

The Evolution of Catastrophe Risk Management in Mexico

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Abstract

As catastrophe risk management has become increasingly important for the private sector, sovereigns are also devoting more attention to their catastrophe risk exposure. As governments examine ways to manage their catastrophe risk, Mexico has established itself as a leader in the field. In 2006, Mexico issued a catastrophe bond, CAT-Mex, to provide post-disaster funding in the event of a large earthquake. Based upon the CAT-Mex example, other sovereigns are exploring different options to secure post-disaster funding. Although the issuance of CAT-Mex has rightly established Mexico as a pioneer in this area, CAT-Mex has its roots in more than a decade of disaster planning. Prior to CAT-Mex, the Mexican government devoted resources and planning to address the country's catastrophe risk exposure. In the 1990s, Mexico established a Fund for Natural Disasters (FONDEN) that was the first natural disaster fund in a developing economy. Its government has been active in examining alternative tools to cope with its natural hazard risk. Since 1998, the World Bank and other international financial institutions have worked diligently with Mexico to explore alternatives to cope with the costs of natural disasters. The work in Mexico is often the model to explore options in other developing countries.

Introduction:

Beginning in the 1990's, an effort was undertaken by a small group of researchers to develop alternative strategies for emerging economies to finance post natural disaster reconstruction. This effort was spearheaded by the World Bank. The World Bank was concerned that the increasing costs of natural disasters by its client countries required more resources than the Bank was able to provide. Historically, post disaster reconstruction for emerging economies was financed by a combination of diverting loans approved for other purposes and making new credit facilities available post disaster. From the period 1980-1998, the World Bank funded post-disaster reconstruction loans in excess of \$14 billion. This amount does not include the diversion of prior approved loans that were converted to post-disaster reconstruction. By 1997, disaster assistance accounted for 12% of all overseas development assistance from all sources.

In 1998, the World Bank created the Disaster Management Facility (DMF). One of the primary goals of the DMF was an examination of private market alternatives to deal with the post-disaster financing needs of developing countries. This interest was fueled by the increasing options being used by the private market in developed countries to cope with the increasing costs of natural disasters in the developed world. In the mid 1990's, a whole new array of catastrophe linked derivatives were being created to absorb portions of natural catastrophe risk in developed countries. These catastrophe linked derivatives bring risk directly to the capital market, thereby bypassing the traditional use of insurance. The first "Act of God" bonds were issued in 1996. By 1998, the market issued more than \$2.5 billion in bonds to about 50 institutional investors.

In 1999, the World Bank first proposed the use of catastrophe linked securities to Mexico as a means to provide financial support for post disaster reconstruction. The original proposals envisioned Mexico issuing a catastrophe bond in the amount of \$500 million to supplement the resources of the government contained in the Fund for Natural Disasters (FONDEN) that the government had established in 1994 (Kreimer et al. 1999).

In 2006, Mexico became the first transition country to transfer a portion of its public-sector natural catastrophe risk to the capital markets using an insurance linked derivative product. The government of Mexico issued a mix of reinsurance and a catastrophe bond in the amount of \$450 million. The funds were intended to supplement the funds otherwise available to FONDEN. The issues identified and resolved from the first proposals in 1999 until the issuance of the Mexican government sponsored catastrophe derivative is important for other policy makers and their advisors interested in duplicating the Mexican experience. This paper explores some of the salient issues that were identified and resolved by the Government of Mexico and the capital markets in issuing the derivatives in 2006. By identifying these issues, the Mexican experience may prove to be educational for policy makers examining similar issues in other emerging economies.

