisms diminishes. However, publicly financed disaster relief creates incentives different from those of privately priced insurance and can induce risk-taking and other problems related to moral hazard.

Mexico's Fund for Natural Disasters (FONDEN) illustrates some of these points. The government established FONDEN in 1996 to finance postdisaster reconstruction of public infrastructure and compensate low-income producers for crop and livestock losses arising from natural disasters. FONDEN targets beneficiaries and limits the amounts it disburses per beneficiary. FONDEN was never intended to compete with private insurance, but analysis of historic reinsurance payouts reveals that weather events similar to those covered under FONDEN are the primary source of systemic payouts by farmer mutual insurance funds. The funds were formed to provide mutual

crop insurance to their members. Reserves for paying indemnities and covering operational costs come from member premiums and government contributions (equal to one-third of member premiums). The funds also purchase traditional reinsurance for times when claims deplete reserves. Because privately insured farmers are not eligible to receive payments from FONDEN, the result is a choice between public and private insurance, a situation fraught with moral hazard. Recently, to make disaster relief more transparent and predictable, FONDEN has started to adopt objective rules for declaring catastrophic events, using triggers analogous to those used for index insurance. For example, technical guidelines are given for drought- or frost-related natural disasters.

Parametrization of public disaster programs has several advantages. First, it removes an ad hoc dimension from the declaration of catastrophes, which helps programs provide appropriate levels of relief in a timely and consistent manner. Second, the information required to parametrize relief programs may help governments design better policies. Third, parameterization enables governments to assess the potential program costs. If governments, especially provincial or local governments, find that under some conditions they would be unable to fund their share of the relief program, they may decide to curb benefits, seek more federal support, or purchase reinsurance from private markets.

Government insurance of risks that are sufficiently rare will not induce moral hazard, even when the consequences of the event are considerable. Nevertheless, when rare events are associated with extensive damage, the cost of private insurance may be high. This suggests an appropriate way of sharing risks on the basis of event likelihood, with governments insuring rare but catastrophic risks and private markets insuring more frequently occurring risks.

Conclusion

During much of the past 50 years, agricultural risk management policies advocated by governments and multinational organizations focused on stabilizing national and sectoral incomes, primarily through interventions meant to stabilize the prices of key food or export commodities, such as rice, maize, coffee, and sugar. Frequently, these policies also set out to change relative prices. Successful efforts to manage these markets were rare and usually short-lived. Most countries came to view these interventionist policies as an impediment to growth and subsequently moved to sharply reduce or eliminate domestic market interventions, often in times of fiscal crisis. Contemporaneously, researchers and policymakers gained a better understanding of the role of risk and the negative consequences of volatility for growth and development, in large part through new household-based surveys.

Currently, strategies for managing the negative consequences of volatile rural incomes are emerging that rely more heavily on markets to supplement the many ways governments and households manage risks. These strategies face demanding challenges because the costs of risk avoidance to households and businesses can be high; the capacity for self-insurance by households, groups, and even governments can be limited; and markets that support risk sharing are incomplete. Finding ways that extend the reach of risk markets is therefore important. These strategies must also address risks that markets cannot address, and key questions remain concerning the roles for formal, informal, private, and public insurance markets and the links between them. Issues include the extent to which informal risk-sharing systems benefit from formal insurance markets, how climate risk information can be used to understand the implicit value of publicly provided insurance and the capacity of governments to meet those obligations under all circumstances, and what components of price and yield risk should fall to individuals, governments, and multinational donors.

Notes

Donald F. Larson is senior economist in the Development Research Group at the World Bank; his e-mail address is dlarson@worldbank.org. Jock R. Anderson was an adviser and is presently a consultant in the Agriculture and Rural Development Department at the World Bank; his e-mail address is janderson@worldbank.org. Panos Varangis is lead economist in the Agriculture and Rural Development Department at the World Bank; his e-mail address is pvarangis@worldbank.org. Seniority of authorship is not assigned, but a novel ordering of authors is used. An earlier version of this article was prepared for a seminar held in honor of Ronald C. Duncan (former Chief of the Commodities Division, World Bank) on the occasion of his retirement as executive director of the National Centre for Development Studies and Director, Asia Pacific School of Economics and Management, Australian National University, Canberra, in July 2001 (Anderson, Larson, and Varangis 2002).

1. See modern treatments by Sapsford and Balasubramanyam (1999) and Lutz (1999).

2. As it turns out, evidence of increased commodity price volatility is hard to find (Dehn 2000; Akiyama and others 2003.)

3. See Reutlinger (1970) and Anderson (1989) for discussion concerning uncertainty and public project appraisal. See Grosh and Glewwe (1995), Deaton (1997), and Grosh (1998) for discussions of household surveys, the World Bank and poverty analysis.

4. This test is based on the notion that households that can freely save and borrow will ignore transitory changes in income and base consumption on the permanent component of income. Friedman's (1954) response to Caine (1954) contains early elements of the permanent income hypothesis.

5. Kranton (1996) discusses this in the context of personal exchange generally; Morgai and others (2002) discuss transaction and enforcement costs specifically in the context of mutual insurance schemes. See also related studies by Coate and Ravallion (1993), Platteau (1997), and Ligon and others (2002)

6. Studies of pastoralists show the limits of diversifying climatic risks. See for example, Little and others (2001), McPeak and others (2001), and Smith and others (2001) and references therein.

7. Reinikka and Collier (2001) document how increased market participation by households characterized Uganda's recovery in the 1990s.

8. Williams (2001) provides a survey on the organization of commodity futures market. See Peck (2001) for a discussion of emerging exchanges in the former Soviet Union, Eastern Europe, and China.
9. Basis risk refers to a situation where local prices fail to move exchange prices. This topic is discussed in the context of West African cotton by Satyanarayan and others (1993); coffee in Costa Rica by Claessens and Varangis (1993); and wheat in Pakistan by Faruqee and Coleman (1996).
10. Insurance against specific risks—especially hail and some multiperil livestock insurance programs—have proven successful (Harwood and others 2000).
11. Lack of liquidity, partly a result of crowding-out by other U.S. programs, was a primary reason for a failed attempt by the Chicago Board of Trade to market area-yield options.
12. Christiansen and others (2003) show sobering results that quantify the stunting effects of drought on children in Ethiopia.

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