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Managing Agricultural Price Risk in Developing Countries

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Abstract

We survey the experience of risk management in developing country agricultural supply chains. We focus on exposure, instruments, impediments to access and developing country futures markets. We draw on lessons from experience over the past two decades.

JEL subject code: Q13, Q14

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1. The Liberalization Context

Agricultural commodity prices are volatile because short term production and consumption elasticities are low. Production responsiveness is low for annual crop commodities because planting decisions are made before prices for the new crop are known. These decisions depend on expected prices and not price realizations. Price outcomes are seldom so disastrous as to result in the harvest being abandoned. For tree crop commodities, production responsiveness is low because the stock of productive trees takes between two and five years to respond to price increases, because input application generally gives only a modest increase in yield and because prices are seldom so low as to make it worthwhile to cut down trees which still have a productive future. Short term demand elasticities are low because the actual commodity price will seldom be a large component of overall value of the final product (examples are cocoa in chocolate and coffee beans in soluble coffee powder – see Gilbert, 2007a) and because substitutability between different raw materials is seldom large. Elasticities may be higher for subsistence crops in poor economies where high prices may force families to try to get by on less.

Throughout the twentieth century, the variability of agricultural prices induced both developed and developing country governments to seek to prevent or offset these movements. By the 1980s unilateral and multilateral interventions in agricultural commodity markets had become the norm. The United States used support prices and inventories to manage domestic prices. The EU had a similar scheme, but also operated a special set of commodity-specific exchange rates (“green rates”) for trade among EU members. For those commodities produced predominantly in developing countries, interventions were either multilateral, for example through buffer stock or export control agreements under the auspices of international commodity agreements (cocoa, coffee, natural rubber and sugar – see Gilbert, 1987, 1996) or through domestic agencies. Marketing boards and stabilization funds were common in both developed and developing countries. There were buffer stock schemes in Bangladesh, India, Indonesia, Mexico, the Philippines and South Korea; buffer funds in Côte d’Ivoire, Papua New Guinea, and South Korea; marketing boards with monopolies on trade in much of Africa and parts of Latin America and Asia; and variable tariff schemes in Chile, Malaysia, and Venezuela (Knudsen and Nash, 1990).

Many of the developing country schemes (national and multinational) encountered serious problems during the 1980s. Producers and producing country governments became over-optimistic about the prices they could obtain in what were generally weak market

conditions. At the same time, the inefficiency costs associated with controls became higher over time as rent-seeking activities became increasingly entrenched. In coffee, high prices induced expansion of area in a number of countries with relatively high production costs (mainly in Africa), while quota restrictions held down production in lower-cost origins such as Brazil. Marketing board bureaucracies, such as the Instituto Brasileiro do Café in Brazil and Cocobod in Ghana, multiplied in size and absorbed much of the benefit of higher prices, and other forms of rent extraction were established (Bohman et al., 1996). The consequence was that, as prices weakened through the 1980s, almost all previously successful national intervention schemes succumbed to financial difficulties. The international commodity agreements, in turn, were unable to adapt to changes in the market, and by 1996 the economic clauses in them had all lapsed or failed, victims of politics and economics (Gilbert 1987, 1996).

In many cases, donors were called upon to rescue or restructure national stabilization agencies of funds which found themselves in distress. Market liberalization, in particular the abolition of monopsony-monopoly marketing arrangements and radical reduction in the size of bureaucracies, was often a precondition for such assistance. Thus, a series of reforms aimed at liberalizing developing country agricultural markets was launched in the 1980s and 1990s, largely at the urging of multilateral lenders such as the European Union, USAID, and the World Bank. Akiyama *et al* (2001) illustrate the rapid pace of these reforms for Africa. With only a few exceptions, marketing boards and stabilization agencies were either abolished or restructured so that their activities were confined to those of general oversight, regulation and collection and dissemination of market data. A major objective of the liberalization policies was to ensure that farmers received a higher share of world prices. National and regional monopsonies were largely abolished (an exception being cotton through francophone West and Central Africa) and pan-national pricing was dropped. At the same time, export taxes tended to be reduced. Many of these changes encountered strong opposition from market incumbents and entrenched governmental interest groups.

As a consequence, since the mid-1990s, agricultural products in developing country have been produced and marketed under much more competitive conditions than at any time since (or during) the colonial period. Lower taxation and greater competition in the supply chain have helped farmers achieve higher shares of world prices, and the price pass-through process has become faster. On the negative side, liberalization may also have resulted in lower world prices, to the benefit of consumers rather than producers (see Gilbert and Varangis, 2004), and more rapid pass-through has resulted in more variable producer

(farmgate) prices. This has been particularly true in Africa, where markets had previously been highly controlled, and also to a large extent in Latin America. It has been less true central Asia where important prices remain controlled by government.

More complete and more rapid pass-through of world to farmgate prices has increased the exposure of developing country farmers and supply chain intermediaries to price variability. This was an unintended consequence of market liberalization (sometimes referred to as a “second generation problem”) which has had particularly serious implications in developing countries where banks have often poor outreach to the agricultural sector, financial markets are poorly developed and access to international markets is limited. Management of this risk becomes a problem and is the focus of this contribution. For previous literature see Claessens and Duncan (1993), ITF (1999) and Gilbert (2003).

In the developed “market” economies, change has been less marked, particularly where agriculture remains largely protected. Farmers in the United States, the EU, Japan and many other developed economies continue to receive prices well-above world market levels. Because much of this support is delivered through price guarantees, the gap is particularly large in periods when world prices are low. High prices are therefore passed through to developed country farmers who nevertheless still remain partially insulated from low world prices.

Section 2 of this chapter discusses price exposure in the developing country agricultural supply chain. Section 3 looks at the available risk management instruments, and the challenges to which they give rise. Section 4 discusses application of these instruments in the developing country context. Section 5 concludes.

2. Incidence of Risk Exposure

Agents in the agricultural value chain are exposed, to differing extents, to differing risks. In this section, we will be concerned predominantly with price risk. However, it is important to emphasize that this is not the only, and not necessarily the most important, risk faced by market actors. For many agricultural commodities, weather-related quantity risk may be problematic. For exporters in developing countries, political risk, in particular risks associated with the availability and terms of export permits, may be dominant. For exporters and banks, currency risks can be quite serious, as has been demonstrated most recently in countries such as Zambia and Tanzania which have experienced currency appreciation relative to the US dollar to the detriment of exporters selling commodities in US dollar terms.

The justification for compartmentalizing risk into different categories (price, yield, political, currency etc.) and analyzing these separately is that agents need to adopt different strategies to manage different types of risk.

2.1 Farmers

Taking a simple example of price risk in the coffee supply chain, we start with farmers, who are naturally “long” the crop. They benefit when prices rise and lose when they fall. Because intermediation costs are largely independent of the price level and because export and other taxes are normally constant in absolute rather than in percentage terms, price variations at the fob stage are attenuated at the farmgate level. Farmers obtain the residual of the price after all other agents in the value chain have taken their cut. As an example, suppose the fob price of a commodity is \$1/kg and price variability measured as the coefficient of variation, is 15% so that a one standard deviation price movement is 15c/kg. If intermediation costs are 50c/kg and are constant, the same 15c/kg price movement amounts to a farmgate coefficient of variation of 30%.

Farmers are primarily interested in net revenues. Net revenues are gross revenues less production costs. Gross revenues are based on price multiplied by quantity (yield), and both are subject to volatility. Variation in these may be partially offsetting if, for example, adverse weather affects many producers at the same time (as, for example, in the possible effects of El Niño). In such a case, the farmer is somewhat self-insured since although yield has decreased, prices have increased. This situation, however, is exceptional and in a competitive market with geographically dispersed production it is more plausible that yield and price risk are uncorrelated.

We can identify two sets of impacts resulting from farmgate price variability. First, revenue variability is likely to transfer into variability of consumption, and also investment, including investment in new technologies. Second, price uncertainty will lead farmers to be cautious in the application of costly inputs and this will tend to reduce yields.

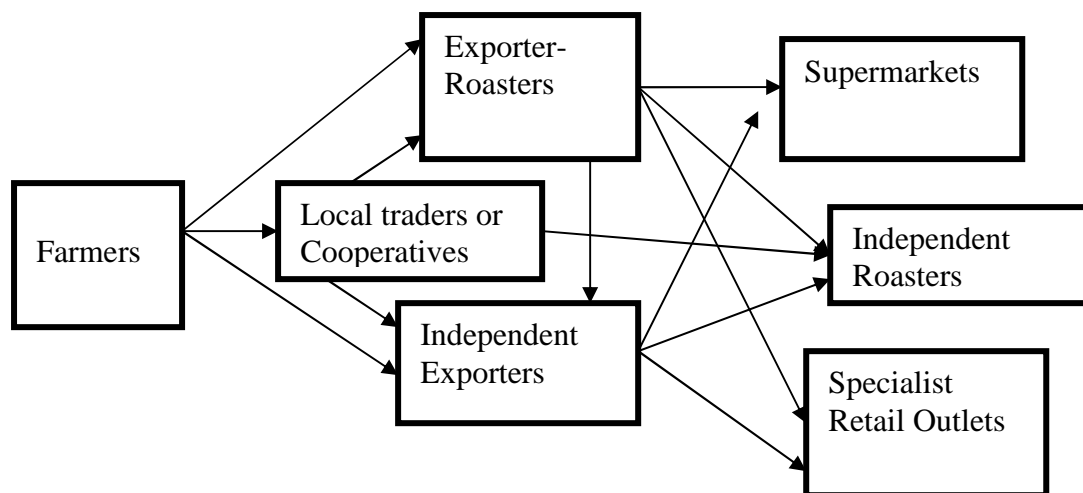


Figure 1: The Coffee Supply Chain

First, consider the impact on consumption and investment. Farmers in developed economies, and possibly also the richer farmers in developing countries, can smooth consumption by saving and dissaving to maintain consumption equal to permanent income. Farmers in developing countries typically have low or zero savings and little collateral. The rural areas of many developing countries are virtually unbanked and this inhibits the accumulation of savings in good times. Even if farm households have managed to save in terms of agricultural capital, e.g. animals, it may be difficult to realize these savings in the even of an adverse shock which affects the entire community. In such circumstances adverse price or yield shocks will force poorer farmers to adopt other strategies. These include reduction of consumption but also, in countries where other labor market opportunities are available, one or more family members taking an additional off-farm job or even migrating. In both cases, this may involve withdrawal of a child from school resulting in an irreversible loss of potential human capital (Duryea et al., 2007). See also section 4.7, below.

