WEATHER INSURANCE AND DERIVATIVES IN DEVELOPING COUNTRIES

AN ALTERNATIVE TO AGRICULTURE INSURANCE (2)

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5.0 The Case Studies

Given the above discussion, let us look at few case countries where weather index based insurance in agriculture sector has been applied. Mexican and Moroccan are the two most referred instances of successful interventions. South Africa and India are being observed lately.

5.1 Mexican Case

Mexico has two institutional innovations that could be combined with well-crafted weatherbased index risk management products. Not only could such indices be developed to offer insurance to the rural people, but the same indices can be crafted to allow improvised governments opportunities to hedge budgetary exposure when they provide free disaster aid (Varangis 2001).

The Mexican government set-up a Fund for Natural Disasters (FONDEN) for post-disaster financing for reconstruction of public infrastructure, and compensation to low-income producers for crop and livestock losses arising from natural disasters in 1996. FONDEN is targeted fund and disbursements per beneficiary are set to limits. It does not compete with private insurance. FONDEN comes into play only when drought, frost or other weather perils affect most people in a region. FONDEN pays out against systemic risks only. More recently, it has started to adopt objective rules for declaring catastrophic events. The parametric rules for triggering payments removes an ad hoc dimension in the declaration of catastrophes and reduces the political interference in its operations. The government of Mexico has been toying with feasibility of obtaining financial re-insurance for FONDEN to cover its' exposure from weather risks affecting the agricultural sector.

Skees, Varangis and Larson (2001) examined the development of weather contracts based on rainfall to insure against drought in four Mexican states viz., Durango, Jalisco, Tamaulipas and Zacatecas. The feasibility study had two main components. First, it examined the correlation between rainfall and yields to determine the loss due to lack of rain. Second, it designed a prototype rainfall contract and examined how this contract affects the variance of revenues from these crops. The study finds that weather contracts are feasible in about 40% of the planted area in these four states where the correlation between rainfall and yields is around 60-80%. Also, rainfall contracts could reduce the relatively risk by up to 30%. These findings suggest that rainfall contracts have potential in Mexico.

5.2 Moroccan Case

Morocco has made efforts to develop insurance programmes related to weather events. Drought is (vox populi) the main risk for Moroccan agriculture. It at times becomes the single most important cause of crop failure. So both the public sector and the insurance industry for quite sometime has been focussing on developing appropriate safety nets to protect farmers from its dangerous effects. In 1995 the Moroccan government, in partnership with the insurance industry, activated the "Programme Secheresse" (drought plan). There is no direct reference to drought in the revised scheme of 1999. It is in fact a yield insurance programme. The only connection to the weather event being the ministerial declaration that officially declares the existence of a drought period and allows the insurance company to activate the 24 indemnification procedure. The 1999 scheme was structured on the coverage of three revenue levels of 1000, 2000 and 3000 Moroccan Dirhams (MAD) per hectare. For he first revenue threshold the payout is based on an area-yield base mechanism, while for the 2000 and the 3000 MAD/hectare level, specific farm yield assessment are required (Stoppa and Hess 2003). The programme was very successful as in 2002 the subscription reached 80% of 300000 authorised hectares, but was laden with few problems (Skees, Gober, Varangis, Lester and Kalavakonda 2001).

The World Bank in 2001, in order to evaluate the possibility of developing an insurance programme directly related to weather events helped the Moroccan government to launch an on-field international research project. After an accurate analysis of the productive environment in agriculture as well as rainfall patterns and agricultural yields, it was concluded that Moroccan agriculture could significantly benefit from a rainfall insurance programme. A pilot area-based rainfall insurance scheme was recommended the adoption (Skees 2001). The programme recommended is a rainfall insurance programme for crops, especially cereals and sunflower. It indemnifies producers if rainfall levels fall below a specified threshold. Rainfall is measured at the synoptic stations of the National Meteorological Service (Direction de la Meteorologie Nationale, DMN). Rainfall information is accessible in real time to all parties involved in the transaction. To help the local insurance industry design the practical details of the programme and facilitate access to international weather risk management markets, the International Financial Corporation (IFC) with the help of Italian Government, sponsored a project to help structure the weather contracts. A company was set up that would launch and manage such products (Bryla, Dana, Hess and Varangis 2004).