For those interested in the problem of whether there was something of benefit for emerging economies in the development of catastrophe hedges in the developed world, there quickly emerged two structural problems to analyzing the issue. The first problem was the fact that no sovereign government had purchased catastrophe hedges for its own risk related to natural hazards. There was a rich history of government's intervention to resolve perceived

market failures to provide insurance against natural catastrophe risk for its citizens in Japan, Europe and the United States, but no examples of governmental purchase of insurance at a national level existed. The unwillingness of governments to purchase insurance was based on analysis pioneered by Ken Arrow that governments should not purchase insurance since they can absorb risk more efficiently by spreading the risk across large populations using governmental power of taxation. This raised an initial threshold question of whether there was something distinctive about developing economies that would justify their using catastrophe hedges. The second problem related to the insurability of catastrophe risk in emerging economies. In many developed countries with deep markets for insurance products, considerable analysis had been done using catastrophe models to estimate probable losses from natural catastrophes. In most developing countries, little if any data existed upon which models could be based. Further complicating the problem, most government had not clearly delineated the natural catastrophe risk for which the government bore responsibility. These core issues required attention before the difficult process of examining whether there was a price at which any catastrophe hedge would be purchased.

Why Should Sovereign Governments Purchase Insurance?

The question of whether any governments should purchase catastrophe hedges (like insurance or catastrophe bonds) is an interesting economic issue. According to work done by Arrow and Lind (1970), government should insure risks only if they are risk averse. Generally, governments should never be risk averse. Through either their power of transferring risk through their power of taxation or by diversifying risk through a large portfolio of independent assets, governments are generally the most efficient entities to hold risk. Governments are “the most effective insurance instrument of society” (Priest 1996). Governments are generally advised not to pay the costs of transferring risk to private risk bearers.

In trying to understand the limits of the Arrow-Lind theorem, research was undertaken to understand the application of the theory to developing countries with high natural catastrophe risk. Much of this work was pioneered at the International Institute for Applied Systems Analysis (IIASA) located outside of Vienna, Austria. Beginning in 1998, a small group at IIASA under a project (Natural Disasters and Developing Countries Project) partially sponsored by the World Bank and the Swiss Reinsurance Company explored the capacity of emerging economies with

high natural catastrophe risk to efficiently absorb the costs of natural disasters. The work began by identifying the probabilistic long term macroeconomic impacts of natural disasters on three countries: Argentina, Honduras and Nicaragua. The project integrated the macroeconomic planning models of the World Bank with catastrophe models for each country developed by Swiss Re. The resulting modeling identified the long term probabilistic impacts of disasters on each country. An most important conclusion of this work was that the long term macroeconomic impacts of natural catastrophes was highly correlated to the ability of countries to reconstruct essential infrastructure quickly after a disaster occurred. If reconstruction was delayed, natural catastrophes could significantly impact long term development objectives for a series of highly vulnerable countries (Freeman et al. 2002).

What then were the variables associated with access to post disaster reconstruction? The modeling was extended to isolate for each country its capacity to access internal and external sources of reconstruction funding based on each countries fiscal condition. This work provided an initial indication of the weakness of the Arrow-Lind theorem. For some countries, the relative high cost of a disaster combined with limited access to either internal or external savings meant that those countries could not fund post disaster reconstruction. As a result, the expected losses from natural disasters could impact long-term development objectives as well as poverty reduction measures. This analysis proved true for highly exposed countries in Central America like Honduras and Nicaragua (World Bank 2002).

The IIASA team extended its initial work beginning in 2001 with a series of studies done for the Inter-American Development Bank. These studies expanded the initial work done by World Bank to identify the capacity of countries to access capital post large scale natural disasters. The work focused on Bolivia, Colombia, the Dominican Republic and El Salvador. A particular focus of the study was to identify those countries with the capacity to either shift risk internally after a disaster (the common assumption applicable to sovereign governments) or to access sufficient external capital after a disaster. What the analysis found was that for a set group of countries, the probabilistic losses to infrastructure from natural catastrophes exceeded the capacity of the countries to finance reconstruction. In the terms of the research, some of the countries (the Dominican Republic and El Salvador in particular) had a “resource gap” that

restricted their ability to reconstruction infrastructure destroyed in their probabilistic losses from natural catastrophes (Freeman et al. 2003).