Periods of low prices can therefore impose substantial utility costs on developing country farmers. Because adverse shocks are likely to impact investment as well as consumption, these effects can be long term and can endure after prices have recovered (Raddatz, 2005). The irreversibility of investment decisions implies that the effects may be asymmetric between positive and negative shocks and may be permanent (Collier, 2005).

We now turn to the cost side of the equation. Production costs comprise capital, labor and input (fertilizer, insecticide etc.) costs. The balance between these varies from one crop

to another. Some costs, particularly labor costs, depend on the quantity harvested. Other costs, particularly input costs, are incurred earlier in the crop year and, in the case of annual crops, at the time of planting. Short term supply responsiveness arises out of the ability of farmers to adjust input decisions in relation to their expectations of likely prices. Risk aversion will lead farmers to reduce inputs to the extent that harvest prices are subject to uncertainty. Price uncertainty therefore tends to reduce yields and hence revenues.

The importance of these yield impacts varies from commodity to commodity. In general, we should expect the effects to be highest for annual crops where planting decisions can be very sensitive to expected prices. It is relatively easy, for example, for farmers to substitute between alternative grains. For other crops, such as cotton, which are typically highly fertilizer-intensive, the crucial decision is how much fertilizer to apply (and hence purchase). For tree crops, such as cocoa and coffee, yield responsiveness will depend on the extent to which production is input-intensive. Fertilizer is used in only modest quantities in cocoa production but insecticide application can be important. The fertilizer-intensity of coffee production varies from region to region but modern, fast-growing, varieties tend to require more fertilizer than traditional trees.

Farmers therefore face two distinct price risk problems. The first relates to price uncertainty over the crop year: farmers commit time and material inputs based on their expectations at the start of the crop year. If prices turn out lower than they expected, they may fail to cover input costs, while if they are higher, they will have failed to take advantage of market opportunities. Managing this price risk can increase productive efficiency and, in the case of sharp price falls, protect against the risk of financial loss. The second problem is that of sustained low prices. Such periods typically result from global excess supply and, if they persist over a number of years, may not involve significant intra-annual uncertainty – indeed, prices are often less volatile when they are low. Prolonged periods of low prices undermine livelihoods. This is an income maintenance issue and not a risk management issue. The balance in importance between these two factors varies from commodity to commodity depending on the extent of discretion in input decisions and the length and amplitude of price cycles.

2.2 Intermediaries, Exporters, Stockholders and Banks

Intermediaries buy from farmers and sell either to exporters or to other intermediaries. They include low level traders and traitants, who tour producing areas with trucks and purchase from farmers, producer groups, cooperatives, intermediate aggregators such as

transport companies, and intermediate processors such as cotton ginner, millers, etc. The common feature across all market intermediaries is that they both buy and sell at market-determined prices and operate on a margin between the two.

Like farmers, intermediaries are generally long the commodity, but they have much shorter price horizons. They will typically not be concerned by the overall level of prices, since this will affect both purchase and sale prices. (High prices will increase financing requirements and may therefore constrain operations). However, they will be concerned by price variability over the period (generally short) over which they hold a position. Even a small price fall over this period can easily completely wipe out profit margins and there is the danger that such trading losses can consume a significant proportion of the intermediary's capital.

Some intermediaries also operate, from time to time, by shorting the commodity through forward sales to end buyers. In these cases, since the intermediary has not yet covered the short sale by buying the raw material, the risk is that prices will move higher.

Exporters are in a similar position to intermediaries but their holding period will typically be longer reflecting transport times from the producing to the consuming market. Exporters may be locally-based companies, cooperatives, companies based in consuming countries or local affiliates of such companies. Liberalization has resulted in many industries coming to be dominated, directly or indirectly, by major multinational companies – see section 4.1. This is true, for example, both of coffee and cocoa. Exporters will normally be long the commodity, although it can also happen that they are short if they sell to consumers prior to purchasing the product at origin.

Stockholders are a particular category of intermediary, and they generally hold long positions in the market. Stocks may be held in the producing country, a consuming country or a third location. For many tropical commodities, there is advantage in holding stocks in a temperate climate. Often financing will be easier if stocks are held in warehouses designated for exchange delivery. These warehouses tend to be in consuming countries to allow consumers to take delivery for purposes of immediate consumption. Stockholders may buy and sell at market prices, or may simply earn a fee for storage and collateral management services. Stockholders in the former category, who are trading the commodity profit either from expected price appreciation or from the opportunity to consume (or sell to a consumer) should the need arise (the “convenience yield” of stock).

Banks are a final category of intermediary with exposure. In their case, the exposure is indirect and results from default risk associated with lending to intermediaries with specific

price exposures. A fall in the commodity price can result in inability to repay on the part of intermediary who is long the commodity and has borrowed in order to finance operations in the supply chain. Once banks have experienced such defaults, they become unwilling to advance credit to the sector and prefer to retreat to safer activities such as lending on urban real estate where collateral is available. Diminished access to credit in the supply chain and increased cost of credit where it is available thus become direct results of poorly managed price risk.

2.3 Producing country governments

Governments may have direct or indirect exposure to agricultural commodity prices. Direct exposure arises when tax revenues or fiscal subsidies depend on the level of prices. Price dependence of tax revenues is much less acute now than a few decades ago. In part, this is the consequence of an extended period of low agricultural prices which has obliged governments to look elsewhere for tax revenues. Also, in many countries there has been a move to taxes which are independent of values, since quantities are more easily monitored than values. Direct price exposure therefore tends to be small for export crops.

Food crops may give rise to more complicated exposure patterns. This is most obviously the case in countries in which government imports food, typically grains, for off-market distribution (e.g. for use in schools and hospitals or for subsidized distribution to poor households as a form of social security). The same situation arises in which governments are committed to cap food price rises and manage strategic grain reserves. As current (2008) developments in food markets show, these commitments will often be implicit. In such circumstances, government has a short exposure: it will have an increased financial liability as food price rise.

Exposure also arises indirectly when governments act, either implicitly or explicitly, as guarantors of stabilization funds and parastatal organizations. This has happened most obviously in the case of stabilization agencies, such as *caisses de stabilisation*. Financial difficulties can arise either if the stabilization agency fails to reduce prices sufficiently in the face of prolonged periods of low prices or if it fails to hedge a price guarantee given to farmers at the start of the crop year and the price then falls through the crop year. These circumstances have both arisen in the Central and West African cotton sectors where this form of market intervention is standard – see Box 1 which illustrates this for Burkina Faso.

Box 1: Governmental Exposure to the Cotton Price in Burkina Faso

Market liberalization has resulted in three cotton ginning-exporting companies in Burkina Faso, each with a regional monopsony. The largest is SOFITEX, the ex-state ginner which accounts for 80% of Burkina production. Subsequent to liberalization, SOFITEX was owned 35% by the Burkina government, 34% by a multinational trading company and 30% by the cotton farmers through a producers association. In conjunction with producers, ginners fix a pan-national initial price to be paid to farmers in at the start of the season. This was price was set at over-optimistic levels in both 2004-05 and 2005-06 resulting in substantial losses to SOFITEX, which was unhedged. The following paragraph is a quote from the Letter of Intent to the IMF signed by Finance Minister Jean-Baptiste Compaouré on 11 April 2007. It makes clear that the incidence of SOFITEX's stabilization losses fell directly on the Burkina Faso government. Much of this incidence was subsequently passed through to donors.

“After sizable losses in two consecutive campaigns (2004/05 and 2005/06), the net worth of Burkina Faso's main cotton company SOFITEX was reduced to below zero. The main reasons behind the loss, based on audited accounts, were the low world cotton prices, the appreciation of the CFAF, and high prices paid to farmers, reflecting slow adjustment to the external shocks. The recapitalization was complicated by the fact that ultimately SOFITEX's main private shareholder decided not to participate. In this context, the government had offered to extend a guarantee of CFAF 50 billion for the outstanding loans from the 2005/06 campaign so that domestic banks would release the funds to pay farmers. The recapitalization need for SOFITEX is currently estimated at CFAF 38 billion. The actual amount will be confirmed in an extraordinary general assembly meeting of shareholders in June 2007. Shareholders must contribute at least 75 percent of the recapitalization amount by end-2007. The final phase, expected after 2007, would bring the company's net worth back to a level compatible with regional business regulations (OHADA). The government's 35 percent share in SOFITEX could temporarily increase as a result of the recapitalization.”

Source: IMF <http://www.imf.org/external/np/loi/2007/bfs/041107.pdf> (paragraph 22, part)
F.CFA 38 billion was equivalent to \$79m at 2007 exchange rates.

A frequent consequence of financial problems in stabilization funds is that governments turn to donors to assist in the refinancing. This was the case in Burkina Faso (Box 1). Similarly, when parastatal organizations incur large trading losses, as a result either of not recognizing or mismanaging price exposure, local banks and governments are often called upon to support bail out programs, which can take the form of debt forgiveness or debt rescheduling.