The structure of the rainfall insurance programme was developed in analogy to a European put option where the option price is the cost of the coverage and the strike is the rainfall threshold below which an indemnity is triggered. The idea underlying such types of contracts is that, once the existence of a sufficient degree of correlation between rainfall and yield is established, an agricultural producer can hedge his production risk by entering into a contract under which payments would be made if rainfall levels fall below the selected strike. In order to structure the contract, the issues to evaluate are therefore how to determine the strike and at what level to set it. In the case of cereal and sunflower production in Morocco, the adopted procedure for developing rainfall insurance contracts was: (i) production and rainfall data were collected and organised; (ii) the most appropriate rainfall period was selected estimating correlations between yields and different rainfall periods; (iii) specific rainfall indexes were constructed assigning “weights” to different rainfall periods in order to maximise correlation between yields and rainfall; and (iv) different payment schemes were analysed and evaluated. The ultimate condition for the success of the programme is the price at which the coverage can be provided. The market will decide it (see for details Stoppa and Hess 2003).

5.3 South African Case

South Africa is another country

where traders have begun paying close attention to the market. Demand for weather hedging products comes predominantly from the agricultural sector as it is not subsidised and because the energy sector currently remains regulated. Gensec’s deal in February 2002 with Aquila, a subsidiary of the listed Kansas City based company UtiliCorp United, was the first weather derivatives deal in the South African market. The deal was structured to provide ZZ2 Ceres, one of South Africa’s largest producers of deciduous fruit and vegetables, protection against early spring frost. It is one example of how weather derivatives can be utilised by the country’s agricultural sector. The transaction saw ZZ2 being paid for days when the temperature was equal to or below 0 degrees Celsius during the crucial budding phase (Douglas-Jones 2002b). Since the Gensec deal in 2002, there has been a positive 25 response to the products from a number of industries, particularly wheat and maize growers, silo owners, transport companies in the sugar industry, fishing as well as insurance companies (Bolin 2002).

5.4 Indian Case

The first weather insurance pilot in India was set in July 2003 (monsoon-based weather insurance) in Andhra Pradesh state by Mahindra Shubhlabh, ICICI Bank, ICICI Lombard and Basix. Basix launched this weather insurance programme through its local area bank KSB (Krishna Bhima Samruddhi Local Area Bank) in Maboobnagar. Local area banks are limited to operations in three adjacent districts and therefore face limited natural portfolio diversification, which helped to convince KSB that weather insurance contracts for its borrowers could mitigate the natural default risk inherent in lending in drought prone areas such as Maboobnagar, at the extreme Eastern end of AP, bordering Kamataka. The district has experienced three consecutive droughts during 2000-2003.

KSB bought a bulk insurance policy from ICICI Lombard and sold around 300 individual farmer policies for three categories of groundnut and castor farmers, small, medium and large10. Premium rates are Rs.456 for the small farmers with a liability of Rs.14250, medium farmers pay Rs.600 with a maximum liability of Rs.20000 and large farmers pay Rs.900 for a liability of Rs.20000. At the pilot stage KSB decided to limit liability per farmer rather than imposing per acre limits in order to manage overall liability. KSB sought to sell policies to up to 300 farmers for each of the two-targeted crops during the pilot stage. Farmers uptake was immediate, with around 100 farmers signing up on very first day. KSB and ICICI Lombard opted for a weighted and capped rainfall index, which means that the maximum rainfall counted per sub-period is limited to 200m and more critical periods for the plant growth are more heavily weighted than others. Informal interviews with 15 contracted farmers revealed that they were well aware of the rainfall based index nature of the contracts and the associated basis risk (Hess 2003). They also understand the two step payout structure of the policy and the fact that the liability limit is a theoretical number and historical maximum payouts are around 3025 and would have occurred in 2002 and 1997. Thus, the premium rate at that level was around 15%. Nevertheless, the farmers appear to value the quick payout of the weather policy, which distinguishes it from the federal crop insurance policy in India. However, farmers preferred claim calculation based on absolute shortfall in millimetres rather than in percentiles (Sinha 2004). They also had problem with the rain gauge station which was located at a district headquarter. They also preferred a simple linear relationship between the rainfall and the claim amount. They were unable to appreciate the trigger points and different slab rates. Farmers like to have phase-wise payouts subject to the maximum limits. KSB decided that only borrowing farmers could buy weather insurance policies. Eventually KSB contemplates to lower the interest rate for these farmers due to the reduced default risk. Basix/KSB has also designed policies for Soya farmers in MP, Ujjain and UP, A1igarh. One of the top 5 reinsurers in the world has agreed to reinsure this entire weather insurance portfolio.