This resource gap provided a rationale for sovereign governments to examine risk transfer as an option to fill the resource gap. The next question raised is the relative benefit of closing the resource gap using private risk transfer tools versus the cost of allocating scarce budgetary resources to purchase risk transfer. To address this problem, IIASA developed a stochastic modeling technique (CATSIM) that compared tradeoffs between the financial benefits of insurance versus the opportunity costs of expending current funds to buy contingent protection against unknown future events. As noted by researchers at IIASA, “CATSIM analyses the risk-transfer decision in the wider context of a public investment decision by assessing both the direct financial as well as the opportunity costs in light of the government’s fiscal and macroeconomic constraints.” The core of the model is a detailed public finance module to analyze the ability of government to finance unexpected liquidity needs like post disaster reconstruction. This finance module created for each analyzed country a measure of “financial vulnerability”.

In 2005, the Mexican government began working with CATSIM to inform their decision about the comparative benefit of the government to purchase private risk transfer tools to supplement the budgetary allocations they make through FONDEN. The use of CATSIM identified a financial vulnerability for Mexico. The financial vulnerability provided the government of Mexico a basis to evaluate whether the purchase of private insurance was an efficient policy decision (Cardenas et al. 2007).

Insurability of Governmental Risk

While the use of the CATSIM helped the government of Mexico weigh the desirability of insuring sovereign natural catastrophe risk, another major obstacle to providing risk transfer is determining the insurability of the risk. In examining developing countries, the process of understanding governmental responsibility for natural catastrophe risk is not transparent. What is the risk that is meant to be hedged? While it is clear the natural catastrophes can cause significant losses in developing countries, the payment of those losses may not be the responsibility of the government. Only those losses that the government is responsible to pay constitute a “risk” to the government: governments will only pay to hedge risks they believe they

own. In many countries, the risk owned by the government in the event of natural disasters is poorly defined.

Generally, governments may own one of three types of natural catastrophe risk (Freeman et al 2001). The first risk is related to government provision of essential public goods and services. A government fulfils one of its primary obligations when it decides to invest government revenue in essential public assets like infrastructure. In the developing world, 90% of all essential infrastructure is owned by governments. The main source of funding for new infrastructure is still public investment. In making the investment decision, a government assumes risk just like any other economic agent making an investment. Investments made in natural-hazard-prone regions carry the risk that the investment will be damaged by a hurricane, earthquake, or other natural peril. The risk of loss from natural catastrophes can be quantified using catastrophe modeling.

Another risk of governments is their willingness to assume the risk of others in the economy. In dealing with natural hazard risk, there are abundant examples of governments assuming a portion of the risk of others from damage. The creation of government subsidized insurance scheme is the most common example. The natural hazard programs in France and Spain are two well known examples. The flood insurance program in the United States is another example. The obligation of the government to fulfill commitments made to these programs is a risk to the government. The payment of future sums based on the occurrence of catastrophic natural events is a claim on future government revenue. This claim may be as powerful as the claim to rebuild essential government-owned infrastructure.

A third risk for governments in natural disasters is the claims of the poor on government assets in times of crisis. This claim is particularly acute in poorer countries with large segments of the population subject to significant hardship with minor losses of income.

The use of a catastrophe hedge to transfer risk of natural hazard losses requires a clear understanding of the risk that the hedge is meant to reduce. In the instance where the hedge is being considered to transfer sovereign government risk, the nature of that risk needs to be segregated into its component parts. Unlike many emerging and developing economies, Mexico

has done considerable work identifying the role of the government and natural hazard risk. This identification of the risk is the first step in determining if the risk is insurable.

Mexican Government Risk Identification

Mexico has a long history of natural disaster exposure. Mexico is a seismically active country located along the world's "fire belt", where 80% of the world's seismic and volcanic activity takes place. Mexico is one of the countries most severely affected by tropical storms. It is one of the few regions of the world that can be affected simultaneously by two independent cyclone regions, the North Atlantic and the North Pacific. Historically, Mexico has been consistently impacted by natural disasters.