One of the objectives of market liberalization was to reduce the likelihood of such calls for ex post financial support by transferring responsibility for stabilization to the sector, in particular to so-called industry representative organizations. In practice, governments have difficulty in standing aside and letting a major institution fail. When industry participants

know that this type of bailout is likely to be available if there is a problem, this can lead to reckless behavior. More fundamentally, because many actors in the supply chain do not have the skills to properly assess risk in an ongoing way, and manage it throughout the season, unhedged price exposures lead to trading losses at every level of the chain. Implicit guarantees of this sort described here result in a long exposure on the part of government, although the imprecise nature of the guarantee makes quantification of the exposure problematic.

2.4 Consumers

By consumers, we intend the companies who purchase the commodity in the final market. Often, the commodity will be processed before being sold at the retail level. Converters, often large multinational trading companies, import cocoa beans and grind (“convert”) then to obtain cocoa liquor, cocoa butter and cocoa powder which are inputs into the manufacture of chocolate and confectionary products. Many of these products, including standard retail chocolate, will contain more milk and sugar than cocoa. The cocoa value can therefore effectively end at the conversion stage. By contrast, coffee is roasted and packed (if soluble, roast, processed and packed) but is then sold on the retail market as coffee or as a coffee drink. Here the value chain continues to the retail stage. In this respect, cotton is more akin to cocoa and sugar to coffee.

The price exposure of consuming companies depends on how they sell the end product. Cocoa products are generally sold to the chocolate and confectionary industry at prices which closely follow exchange cocoa prices. The converters are therefore in a similar position to that of the producing country intermediaries. They will be long cocoa for the period in which they hold the cocoa for conversion. Coffee roasters buy coffee at market prices and sell at prices which are typically fixed over some period of time (often only a few weeks). They are often short coffee since they will sell first, and then focus on procurement. A rise in the input price, given fixed retail prices, will erode profits, and a fall will enhance them. Chocolate manufacturers are in a similar position relative to cocoa – a rise in the price of their cocoa ingredients will erode their chocolate margins. In their case, the problem is exacerbated by the fact that it is costly to change vending machine prices.

Final (retail) consumers are, of course, short all commodities. In developed countries, unlike agents in the commodity value chains, consumers are highly diversified. Gasoline is a large item in consumer budgets, but for other commodities, price rises are irritating rather than painful, except when they move together. This implies that final consumers will not

suffer a serious decline in their standard of living if a poor harvest leads to a rise in the price of a particular commodity, but they will be worse off if a rise in demand (perhaps in China) results in an across-the-board rise in prices. In developing countries, particularly in countries with one or two main staple foods, consumers are not diversified and are highly exposed to the risk of price increases. As we have seen recently (in 2008), when consumers of food staple commodities are affected by severe price shocks, the call for government intervention can be strong

2.5 The Overall Supply Chain

Overall, the value chain is long the commodity. Final consumers, and those consuming companies which sell part or all of their output at fixed (list) prices, will be short. The more links there are in the chain, the greater the number of agents who will have long exposure, but the shorter the duration of their exposure. And because most supply chains are fragmented at least to some extent, we should expect an excess of agents with long exposure to those with short exposure.

It follows that the supply chain gains if prices rise and loses if they fall. However, because holding periods differ, different agents will be interested in price variability over different horizons. Farmers have the longest horizons. The time between planting (or input application) and harvesting is typically around six months. Farmers are vulnerable to price falls over this period. Cooperatives who offer guaranteed prices at the start of the crop year also have long duration exposures. By contrast, most other intermediaries, such as transport companies, have much shorter holding periods.

Farmers' exposure to short term price variability is more complex. High prices at the tail end of the old crop year bring no benefit to a farmer who can only sell once his new crop is harvested. Farmers have no exposure to variability at this stage of the crop year. However, once his crop is harvested he needs to decide when to sell. It is often alleged that intermediaries extract higher margins at the peak of the harvest (perhaps consistently with rising marginal costs of intermediation) giving farmers an incentive either to harvest early or to hold back on their sales. Discretion with respect to the time of marketing generates a short term exposure.

Capital investment, either in tress or in equipment, such as in a cooperative gin, gives rise to a very long term exposure, extending possibly over decades. This is more akin to an equity investment issue rather than a risk management problem.

These are the general categories of price exposure faced by actors in the supply chain. Specific risk assessment is necessary to identify and quantify the specific exposure faced at a particular time. Price risk assessment should be an ongoing exercise for all supply chain actors since the costs of not appropriately identifying, monitoring, and managing price exposure can be severe.

3. Instruments and Problems

Price risks can be managed in a number of different ways. Different agents in the supply chain will find different choices to be appropriate. Some developing country agents may find that none of these risk management methods are feasible and they may thus simply have to bear the exposure. Others may not be aware either of the available management methods or, more fundamentally, of their exposure. They may also end up bearing the exposure even in cases in which risk management is feasible. We discuss the instruments in section 3.1 and review access problems in section 3.2. Section 3.3 looks at basis risk, which may reduce the contribution of these instruments. Section 3.4 looks at the potential offered by developing country futures exchanges.

3.1 Instruments

In the developed market economies commodity price risk within a commodity chain is generally offset using exchange-traded financial products, such as futures and options. (Swaps are potentially important but have not yet played a major role in developing country agriculture). Typically, these instruments are used to mitigate short-term price risks, say three - eight months forward.

A futures contract obliges the seller, who is said to be “short” the future, to deliver a specified quantity of the commodity, satisfying a specified range or quality conditions (generally including origin) in one of a range of a specified locations at or by a specified date. The buyer, who is said to be “long” the future, has the obligation to take delivery under the same terms. In the majority of cases, neither of these events will take place, and both shorts and longs will take exactly offsetting positions in the same futures contract prior to the specified delivery date. These offsetting positions cancel the physical delivery obligations and achieve the financial purpose of taking futures positions, which is generally to lock into the quoted futures prices at the time of the original contract when it is not possible to manage the price exposure through an immediate back-to-back physical contract. The futures

contract thus achieves a “hedging” function, operating as a financial risk management tool in parallel with physical trades.

In a well-functioning futures market, futures prices correlate closely with the prices in the physical market, and indeed generally form the benchmark prices for pricing commercial transactions. This correlation allows a futures position to lock in an as yet unknown future cash market transaction. Suppose I sell at the current futures price of \$100 to fix the price in pending sale of the physical in one month’s time. If both the futures and the cash price fall over the month to \$90, I will obtain only \$90 on my cash sale but will profit \$10 by buying back the futures contract at \$90 against the \$100 I have paid. My net price is the \$100 I locked in through the futures sale. In section 3.3 we look at reasons why actual outcomes may not be so clear.

Whereas futures contracts allow transactors to lock into current futures prices, options allow transactors to guarantee minimum or maximum prices. A minimum price is guaranteed by purchase of a put option which gives the holder the right (but not the obligation) to sell the physical at a specified strike price. A maximum price is guaranteed by purchase of a call option which gives the holder the right (but not the obligation) to buy the physical at a specified strike price.

As in the case of futures, these positions will normally be purely financial and will not result in the contracted purchase or sale of the physical commodity. To continue with the previous example, consider a put option with a strike price of \$95. If the futures price falls from \$100 to \$95 over the contract period, the put option is \$5 in the money and can be closed out for this amount. I sell my physical for \$90 but make \$5 on the put giving me a net price of \$95 which is the floor price I had locked in when purchasing the option. On the other hand, if the futures price remained at \$100, the put would expire worthless and I would simply obtain the cash price of \$100. The call operates in the same way but allows a purchase price to be capped.

Both futures and options may be exchange instruments (i.e. instruments traded on the originating exchange) or over-the-counter (OTC) instruments. In the latter case, they may either be exchange-look-alikes or specifically designed to suit client requirements.

The price exposures in the developing country agricultural value chains, discussed in section 2, establish the potential for application of price risk management instruments. Two sets of factors reduce the extent to which this potential can be realized in developing countries. The first, access problems, discussed in section 3.2, reduce the supply of risk management instruments to developing country agents. The second, basis risk problems,

discussed in section 3.3, reduce the value of risk management instruments in developing countries, and hence the demand for these instruments.

3.2 Access problems

Not everyone can simply walk into a futures broker and establish a futures or options account. There are three major factors which can limit access:

- a) Size: Contract sizes are often much larger than the exposure of many developing country actors. Furthermore, brokers incur fixed costs of trading – there is little cost difference between selling one contract and ten contracts. Both considerations require smaller developing country agents to aggregate their positions.
- b) Credit: Futures trading requires credit lines, which can be sizeable because commodity exchanges require daily monitoring and management of the overall financial liabilities of all market actors. This is done through a process of marking to market all open positions and then making margin calls. The mark-to-market process involves comparing the net value of open positions to the current market price to establish a dollar value of open liabilities. Futures brokers, and the exchange as a whole, then limit the overall financial liability of the positions by “calling” the margins of these open liabilities. This is done, on an individual customer basis, by requiring either a cash deposit to cover a percentage of the overall liability, or using a credit line to establish coverage for that liability. This credit line will need to be in dollars or an equivalent freely convertible currency. Since many developing country actors simply lack access to credit facilities needed to cover these liabilities, hedging with futures on international exchanges is typically infeasible. As an alternative, developing country can hedge with options which can be purchased by payment of an up-front options premium, thus avoiding the need to manage a credit line and margin calls.
- c) Regulation : Post 9/11, regulatory authorities have become increasingly vigilant about the possibility that financial markets, including commodity futures and options, can be used for money laundering purposes, including those that may fund terrorism. Developing country institutions are obvious candidates to front such illegal activities. Developed country regulators now impose very substantial obligations on brokers before they can trade with developed country entities. These requirements relate to any type of business done between developed country financial institutions and developing country market actors. It implies a high start-up cost for developed country actors wishing to expand business in developing country markets. If the business volumes do not appear to be high

enough to offset these costs, brokers based in developed countries will simply choose not to invest in these new markets. (In certain developing countries, exchange regulations may also prohibit hedging on international exchanges).

Overcoming these access problems is a challenge to bridging the market gap between unhedged commodity price risk, and the use of instruments that can mitigate that risk.