The groundnut rainfall contract for Mahboobnagar is clearly associated with an insurable loss. This has been achieved through the weights used in the construction of the rainfall index and the relationship between the payoffs and the level of the index. The weights have been chosen to maximise the correlation between the rainfall index and groundnut yield in the region. The payoff pattern is supposed to capture the increasing severity of losses with progressive rainfall deficiency. These features tend to increase the complexity of the product and make it difficult for the farmers to understand (Sinha 2004). However, if the weights were removed and the payoff made linear the product would become closer to a derivative. Reinsurance would also be more easily available for this product since solely the rainfall, independent of the area crop yield, determines the payoff.

The AIC also introduced Varsha Bhima as pilot project in about 25 rain gauge stations across four states during kharif 2004 season (summer). The product included insurance based on seasonal rainfall, sowing failure, rainfall distribution index, agronomic optimum index and catastrophe cover. The scheme has been withdrawn after its maiden trail.

6.0 Final Remarks

Given the above discourse, weather markets can provide new opportunities for developing countries in dealing with weather risks whether for catastrophic or more frequent weather events. Policy makers could use these markets to design effective weather disaster assistance programmes and support the development of private markets within their countries. A critical element for encouraging the use of weather risk markets in developing countries is for governments to provide access to their meteorological data and make the necessary investments in their weather stations in order to ensure accurate and tamper-proof measurements. International weather trading companies stand to benefit from including developing countries into their activities because they achieve diversification of the weather risks they cover on a global level (Skees, Hazell and Marinda 1999). This may contribute to reducing the overall risk of their weather portfolio and reduce the overall costs of covering weather risks. Finally, understanding and modelling the relationship between economic losses and weather events will be critical in designing tailored weather products that meet the requirements for various agricultural users (Skees 2001). Developing countries have a long way to go before real weather markets are developed and put in place. The pre-conditions are many to fulfil before the nail is put in the wood.

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Appendix 1

Weather Derivative Structures

Weather derivatives are usually structured as futures, call/put options and swaps based on different underlying weather indices.

Weather Futures

The Chicago Mercantile Exchange (CME) offers trading with futures based on the Degree Day Index, which is the cumulative sum of daily, HDDs or CDDs during a calendar month. The HDD/CDD Index futures are agreements to buy or sell the value of the HDD/CDD Index at a future date. The notional value of one contact is $100 times the Degree Day Index. On the CME the options on futures are European style, which means that they can only be exercised at the expiration date.

Weather Options

For generic weather options, the buyer of a HDD call pays the seller a premium at the beginning of the contract. In return, if the number of HDDs for the contract period is greater than the predetermined strike level, the buyer will receive a payout. The size of the payout is determined by the strike (S) and the tick size (k). The tick size is the amount of money that the holder of the call receives for each degreeday above the strike level for the period. Often the option has a cap on the maximum payout unlike, for example, traditional options on shares.

Weather Swaps

Swaps are contracts in which two parties exchange risks during a predetermined period of time. In most swaps, payments are made between the two parties, with one side paying a fixed price and the other side paying a variable price. In most types of weather swaps, there is only one date when the cash flows are "swapped", as opposed to interest rate swaps, which usually have several swap dates. The swaps with only one period can therefore be thought of as forward contracts. Often the contract periods are single calendar months or a period such as January-March.