3.3 Basis risk problems

Basis risk arises where the price of a traded instrument, such as a futures price, is imperfectly correlated with the price that is relevant to the exposure in the supply chain. The prices of most exchange-traded agricultural products relate to transactions in the developed countries, often on the eastern seaboard of the United States and in North Sea ports in northern Europe. Price movements in commodity producing countries will not always correlate well with these exchange prices. The resulting basis risk is therefore likely to be more acute for agents in the developing country sections of the agricultural value chains than for those in the developed country sections of the same chain for whom the US and northern European prices are directly relevant.

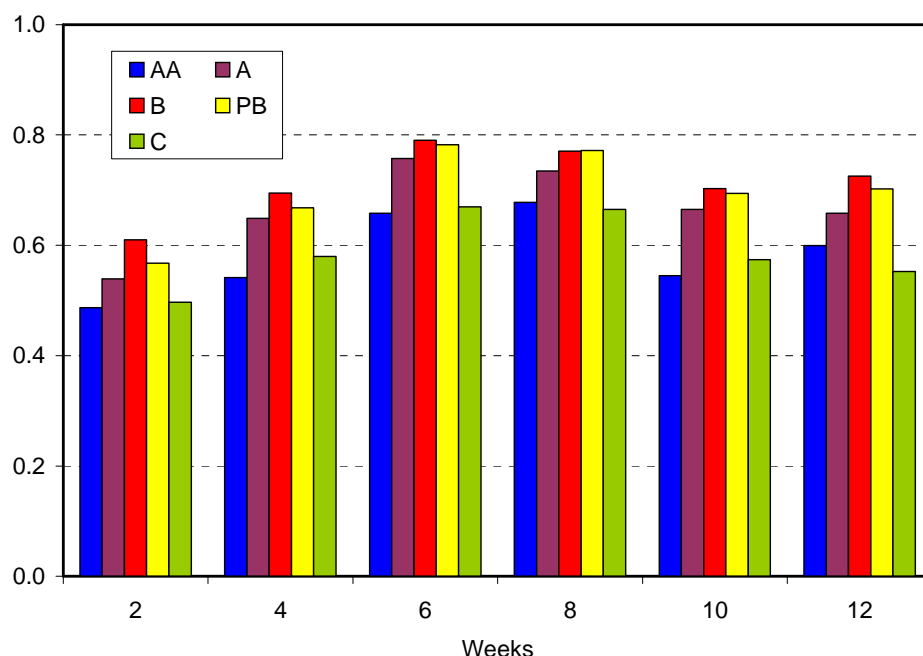
Consider an intermediary who buys the commodity on a particular date, say 7 November, and who expects to hold this position for 14 days. He is vulnerable to adverse movements in the price over this two week period. He can offset this exposure by selling a nearby futures contract in the commodity in question with the consequence that he is now long the commodity and short the future. Provided the commodity price in the origin country moves closely with the futures market price, any fall in price which would result in a loss in his physical position is offset by a corresponding gain on his futures position. On 21 November, when he sells the intermediated product, he buys back his futures position to close out the original hedge. This leaves him with zero net exposure.

The hedge quality (i.e. the extent to which the hedge does eliminate price exposure) depends on the correlation of changes in the local price and the futures price over this two week period. If the correlation is unity, the price exposure is completely eliminated. In practice, hedge quality is always imperfect since the price at origin reflects local as well as global market conditions. The difference between the local price and the futures price is known as a “basis” and the risk associated with movements in this basis (i.e. the price relativity) is known as “basis risk”. Once the correlation falls beneath around 0.8, basis risk becomes large and offsetting via futures contracts ceases to be highly effective. Box 2 provides illustrative figures for Tanzanian arabica coffee.

Box 2: Coffee Basis Risk in Tanzania

Tanzanian arabica coffee is priced relative to the NYBOT Coffee “C” arabica price. Most coffees delivered against this contract are central American mild arabicas. The NYBOT price is therefore most appropriate for those coffees rather than Tanzanian coffee which is largely sold in Japan and northern Europe. This creates the potential for basis risk for Tanzanian intermediaries.

Tanzania requires coffee to be sold at auctions held in Moshi at the centre of the coffee producing area. “Segregation” requires that exporters can only buy at auction. Auctions are held weekly from September to April, with occasional gaps for holidays, and biweekly at the end of the season. Cooperatives and other intermediaries purchase coffee from farmers, transport it to Moshi and warehouse it there until auctioned. The consequence is that they bear a long price exposure for between two weeks and perhaps two months.



Basis risk can vary with coffee grade, holding period and also from one year to another. We look at basis risk for the major grades over the seasons 2001-02 to 2006-07 for holding periods of 2,4,6,8, 10 and 12 weeks.. We consider hedges which, when closed out (i.e. at the end of the holding period) will be in the second nearby contract. Basis risk was broadly constant over this six year period. The correlation between NYBOT price changes and those in Moshi was generally highest for the six and eight holding periods and for the A, B and PB (peaberry) grades which are also the most important in terms of volume, where it approached 0.8. It was lower for short holding periods and for the speciality AA and poorer quality C grades (in the range of 0.5-0.6). See the figure which averages the six annual correlations for each grade and holding period. A basis correlation of 0.8 implies a 64% variance reduction whereas a correlation of 0.5 reduced this to 25%. The basis correlations therefore vary from acceptable to poor, and are stronger for the higher grades.

Data sources: DfID (Tanzanian coffee prices), ICE (NYBOT “C” prices).

Basis risk is lowest for commodities which conform closely to the specification for delivery against the futures contract, and specifically for those that conform to the “cheapest to deliver” specification since this is the specification which the futures price will most closely reflect. Ivorian and Ugandan robusta have low basis risk relative to the Euronext LIFFE robusta coffee contract, Ivorian cocoa has low basis risk against the Euronext LIFFE cocoa contract and central American arabicas have low basis risk relative to the NYBOT arabica coffee contract.. By contrast, the NYBOT arabica basis risk is less good for Kenyan and Tanzanian mild arabicas (see Box 2) and for Brazilian and Ethiopian unwashed arabicas. Similarly, West African cotton has a high basis risk relative to the NYBOT cotton contract.

There must always be an element of judgment as to whether it is worthwhile for an intermediary to hedge. The vast majority of agents in developing country agricultural supply chains lacks basis price risk management knowledge and also often only has a weak understanding of the price risks to which they are exposed. It follows that they are often not well-equipped for implementing improved risk management approaches.

3.4 Developing country exchanges

Historically, the major agricultural futures markets have been concentrated in a small number of developed economies, of which Britain and the United States were the most important. Markets have also been active in Australia, Canada, France, Germany, Japan and the Netherlands. More recently, futures exchanges with agricultural contracts have been established in a number of liberalized developing and transition economies and economies, including Brazil, China, Hungary, India, Indonesia, Malaysia, Poland, Singapore, South Africa and Turkey.

Viable futures trading in developing countries reduces basis risk and improves access for those actors in the supply chain located in the country in question. Developing country futures exchanges therefore have the potential to facilitate risk management in the developing world. UNCTAD has played a leading role in advising on these issues – see UNCTAD (2005a,b). However, at the same time, they can prove controversial when politicians find it convenient to attack futures market speculators for price changes which impact adversely in sections of the population, for example low coffee prices from 1999 to 2002 and the 2008 increases in food prices.

The most dramatic increases in agricultural futures changes that have taken place over the past decade are in China and India. It is probably not coincidental that these are the two countries with the largest domestic agricultural sectors. The majority of the active contracts in

China and India are in products which are primarily consumed domestically rather than traded internationally. Neither country has enjoyed the same success in developing futures contracts for agricultural products which are already traded on a developed country exchange.

Successful futures trading requires liquidity. Unless markets can ensure liquidity, potential market participants will be reluctant to trade for fear of being unable to liquidate their positions except at substantial cost. This generates a classic “chicken and egg” problem. Further, if two or more exchanges compete for the same business, traders will generally opt for the exchange with the highest liquidity and hence the lowest spread. Exchanges compete for liquidity and it is difficult for an entrant to attract liquidity from a successful incumbent contracts. This generates “first mover advantage”. Taken to an extreme, it can imply the principle “one product, one contract”.

In the case that a developing country exchange introduces a contract which competes with a contract on a developed country exchange, hedgers will compare the costs and benefits of hedging with the new contract relative to the existing contract. Market liquidity is a major determinant of the cost of hedging – the less liquid the market, the higher the likely spread and the more expensive it may be to close out a position. The new contract will have lower liquidity than the existing contract, at least initially, implying that choice of the new contract will raise costs. Against this, the new contract will be more appropriate, in terms either of product specification or of delivery location, for local and regional hedgers and so will have lower basis risk. Hedging with the new contract will therefore be associated with both higher costs and higher benefits than use of the existing contract. The balance between these two factors will determine whether the contract is attractive.

Examples of successful competition by developing country exchanges include the arabica coffee contract on the Sao Paulo exchange (the Brazilian Mercantile and Futures Exchange, BM&F), and the white maize contract on the Johannesburg exchange (South African Futures Exchange, SAFEX). The BM&F arabica contract competes with the NYBOT contract which effectively defines the reference price for arabica coffee in world trade, while the SAFEX white maize contract competes with the CBOT corn contract which is the reference price for world maize. However, product specifications differ in important respects. NYBOT specifies delivery of washed arabica, suitable for mild coffees, while Brazil predominantly produces the more bitter unwashed arabica. Brazilian coffee therefore has a poor basis with respect to NYBOT. The SAFEX contract is for white maize while the CBOT contract is for yellow maize. Again, there is substantial basis risk, in this exacerbated by transport costs between North America and southern Africa, which can drive a significant

wedge between prices in the two continents. Where basis risk is less serious, contracts in the same exchanges have performed less well (soybeans and sugar on the BM&F, yellow maize on SAFEX). Box 4 (section 4.6) discusses a hedging application which makes use of the BM&F arabica coffee contract and Box 6 (section 4.8) discusses use of the SAFEX white maize contracts for capping food security costs.