Weather Measures

As the weather market has been born out of demand for risk management products from the power industry, the most common and liquid products are designed to fit its requirements. However, the market has started to actively trade a growing number of indices tailored to the demands of all participants. All weather contracts are based on the actual observations of weather at one or more specific weather stations. Most transactions are based on a single station. However, some contracts are based on a weighted combination of readings from multiple stations while others on the difference in observations at two stations.

The underlying index of a weather derivative defines the measure of weather that governs when and how payouts on the contract will occur. There are many other indices used in the market. They are: Heating Degree Days (HDD)- This index is designed to measure how cold a period is compared to a standard temperature (18 degree C in Europe and 65 degree F in the US). This index is favoured by the power industry to hedge against a warm winter in which less power needs to be generated as compared to expectations. Cooling Degree Days (CDD)- Likewise the CDD index is used to measure how warm a period is compared to the standard temperature. This index is favoured by the power industry to hedge against a cool summer in which less power needs to be generated compared to their expectations. This is a common contract in the US where power is required for air conditioning units and not so common in Europe where air conditioning in homes is less common (Douglas- Jones 2002a). The other indices in use include: Precipitation; Rainfall; Snowfall; Wind speed and direction; Maximum or minimum daily temperature; Sunshine; and Humidity. A wide range of other indices are also used to structure transactions that provide the most appropriate hedging mechanisms for end-users. Average temperature is another common index for non-energy applications. Some transactions are also based on so-called event indices, which count the number of times that temperature exceeds or falls below a defined threshold over the contract period. Similar indices are also used for other variables. They are cumulative rainfall or the number of days on which snowfall exceeds a defined level. All contracts have a defined start date and end date that constrain the period over which the underlying index is calculated. The most common terms in the market are November 1 through March 31 for winter season contracts and May 1 through September 30 for summer contracts, however there has been an increasing volume of trading in one month and one week contracts as the market has grown. Some contracts also specify variable index calculation procedures within the overall term- such as exclusion of weekends or double weighting on specific daysto address individual end-user business exposures.The buyer of a weather option pays a premium to the seller that is typically between 10 and 20 percent of the notional amount of the contract. However, this can vary significantly depending on the risk profile of the contract. There is typically no upfront premium associated with swaps. A common form of weather derivative is a put option providing protection against a warm winter. Example: Reference weather station: New Delhi International Airport; Underlying index- Heating Degree Days; Term-November 1 - March 31; Structure-Put option; Strike- 4850 HDDs; Tick size- Rs.5,000; Limit- Rs.1 million; Premium- Rs.150,000.

Appendix 2

Black-Scholes

Fisher Black and Myron Scholes developed a model in 1973 to price put and call options that is still commonly used today. The Black-Scholes model is based on certain assumptions that do not apply realistically to weather derivatives. One of the main assumptions behind the model is that the underlying of the contract (HDD or CDD) follows a random walk without mean reversion. More appropriately, this model predicts that the variability of temperature increases with time, so temperature could wander off to any level whatsoever. The Black-Scholes model is inadequate for weather derivatives. There are many reasons for it. The primary reason is that the model is based on an underlying tradable commodity and in weather derivatives there is no underlying commodity. For instance, in the natural gas market, the model derives the prices of the gas derivative from the price of physical gas itself, because weather doesn’t have a price. The payoff of a weather option is instead based on a series of weather events, not on the value of the weather. The model also requires possible setting up of a conceptual portfolio with a position in both the options and the security from which the option value is derived. Without the means to trade weather as a security, one cannot build a risk-less portfolio. Weather options are a different kind of derivatives than those analysed by Black and Scholes

(Dischel 1998a; Martin, Barnett and Coble 2001).

Burn Analyses

This approach is commonly used in the insurance industry. It essentially uses a simulation using historical information to estimate uncertain weather related payments. It is easy to implement and understand and in the valuation of complex transactions involving correlated weather indices, the correlation is embedded in the historical data. However, if an extreme event is included in the data, it can distort the results of the analysis, as it tends to omit low frequency extreme events.

Monte Carlo Based Simulations

Monte Carlo is a computer-based method of generating random numbers, which can be used to statistically construct weather scenarios. These simulations provide a flexible way to price different weather derivative structures. Various types of averaging periods, such as those based on cumulating HDDs or CDDs can be easily specified. Similarly, a contractual cap placed on the price of the derivative can be easily taken into account.

Stochastic Process

In this approach a stochastic differential equation is chosen to represent the diffusion of the weather index. The process is calibrated to either historical data sets or market quotes for weather derivatives, should they exist. The equation is then solved using the boundary conditions provided by the payment terms of the derivative transaction. Common features of the processes chosen would be mean reverting or auto-regressive processes. The one main advantage of this method is that the risk statistics are easily expressed. This method is complex to 30 implement, especially if modelling multiple indices simultaneously.

1. International Task Force on Commodity Risk Management in Developing Countries is looking at the use of index-based weather risk management to complement existing activities.

2. In weather risk management initially areas affected by weather shocks are identified to provide price information that can be analysed to determine its relationship with yields and output. A prerequisite for developing a risk management programme is access to good weather data. Weather data can only be gathered if adequate meteorological infrastructure has been and remains available. Additional implementation activities are the provision of technical assistance to local insurance companies and gaining the support of international re-insurers in order to structure and place weather-based insurance products in the market. As with price risk management, it is important to identify appropriate delivery channels, including: Banks/ micro-finance institutions; Local insurance companies; Input suppliers; Traders/processors and Producer groups.

3. Many companies in the US reported revenue losses and incurred higher costs as a result of severe winter storms in 2002. Sales were sluggish for many departmental stores (Douglas- Jones 2003).

4. A derivative contract is an enforceable agreement whose value is derived from the value of an underlying asset; the underlying asset can be a commodity, precious metal, currency, bond, stock, or, indices of commodities, stocks etc. Four most common examples of derivative instruments are forwards, futures, options and swaps/spreads. Investors participate in derivatives market by using futures contract for hedging, speculation and arbitrage. A derivative instrument, futures is a type of forward contract. Futures are contracts to sell/ buy standardised financial instruments or commodities on a specified future date at an agreed price. Futures contracts are used generally for protecting against adverse price fluctuation. Futures prices evolve from the interaction of bids and offers emanating from all over the country, which converge in the trading floor or the trading engine. The bid and offer prices are based on the expectations of prices on the maturity date.

5. A U.S. Department of Commerce estimate indicates that more than $1 trillion of U.S. economic activity in 2001 is exposed to the weather, and transactions over the past several years have provided weather protection to companies in sectors as diverse as entertainment, retail, agriculture, and construction.

6. Futures and Options World.

7. New hardware systems, such as optical precipitation sensors, can eliminate any direct human involvement in the recording process.

8. Catastrophe bonds issued against rainfall events in developing countries could be very appealing to international investors because their risk would be uncorrelated with the risks of most other financial investments. If these instruments could be successfully harnessed through contracts with governments, banks or large insurance companies, the covariate part of catastrophic risks could be reduced to a manageable amount at the country level. The successful examples of using cat bonds are those in Japan and the U.S. to spread the risks of earthquake insurance. Expansion of this approach offers a unique opportunity to link world financiers and emerging economies in a partnership that is mutually beneficial.

9. Under FONDEN rules livestock owners are eligible for drought payouts when cumulative rainfall is below either 50% of its historical average or historical minimum for two consecutive months. Frost is declared when temperatures fall below a certain level depending on the crop. In case of sorghum it is –9 degree C, for wheat –6 degree C, for

oranges –2 degree C, for melons –1 degree C.

10. Small farmers are defined as households farming less than 2 acres of land, medium farm between 2 and 5 acres and large farmers have more than 5 acres.