These examples show that futures exchanges in developing countries can play a significant role in facilitating risk management in developing country supply chains. However, they will do this only if they can change the benefits between the costs and benefits of hedging. The additional liquidity costs of trading a new contract, which gives existing developed country exchanges “first mover advantage”, implies that developing country exchanges are likely to be successful in contracts for domestically consumed commodities and for those internationally traded commodities where basis risk is large.

4. Price risk management in the developing country supply chain

First, in section 4.1, we consider problems faced by developing country intermediaries. Then, in sections 4.2 – 4.7, we consider the issues arising in intermediating risk management to farmers. Finally, in section 4.8, we discuss risk management on the part of governments.

4.1 Developing country intermediaries

Exporters and consumer-importers have mirror-image problems. The exporter sells the commodity to the importer but, because of distance, the transaction takes time to complete. They face a choice between contracting at the price at the time of the transaction, at the time of delivery or at some intermediate date. Typically, the price will be fixed formulaically at the time of the transaction against the price of the relevant futures contract at the time of delivery.

To be concrete, consider the case of a Kampala (Uganda) exporter selling robusta coffee to an importer, a roasting company in Hamburg (Germany). It takes two months to transport the commodity from the Kampala railhead to Hamburg. In a back-to-back sale for his own account, the importer manages the price risk by contracting the purchase (from the exporter) and the sale (to his end consumer) at the same time. He offers the exporter a price based on the current futures market quotation for a month close after the expected delivery, e.g. March for a February delivery, plus a negotiated quality premium or discount. He then immediately contracts the sale of the processed coffee with a similar price basis, e.g. March

futures price for a February delivery, plus a negotiated premium. The importer has eliminated his exposure but the exporter bears the price risk between the transaction date and the delivery date.

Large exporters or importers, in particular multinationals, will monitor a portfolio of transactions on a regular basis and will be able to quantify, to the dollar, the exact price exposure of the overall position. They will typically use futures markets to hedge only their net positions since they can benefit from internally offsetting long and short positions. Relative size is therefore one component in comparative advantage. A second component is access to finance, required for margin payments – in the event that the futures price rises, the short party will need to pay margin into the exchange to maintain his position. As discussed above in section 3.2, this will be difficult for a small exporter located in a developing country.

These factors place developing country exporters, particularly small exporters, at a disadvantage relative to multinational exporters, or local companies affiliated to multinationals. At the time of the push for market liberalization, there was a widespread hope that national monopsony-monopoly exporters would be replaced by a competitive export sector. This has not happened. Instead, after an initial burst of competition, exporting has generally tended to become quite concentrated and to be dominated by multinationals. It was also imagined that cooperatives would be able to export directly. Again, this has proved difficulty except in niche markets (such as those for organic produce) and in the concessional trade (such as “fair trade”). Locally-based traders naturally ask why they cannot be involved as principals in the export of their own crops. The answer is that, absent developed financial market institutions which can provide credit and finance risk management, liberalization has allowed local firms the right to compete but has failed to level the playing field such that they can compete effectively.

Stockholders have a long exposure, analogously with exporters, and can hedge in the same way. Once they have bought, or contracted to buy, the commodity, they sell futures. If the stockholder intends a long holding period, he will choose a distant future, subject to it being sufficiently liquid. By so doing, he has locked in the market “contango” – the difference between the long-dated futures and the cash price he has paid for his physical. When, eventually, he sells the inventory, he unwinds the futures position by purchasing the same contract. The complication is that, if he chooses to hold his physical position beyond the maturity date of his short futures contract, he will need to roll this position forward, buying back the future as it comes to maturity and selling a further longer-dated contract. If

the contango increases, this will be profitable, but if it declines he will lose money. Management of “roll risk” provides opportunities for profitable trading and has the potential to reduce hedging costs. However, when roll risk is mismanaged, this can increase costs and reduce hedge effectiveness.

Commodity futures markets function well for the export and import trade – hardly surprising, since this was the function they evolved to serve. They also facilitate stockholding. As financial instruments, futures can in principle provide the same benefits to developing country supply chain that they currently provide in developed economies. However, the consequence of uneven access is that they are instrumental in shifting the balance of advantage in commodity exporting towards multinationals and against locally based traders.

Other developing country intermediaries, such as traitants and transport companies, also have long exposure albeit over relatively short periods of time. In principle, they might also hedge their exposure. In practice, this proves difficult for reasons both of market access, discussed in section 3.2, and because of basis risk, discussed in section 3.3. Basis risk makes hedging less effective and access problems, make it more difficult. The result is that the majority of developing country supply chain intermediaries generally manage their risk by minimizing holding times. This strategy is reasonably effective provided there are no sharp falls (downward jumps) in prices. The strategy becomes dangerous if holding periods are long. This can happen if the intermediary undertakes substantial processing, as is the case with cotton ginners, if it is inefficient (true of many cooperatives) or if it decides to speculate, waiting on a possible price rise (also a common practice among cooperatives).

4.2 Farmers: risk management *versus* price stabilization

Farmers are always long the commodity. However, as discussed in section 2.1, they have two distinct time horizons. The shorter horizon is the crop year. To commit inputs, they need to be assured of the price at harvest. The longer horizon relates to investment, either in trees (cocoa, coffee etc.), in capital equipment or in cooperative facilities. The relative importance of these two horizons differs across commodities.

Hedging is, in principle, possible with respect to the shorter horizon but will never be effective in relation to the longer term problem. One of the misconceptions of the liberalization agenda was that “market-based risk management” could substitute price stabilization – in fact the two approaches address price variability at different horizons. Importantly, stabilization does not eliminate, and may exacerbate, risk management

problems. Marketing boards and like organizations hoped that, by stabilizing prices, they would be able to commit on harvest prices at the start of the crop year. That transferred the short term price exposure from the farmers to the board. The risk still needed to be managed.

Despite the fact that it has seldom been emphasized, the distinction between price stabilization and price risk management is fundamental – see Gilbert (2007b). This is because, as already stressed, the relative importance of the two activities differs across different agricultural commodities, and because, if these problems are to be addressed, it will in general be appropriate for this to be undertaken by different institutions. Risk management is concerned with locking in prices, and hence profits, at the time decisions are made while stabilization addresses the level of prices, and hence profits, that can be locked in. Put another way, risk management is a contracting activity while stabilization is an activity which relates to saving.

4.3 Intermediation via cooperatives

Even in the developed economies, very few farmers directly hedge using futures markets. In the developing countries, even fewer farmers are able to do this, even if they understand what it would be to hedge. This was always recognized by the advocates of market-based risk management, who looked for intermediaries which might function as “transmission mechanisms” – see ITF(1999). The analogy was to elevator companies in the North American grains sector which offer a variety of contractual price fixing arrangements to farmers. Once a farmer chooses to lock in a price, thereby passing the price exposure to the elevator company, the elevator, which benefits from aggregation and from superior access to credit, hedges the position on a net basis. Possible developing country transmission intermediaries include cooperatives, banks and exporters.

Cooperatives have the size to aggregate. They buy the commodity from farmers and sell to exporters, perhaps after some processing. They may also export directly, but in many markets, they will lack the scale and specialized expertise to do this efficiently. They may also supply inputs to farmers at the start of the crop year, in general on a credit basis with repayment taken as a rebate on the eventual purchase price. In principle, cooperatives might sell the product forward or establish a short futures position enabling them to offer farmers a fixed price at the start of the crop year. This would give the farmers the security they require in deciding what quantities of inputs to purchase and how much labor time to supply.

This is a pure risk management activity and does not involve any element of stabilization. With storage, futures prices are only very slightly less variable than cash prices

– see Newbery and Stiglitz (1981). In a year in which prices start low, a futures sale will lock the cooperative into this low price. The advantage that this gives is that farmers do not unwittingly purchase inputs which the sales price will not justify. However, they may well remain highly discontented with the price that has been fixed and doubt the wisdom of the forward or futures sale.

Similarly to other intermediaries in the commodity supply chain, developing country cooperatives lack the foreign currency credit to organize margin finance, but also because of regulatory concerns with regard to money laundering – see section 3.2. If they are to hedge this must therefore be through purchase of out-of-the-money puts. This will give them an approximate minimum price and not to fix their price absolutely. The requirement to pay an up-front premium, often seen as a disadvantage of non-margined options relative to futures, forces cooperatives to put a value on price security. With futures sales, these costs only become explicit if there is a price rise during the course of the crop year at which the cooperative perhaps belatedly discovers it has foregone.

The institutional structure of cooperatives allows them to manage minimum prices relatively easily by utilizing a two stage payment structure. The initial payment, guaranteed to the cooperative's members at the start of the crop year, is based on the minimum price locked in either through the purchase of the put, less the premium cost, or on the basis of fixed price forward sales contracted prior to the crop year. If, at harvest, the cooperative achieves a higher price than that promised at the start of the crop year, a second payment can be made.

As discussed in section 3.2, it is not feasible for developing country cooperatives to access international commodity futures markets. Few major banks and brokers are willing to invest in building-up relationships with developing country cooperatives and to work with them to overcome regulatory hurdles. There are also practical problems at the level of the cooperatives themselves, particularly in Africa where cooperatives have often become inefficient and over-politicized over time. Many have proved insufficiently sophisticated from a financial and accounting standpoint to use financial markets. Slow democratic decision-making results in hedge quotes becoming stale, and cooperatives have not always been willing to delegate power to contract to officers. It has been observed that while cooperatives often welcome technical assistance and apparently benefit from the improved contracting that this generates, they have seldom been able to continue to manage risks with the same competence once the assistance programs terminate.

One should not be too negative about this experience: farmer cooperatives work well in certain regions of the world (the Netherlands and parts of northern Italy, for example) and less well in others. It is important to understand what leads to success and what inhibits it so that developing country cooperatives can be reinforced wherever circumstances are propitious. If this can happen, these cooperatives may yet be able to securely offer farmers some element of price guarantee at the start of the harvest year.

4.4 Intermediation via exporters

Exporters might in principle offer farmers or cooperatives fixed prices or minimum prices in the same way as that outlined in the section 4.3. They have an incentive to do this if the pre-announced prices increase output sufficiently such that the resulting increased revenue outweighs the costs of making these commitments. Moreover, multinational exporters, or local exporters affiliated to multinationals, have the capacity to manage the credit and regulatory constraints that confront local organizations, such as cooperatives, in operating on international futures markets.

To some extent, exporters do operate in this way. The main practical limitation they face is that of contract enforcement. Where farmers have a choice of to whom they will deliver, fixed price contracts, in practice, become free options – if the market offers a higher price than the contracted price, many will choose to deliver at most only a part of their output against the contract, whereas if the contracted price exceeds the market price, the exporter will find he obtains 100% of the contracted output. The same logic makes it difficult for exporters to offer input credit financed through a rebate on the eventual purchase price – this simply gives an incentive to farmers to deliver to alternative purchasers, a common problem known as “side-selling.”

Competition therefore undermines the ability and willingness of exporters to provide risk management services. The liberalization agenda failed to appreciate this difficulty. The consequence is that it is only in the relatively less liberalized markets that exporters are able to transmit risk management (i.e. guaranteed prices) to farmers. Coffee and cocoa both tend to be very competitive. Traitants and small traders tour round farming communities offering farmers multiple opportunities to sell and hence also to break previous contractual commitments. By contrast, the cotton sector, particularly in francophone Africa, has tended to preserve regional monopsonies reflecting the high fertilizer intensity of most cotton production and the costliness of transporting bulky unprocessed (seed) cotton over significant distances. In cotton, economic efficiency appears best to be served through a collaborative or

symbiotic relationship between regional ginners (often cooperatives) and the farmers who supply them, even though this results in less competitive pressure. The same type of dependency arises in both the cane sugar and the palm oil industries. In these circumstances, exporters are in a position to offer price security without worrying to the same extent whether they will subsequently be undercut by competitors provided that they can manage the price risk that they thereby assume. Facilitation of risk management at the export stage allows the benefits of price security to be transmitted down the supply chain.

4.5 Intermediation via banks

Banks form a further set of potential candidates for intermediation of price risk management to farmers, either directly or via cooperatives, but only to the extent that they are active in the sector in question. This excludes many of the poorest countries of the world where banks have seen little profit in an (until recently) stagnant agricultural sector and have thus tended to eschew both the agricultural sector in general and lending to farmers and agricultural cooperatives in particular.

The potential for banking involvement arises from their concern to avoid default in loans to farmers or farm cooperatives. Such defaults are most likely in periods in which prices are low, or, even if not low in absolute terms, have fallen during the course of the crop year. Two alternative strategies are available to banks. The first is to hedge their exposure directly, by, for example, purchase of puts which pay off in precisely the circumstances that defaults become more likely. The second possibility is to gear the repayment terms on agricultural lending to the commodity price in question so that lower repayments are required if prices turn out to be poor. These lower repayments would need to be compensated by higher repayments in other circumstances, but the lower default risk may yet allow them to offer attractive loan contracts to borrowers. This mechanism would create price exposure for the bank, which would then need to hedge itself.

Box 3 illustrates intermediation of this sort in the context of Tanzanian cotton and coffee sectors. In the current more buoyant context, it is possible that there will be an increased appetite for agricultural lending, and these ideas may become more widely exploited. Box 4 discusses the innovative Brazilian *Cedula Produto Rural* instrument in which commercial bank financing for coffee exports is facilitated by the locally traded arabica coffee contract. This is an interesting model for other developing countries wishing to increase the availability of export finance.

Box 3: Risk Management Intermediation by a Tanzanian Agricultural Bank

CRDB Bank Ltd is one of two Tanzanian commercial banks with a significant role in coffee and cotton financing. In 2001, CRDB was faced with default issues in the coffee and cotton sector both of which were experiencing exceptionally low prices. Rather than pulling out of these sectors, the bank chose to implement a collateral management program which would help it to exert tighter control on lending to these high risk sectors. The process begins when the client brings the goods to the certified warehouse or curing company. Once the collateral manager had evaluated the quality and the quantity of the product, it sends a report to the bank. The bank values the inventory based on then current market prices and advances 65% of the cash value to the client.

This leaves CRDB Bank bearing a long price exposure. It could either hedge the overall portfolio to the coffee and cotton price by using risk management instruments to manage price volatility on its financing flows, or hedge its own exposure through that of individual clients by offering to act as a market intermediary in carrying out hedging transactions on behalf of borrowers. It chose the second option because it wished to expand services to agricultural borrowers and because it was concerned about adding on costs that are not entirely understood by customers and run the risk of being perceived as “hidden”.

CRDB Bank adopted the Swahili term “Kinga Ya Bei” (roughly translated as commodity price protection). The program was introduced at the annual borrower workshops for coffee and cotton in 2004. Since that time coffee prices have recovered and cotton is also somewhat higher. Attention has now shifted to currency risk. Attention has now shifted to currency risk. The bank continues to provide assistance to borrowers in the assessment of price risk throughout the season by helping them to analyze their positions against the market, assess break-even price levels and mark positions to market.

This summary is based on material provided by Erin Bryla, Julie Dana, Roy Parizat and Pauline Tiffen.

Box 4: The Brazilian *Cedula Produto Rural*

The *Cedula Produto Rural* (CPR) is an innovative instrument designed for the agricultural sector. It is essentially a commodity-backed bond, issued by a farmer or cooperative and discounted by a bank. It is used extensively to finance coffee exports.

The CPR structure has three features:

- **Stabilization:** it guarantees farmers a minimum local currency cost-based price which varies only moderately from year to year.
- **Risk management:** It gives farmers protection against movements in prices and exchange rates over the course of the crop year.
- **Finance:** It provides producers with low cost finance at an early stage in the crop year.

There are four important sets of actors in the structure:

1. The *Bolsa Brasileira de Marcadorias* (BBM) is the Brazilian physical commodity market. The BBM started out as a market for physical agricultural crop products. It has now evolved into being an internet-based market for financial products for the agribusiness sector. It issues CPRs, organizes a secondary market in these instruments and is responsible for implementation of government minimum price policies. The CPR requires the farmer to deliver a specified quantity of coffee of specified minimum quality to one of a number of designated BBM warehouses by a specified date. The value of the CPR depends on the lower of the minimum price and the current futures price (at the delivery date), translated into local currency at the forward exchange rate.
2. Commercial banks discount CPRs from coffee farmers with good credit histories. This provides relatively low cost finance for the important coffee export business. The Banco do Brasil plays a dominant role in this provision. The Banco do Brasil is a public-private partnership in which government maintains a large influence and which has an extensive branch network in the coffee-producing areas.
3. Private investment institutions buy discounted CPRs on the BBM secondary markets. If the price is too low (i.e. the futures price is below the support price), the CPRs are retained by the Banco do Brasil which may therefore be seen as a market maker in CPRs.
4. The Brazilian Mercantile and Futures Exchange (BM&F) trades dollar-based futures contracts in arabica coffee and contracts on the Brazilian real exchange rate. Importantly, the BM&F contract specifies delivery is to BBM warehouses eliminating basis risk for institutions hedging CPRs on the BM&F. This increases the attractiveness of hedging on the BM&F relative to NYBOT, despite NYBOT's greater liquidity. When investment institutions buy CPRs, they typically take on an offsetting short position in BM&F futures and a long position in dollars.

In summary, the structure involves a government agency (the BBM), commercial banks of which one acts as a market maker, private sector investment institutions and a local futures market (the BM&F).

4.6 Insurance as an alternative?

From time to time, well-meaning commentators suggest that insurance might be a mechanism by which developing country farmers and intermediaries might manage

agricultural price risk. In fact, insurance is ineffective in dealing with agricultural price risks although it can be used for weather risk.

Economists tend to discuss the failure of insurance markets in terms of moral hazard (not locking your front door because you have full contents insurance) and adverse selection (couples who wish to purchase insurance against the birth of twins disproportionately have twins in their family histories). Neither of these issues arises with price insurance. Instead, there are two other problems. First, the entire supply chain experiences price falls at the same time, so there is no risk pooling. Second, the price distribution varies over time making it difficult to calculate actuarial probabilities

Risk pooling arises when individual risks are largely uncorrelated across a population. The fact that one person dies from a heart attack does not change the risk for any of the other persons insured. Absent moral hazard and adverse selection, this lack of correlation allows the insurance company to rely on the Central Limit Theorem which states, loosely, that the average incidence of a particular problem in a given sample will tend, as the sample size increases, to be normally distributed with variance inversely proportional to the sample size. If probabilities remain constant over time, this fundamental result allows insurance companies to predict their average payout per policy with considerable accuracy even though they have no means of predicting the payout on a particular policy.

The Central Limit Theorem relies on independence. It fails when all or a large group of insureds suffer at the same time. An example is a disaster such as an earthquake in Los Angeles. A fall in a commodity price is similar – most agents in the supply chain have a long exposure and all of these will lose when prices fall. Lack of risk pooling makes insurance unattractive to the provider.

Non-constancy of probabilities makes it difficult for insurers to offer price insurance. Like many economic events, commodity price changes depend in a complicated way on history. Suppose we believe price changes to be log-normal, i.e. the changes in the logarithms of prices are normal. This ignores fat-tail (kurtosis) problems but is convenient since the mean and variance are sufficient statistics for the normal distribution – if we know these two statistics, we know everything. In the presence of a futures market for the commodity, we might suppose that statistical arbitrage will ensure that the futures price is a near unbiased estimate of the mean of the distribution. However, the variance of the distribution will depend on stock levels, on the price itself (governments often impose export restrictions when prices are high) and on the likely variability of production and consumption, which will also be time-varying. We might in principle attempt to estimate these variances from the implied

volatilities on options markets but, in agriculture, these are seldom sufficiently accurate to be reliable. If we cannot characterize the variance, estimation of tail probabilities (which is what will be insured) becomes impractical.

Box 5: Weather Insurance in Malawi

Approximately 50,000 thousand small-scale farmers in Malawi receive agricultural credit for purchasing seed, fertilizer or related agricultural inputs each year. While banks profess an interest in expanding agricultural credit to small-scale farmers, in practice, agricultural loan portfolios are declining. A major reason is defaults arising out of crop loss through either inadequate rainfall or flooding.

Rainfall risk is endemic in Malawi. In 2004-05, the country experienced a devastating drought throwing 40% of the smallholder population into dependence on food aid. Subsequent harvests have been better but in each year there have been pockets of drought in a few areas. Other areas were affected by flooding

An index-based weather insurance policy provides a means to offset the weather related risks of providing credit to a farmer. The policy links possible insurance payouts with a rainfall index calibrated with the rainfall needs of the crop being insured. The main advantage of this index-based approach is the payout is not based on the condition of the crop *per se*, but on the indisputable rainfall record. A limiting factor however is that it requires that farmers to be situated close (in practice within 20 km) to a rainfall station with reliable communications and good historical data.

In 2005, the Insurance Association of Malawi (IAM) agreed to offer an index based weather insurance policy, linked with credit supply, to small-scale farmers. Two banks agreed to offer the insurance backed loans to groundnut producers operating under the auspices of the National Association of Small Farmers of Malawi (NASFAM). The Malawi Meteorological Services Department agreed to provide daily historical rainfall data and daily data from the forthcoming rainfall seasons. Together with a rainfall-based groundnut crop model the historical data was used to design the index-based insurance contracts. The World Bank provided technical assistance in developing the rainfall index and contracts, drafting the index-based insurance policy, monitoring the pilot and brokering the full array of partnerships.

The index-based insurance contracts piloted so far in Malawi cover the value of the input loan, not the crop. If there is drought, the insurance payout repays part of all of the costs of the loan. Insofar as the risks of loan default are reduced, the costs of credit should decline and banks should be willing to extend larger quantities of credit to more farmers. In 2007 and 2008 the program scaled up to include excess as well as deficit rainfall risk for tobacco, paprika, tea and coffee farmers working with several agribusinesses, contract farming companies and banks in Malawi.

Based on work by Erin Bryla, David Rohrbach and Joanna Syroka.

In practice, an insurance company wishing to offer price insurance would very probably choose to offset its position on an organized futures market. It is possible that this may be an efficient way to intermediate access to futures markets, but, since insurance companies are currently absent from the agricultural supply chain, it is more likely that this will simply add an additional level of costs. The two different markets – insurance and commodity futures markets – have different regulatory structures as well, and the regulatory implications make it difficult to offer products structured through some combination of the two.

Contrast price insurance with yield insurance, which is practical. Insurance companies will not offer insurance on the yield on a particular farm since this generates a clear incentive to the farmer to reduce effort (moral hazard). However it is practical to offer insurance on the yield in a well-defined administrative area, if this can be measured, since an individual farmer will have a negligible impact on overall yield. Where yield variability arises from adverse weather conditions, one can define the payout in terms of the weather at a specified (secure) weather station, or in terms of an index over a number of such stations. Weather is generally fairly local, so insurance companies can pool across a range of geographically separate areas, and probabilities, even if not completely constant, tend to evolve slowly over time. Weather insurance is already extending from the developed to the developing world – see Box 5.

4.7 Risk-coping strategies

Developing country farmers have developed their own mechanisms to deal with hardships. It is useful to distinguish here between *ex ante* risk management strategies and *ex post* “risk coping” strategies. The most important *ex ante* strategy is income diversification, including crop diversification. *Ex post* strategies include borrowing, sale of assets, risk pooling through informal insurance arrangements between individuals and entire communities, increasing labor supply to the market and possibly even migration.

Risk management and risk coping strategies both impose costs. First consider *ex ante* risk management strategies. The challenges and preconditions for successful diversification programs have been thoroughly investigated (see, for example, Jaffee, 1993, and Barghouti et al., 1990). Poor households are inhibited from entering into riskier higher return activities because the downside risks are simply too great in the event of a crisis. Crop diversification increases security in the face of possible price and weather shocks but at the expense of allowing farmers to benefit from scale and specialization. The choice of safe but less

profitable choices can result in negative long term consequences (Morduch, 1990; Alderman and Paxson, 1994; Rosenzweig and Wolpin, 1993).

Turning to *ex post* risk coping strategies, richer households can borrow more easily in periods of low prices because they have assets that are available as collateral. If credit is not available, they can smooth their income by selling assets. In contrast, poorer households need to adopt low risk, low return strategies. Informal insurance arrangements appear effective in relation to demographic shocks, such as illness and death, but are less effective with price in coping with risks since low prices will impact all the farmers in a monoculture community. The problem of shock-induced inefficient choices can arise also with *ex post* strategies that deal with the consequences of shock; for example requiring children to drop out of school or to work may have long-term consequence and be socially inefficient (de Janvry et al., 2006). Sale of productive assets to maintain consumption may result in lower future incomes. Short run income maintenance may therefore be at the expense of longer-term well-being.

The fact that farmers are already diversified reduces their demand for more formal price risk management tools – effectively, they have already eliminated a large part of the price risk that market methods seek to address. Indeed, if reliable price risk management tools were available to farmers at low cost, this would allow them to specialize, i.e. undiversify, since the price risk would now be sustainable. It follows that if successful intermediation does become possible, for example through strengthened cooperatives, one should expect the take-up to be gradual with farmers moving towards more specialized and larger scale production as the perceived familiarity of the market-based structures increases with use.

4.8 Governments

We saw in section 2.4 that governments may have either a long or a short exposure depending on the crop, the tax system and the nature of the explicit and implicit commitments into which they have entered. First and foremost, it is important that governments make themselves aware of their exposure so as to avoid unpleasant surprises – there is always a tendency to hope that things work out and an unwillingness to confront problems until they become serious. Risk management is the antithesis of this approach.

In the case of tax revenues arising where the exposure is to export prices, governments have a long exposure which they can, in principle, hedge by selling futures. Governments are, of course, always subject to tax and expenditure shocks. They will normally retain a reserve to deal with these. Active risk management becomes necessary when the size of the shocks is large relative to other shocks and the size of the reserve.

Typically, governmental exposure to export prices is not of this order of magnitude. In the event that they do decide to hedge, governments of poor countries may face many of the same difficulties in accessing futures as do intermediaries in the local supply chain. In particular, they may find that credit issues oblige them to buy options rather than hedge with futures.

The short exposure arising out of commitments on staple food crops can give rise to more substantial exposure, in particular in the event that food prices spike up very sharply, as has happened in 2008. Government often finds itself offering a more or less explicit price cap. Traditionally, food security has tended to be underwritten by food reserves. However, this approach is costly in terms of the capital tied up in the reserve, deterioration and bureaucracy. Currently many governments are subsidizing the price of food staples for consumers. These policies are also costly, and may not be sustainable over time.

The alternative approach is to use financial risk management instruments. Prices caps of this sort are naturally hedged by purchase of out-of-the-money call options which, ignoring basis risk issues, pay off in exactly the circumstances that the government's guarantee is required. By purchasing a call, government is essentially asking the market to store on its behalf. This should result in savings if food shortages are imperfectly correlated across countries, so that the same stock can be available for the entire market, and if international markets can store more cheaply. Dana *et al* (2006) discuss policies of this sort in relation to Malawi and Zambia.

The disadvantage of the market approach is that stocks are distant from the point of consumption and it will be expensive in terms of time and transport costs to bring them to the consumers. Transport facilities may be quite limited in landlocked countries, and even in other countries, ports may be congested. A large jump in transport requirements is likely to result in a corresponding jump in transport costs, which will not easily be hedged. Box 6 looks at a contingent food security import contract backed by an OTC call option which secured both the grain price and the transport facilities in order to ensure timely delivery of grain at a capped price. We suggest that this approach to food security has enormous potential. If it had been widely implemented in 2007-08, many of the food price and availability problems currently afflicting poor food-importing countries could have been avoided at quite modest cost.

Box 6: Use of Call Options for Contingent Food Security Imports

In 2005-06, Southern Africa experienced a severe drought-related food shortage. Affected countries included Malawi, Mozambique, Zambia, and Zimbabwe. During a food shortage maize prices typically increase, thus exacerbating the risk of hunger. In the past, governments have attempted to manage this problem by subsidizing the price of maize but such responses tend to have a large cost both financially and in terms of negative impact on local and regional trade.

In June of 2005, the Government of Malawi announced that it would take an innovative approach to management of the food shortage by using a SAFEX white maize put option contract. (SAFEX is the South Africa Exchange Market). In response to a direct request from Government, the World Bank provided technical assistance to support this operation.

Because government was concerned not only about price increases but also about logistics constraints and delivery performance, the call option contract was customized as an OTC contract which would give more flexibility than a standard financial instrument. First, price protection was provided on a delivered basis, thus combining the SAFEX price for white maize plus transport costs to Malawi. Second, the option contract carefully specified terms for physical settlement so that it could be used as a contingent import strategy if needed. Uncertainty about the extent of the food shortage, levels of commercial imports, transportation constraints, performance of local traders, the humanitarian response, and efficiency of procurement processes made the contingent import aspect of the contract very attractive to the government.

In September 2005, the Government of Malawi concluded an agreement with a commercial bank to provide risk management using the OTC call option structure. The contract represented one of the first-ever instances of macro level hedging by an African government. It covered imports of 60,000 tons of white maize, had a total value of approximately \$17 million, and a premium payment of \$1.53 million. The UK development agency DfID provided budget support to the Government of Malawi for purchase of the contract.

Throughout November and December, 2005 as prices increased and the food shortage grew more severe, the government exercised the call option, elected for physical settlement, and allocated the majority of the maize to humanitarian operations. The maize purchased through the option contract had a superior delivery performance to that of other procurement procedures. Over the delivery period spot prices rose \$50-90/ton above the ceiling price of the contract following increases in the SAFEX white maize price and increases in transport costs.

Currently (2008) the Government of Malawi is evaluating proposals to replicate this approach. Since Malawi is facing a surplus year this year but is uncertain about exports, the idea is to create a second layer of strategic grain reserves held in country, financed and managed by the private sector. The Government will have the option to buy stocks if needed during the lean season. If stocks are not needed in country they will be exported by the private sector.

This material is based on the work of Craig Baker, Julie Dana, Christopher Gilbert, and David Rohrbach.

Exposure to possible losses by stabilization agencies gives rise to a further set of issues. One approach is to argue that problems of this sort are inevitable with such agencies and that governments should therefore avoid stabilization commitments. This certainly solves the consequential risk management problems but, when this approach is advocated by developed country governments, it runs up against the problem of “coherence”, since developed countries clearly do support their own agricultural sectors by offering high and stable prices. If developing countries are to follow the same approach, they need to structure stabilization schemes in terms of collective savings programs which would operate according to the principle that disbursements would be constrained by the level of accumulated savings from previous years. They should also examine the potential to hedge exposure of stabilization schemes. Hedged stabilization schemes are more likely to be financially sustainable than unhedged stabilization schemes. Box 7 discusses a recent proposal for the West and Central African cotton sector, set out in Rajadhyaksha et al. (2007), which goes in this direction.

Box 7: Cotton Price Stabilization and Smoothing in West Africa

Cotton is the major (often only) export crop in the arid areas bordering the Sahara. Major producers are Benin, Burkina Faso, Chad, Cameroon, Côte d'Ivoire, Mali and Togo (all francophone countries). Cotton is input intensive and bulky to transport prior to processing. The francophone countries have traditionally operated the sectors through parastatal monopsonies. They operated in the following way

- Panterritorial producer prices were announced at the start of the crop year (around February). These were often kept constant over long periods of time or moved only modestly with changes in world prices.
- Ginner provided fertilizer to farmers groups, the cost of which was deducted from eventual sales revenues.
- They also sold forward to customers, including prior to the announcement of the producer price, with volumes depending on market conditions.
- In the event of high prices, part of the revenue was paid into a *fond de soutien*. In the event of low prices, funds was transferred to the ginner from the *fond*.
- If the price outcome was good, farmers would also be due a second payment. This was paid as a supplement to the following year's producer price.

Cotton prices declined steadily over the 1990s. With producer prices slow to adapt and political pressure to maintain purchasing power, the *fonds de soutien* became exhausted. Refinancing was required if the system was to continue. Donors were unhappy with repeated calls for replenishment of the *fonds*. The French development agency *Agence Française de Développement* (AFD) proposed that the EU should launch a pilot project based on a "new" concept of *fonds de lissage* (smoothing funds) which would start in 2007 to be piloted in Burkina Faso. In the end, the Burkinabe adopted their own variant of the smoothing scheme.

The structure proposed by AFD differed from the previous in the following ways

- Producer prices would be set on a formulaic and therefore non-political) basis based on prices over recent years (an exponentially smoothed average) and the contemporary forward price.
- Contributions to and support from the fond would be determined formulaically.
- The *fonds* would aim to use market instruments (OTC puts) to ensure that ginner can offer a producer price above the level of production costs.
- The *fonds* would not aim to protect against catastrophically low prices. Instead, donors would be asked to step in if such events occur.
- The *fonds* would have low initial financing, but a regional fond, perhaps the West African Development Bank, would provide second level support for the national *fonds*.

The AFD objective was to smooth prices but not to stabilize at any absolute level. The suggestion that market instruments (effectively OTC puts) might be used to keep prices above production costs might be viewed as optimistic given liquidity in the OTC cotton options market and the substantial basis risk between West African cotton and NYBOT cotton prices, but is worth testing in the market. At the same time, price smoothing would not eliminate the requirement for ginner to manage residual intra-annual price exposure, not covered by likely payments from the *fonds*, arising out of their commitment to pay the agreed formulaic producer price. The extent of this residual exposure depends on when and how contributions from the *fonds* is decided and the extent to which the *fonds* can guarantee to compensate ginner for shortfalls in the price relative to that underlying the formulaic producer price.

5. Concluding Comments

The market approach to commodity price management was born as a response both to the difficulties encountered by international and national price stabilization schemes and to problems perceived to have arisen out of the liberalization of agricultural market supply chains, which was in part itself a response to those difficulties. Liberalization had the effect of increasing the extent and speed of pass-through. The effects of volatility amplification have been felt throughout the supply chain but, given that farmers are the residual claimants on commodity revenues, most acutely at the farmgate. This volatility generates risk management problems. Failure to address these problems can have serious consequences.

Different agents in the supply chain have evolved different responses to volatility. Intermediaries aim to hold the commodity for as short a time as possible to keep exposure to a minimum. Independent exporters often aim to market on a back-to-back basis. This eliminates price exposure at the cost of limiting the exporter's flexibility in marketing and can often force these exporters to sell at a disadvantage relative to multinational exporters. Cooperatives have been among those intermediaries which have coped least well with both the increases in competition and price volatility. Many lack the expertise to evaluate and manage their risks, a problem which is exacerbated by cumbersome decision-making processes which permit insufficient delegation for prompt response to market signals.

Supply chain actors located in developed country offset commodity price risk using commodity futures. Access to these instruments is more difficult for actors located in developing countries. An adequate line of margin credit in a convertible currency is a prerequisite for taking futures positions on a developed country exchange. Many developing country intermediaries, including some governments, lack this credit. In such cases, they are restricted to non-margined options-based hedges with full up-front payment. While options are well-suited to hedging certain types of exposure – out-of-the-money puts for cooperatives wishing to offer guaranteed minimum prices and out-of-the-money calls for governments (or their agencies) wishing to cap the prices of imported food staples – they are less suited to other types of exposure, in particular the wish on the part of intermediaries and exporters to lock in sale-purchase margins.

Access is further impaired by regulatory requirements, which have increased as the result of post 9/11 money laundering concerns, and which impose a high fixed cost on brokers wishing to do business with developing country entities. Often, the value of the business will be insufficient to justify these fixed costs. Finally, in some countries exchange

regulations may actually prohibit use of financial instruments for hedging. Together, these credit and regulatory access problems give multinational supply chain actors, and their developing country affiliates, a clear competitive advantage relative to intermediaries located in the producing countries themselves. This is an important unintended consequence of market liberalization.

Finally, basis risk, resulting from imperfect pass-through of world to local prices, implies that in some cases hedging will deliver a lower degree of risk reduction to developing country supply chain actors than to those in the developed economies. The combination of poor access and sometimes only modest benefits has implied that, with important exceptions, developing country entities typically make only limited use of developed country risk management markets. This is particularly true of farmers, since efforts to transmit the favorable impacts of risk management to the farmgate face very considerable difficulties. The poorest farmers, and these include most of the African agricultural community, continue to rely on crop diversification together with informal family and community-based risk sharing mechanisms in the event of serious adverse shocks – what Dercon (2005) calls risk-coping behavior.

The consequence of access limitations varies from commodity to commodity. Farmers are concerned both about the possible intra-year variability of prices, in particular the possibility that the price may fall over the course of the crop year, and the absolute level of prices. The risk management tools discussed in this chapter deal with the former problem but not the latter – locking in a low export price, or a high food import price, eliminates uncertainty but does not impinge on the distress caused by the price level. The intra-annual price risk problem is most serious for annual crops, where farmers must decide how much to plant, and for commodities which are highly input intensive, where farmers must decide how much input to purchase on credit. Cotton and hybrid maize are commodities which fall into this category. At the other extreme, tree crop commodities do not require annual decisions on planting and in many cases production requires only low levels of inputs (often insecticides to control disease). In this type of environment, although farmers would prefer price certainty, it is the level of the price that is their major concern. Issues of this sort are addressed through the stabilization or “price smoothing” agenda. Stabilization should be seen as a saving and dissaving activity and addressed as such. This is different from price risk management and may exacerbate the risk management problem faced by supply chain intermediaries. To the extent that potential losses of stabilization authorities fall onto governments or donors, they compound these risk management problems.

Price risk management techniques have the potential to improve the functioning of the agricultural supply chain in developing economies. Many countries still lack expertise on market-based approaches to managing risk. An important first step, which is simple, is to apply modern financial techniques for identifying and quantifying risk, and monitoring price exposure throughout the course of the season. A second step is to establish the type of risk management monitoring and reporting functions which are standard to profitable commodity trading businesses and the banks that lend to them. The third step is managing price risk, and as we have seen, solutions will vary and will need to be highly customized to specific market conditions, which change. Finally, improved access to risk management instruments is necessary, and this, in turn, need to be more appropriate to developing country requirements. The experience accumulated over the past two decades of liberalized markets in developing country export crops allow us to see the directions which are likely to generate the greatest returns.

Intermediaries based in many of the poorest countries, including much of Africa, will continue to experience difficulties for the foreseeable future. In a discussion of these issues some years ago one of us wrote that risk management and credit issues are inextricably intertwined: “My belief is that, in the context of developing-country farmers, commodity risk management techniques will, on the main, come to be seen as part of the means in which rural credit can be developed and extended, rather than as a stand alone panacea” (Gilbert, 2002, p.67) That judgment remains valid can be extended throughout the entire developing commodity country supply chains.

At the same time, it has become clear that market liberalization and privatization of parastatal operatives does not eliminate government exposure to price risk. This is acutely evident in the current food crisis. Price risk management becomes an important tool for governments who wish to avoid the adverse budgetary impact of interventions either to support export prices or cap import prices.

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