The event in Mexico that resulted in major institutional approaches to natural disasters was the earthquake in Mexico City in 1985. This earthquake killed 6,000 people, injured 30,000 others and left a total of 150,000 victims. The direct losses from this earthquake were in excess of \$4 billion. In 1986, Mexico established the National Civil Protection System (SINAPROC) as the main mechanism for interagency coordination of disaster efforts. SINAPROC is responsible for mitigating societal loss and essential functions caused by disasters. Responsibility for SINAPROC lies with the Interior Ministry. Also within the Ministry of the Interior, the National Center for Disaster Prevention (CENAPRED) was established. CENAPRED is an institution that bridges the gap between academic researchers and government by channeling research applications developed by university researchers to the Ministry of the Interior.

In addition to establishing agencies to coordinate civil defense and mitigating the costs of disasters, the government of Mexico undertook measures to focus on the economic impacts of natural disasters. In 1994, legislation was passed to require federal, state and municipal assets to be privately insured. In 1996, the government created the Fund for Natural Disasters in the Ministry of Finance. As originally constituted, FONDEN consisted of three separate funds. The infrastructure fund provided for repair of uninsured infrastructure. The agricultural fund provided for immediate assistance to restore the productivity of low-income (subsistence) farmers. The assistance fund provides relief to low-income victims of disaster. At inception, FONDEN was a budgetary tool to allocate funds on an annual basis to pay for expected expenditures for disaster losses. FONDEN was subsequently modified in 1999 by the creation of

a catastrophe reserve fund within FONDEN that accumulates the unspent disaster budget of each year. FONDEN provides financial support to those private individuals that, due to their poverty status, require government assistance.

FONDEN was able to track its budget and spending on a year to year basis. After the severe hurricane season of 2005, all the accumulated budget in FONDEN was depleted. The volatility of the claims on FONDEN and the uncertainty associated with the capacity of FONDEN to provide sufficient post disaster finance led officials to consider hedging against natural disaster risk. The existence of FONDEN, both as a tool to define government responsibility in the event of a disaster and as a means to measure past expenditures based on that liability, helped define the risk the government was interested in transferring.

From 1998 to 2005, two major institutional barriers to a government hedging its natural catastrophe risk to the private market had been overcome. First, a tool had been developed to permit a government to balance the costs and benefits of hedging risks from natural catastrophes. The concept of natural catastrophe “financial vulnerability” had been developed and tools created to measure the vulnerability. This concept clarified circumstances where governments may properly be risk adverse. As a result, the use of and payment for private hedges against government payments in the aftermath of natural catastrophes may be justified. The second development was the identification and quantification of the risk for natural disaster losses assumed by the government of Mexico. This quantification was done by measuring the loss payments made by FONDEN over a number of years. The existence of FONDEN helped the Mexican government to define the types of losses that they were willing to pay. With these two developments, it was possible to consider alternatives for hedging the risks imbedded in FONDEN.

Creating a Hedge for FONDEN

A remaining issue to be addressed was pricing Mexico’s catastrophe risk. Without a reliable risk analysis it would be difficult to develop solutions that transferred risk to the international capital markets. Although cat bonds had been increasingly used to transfer risk to the capital markets, these issuances focused on regions of the world where detailed catastrophe risk analysis was available such as the U.S., Japan and Europe. A key component of nearly all

cat bond issuances is an independent risk analysis executed by a commercial catastrophe modeling firm. By the mid to late 1990s commercial catastrophe modeling companies had well established models for the developed world's catastrophe risk which were familiar to issuers, structuring agents, rating agencies and investors. By comparison commercial models for the developing world did not enter the market until the early 2000s. It was not until the first generation of commercial catastrophe models for Mexico's earthquake risk were released that a cat bond became a viable risk hedging option.

The next step was to utilize the model to create a structure that could be placed in the capital markets. Broadly speaking there are four types of catastrophe bonds: indemnity, industry loss (PCS), modeled loss and parametric. In order to securitize and transfer Mexico's catastrophe risk to the capital markets it was necessary to create a cat bond structure that would provide Mexico with sufficient coverage and at the same time be attractive to investors. Of the four types of catastrophe bonds the first two were not viable options. The indemnity bond is triggered based upon the actual losses incurred. This means post-event loss data must be gathered and tallied to verify if an event has triggered a payment. Since one goal of the risk transfer is to provide a timely payment to assist with emergency response expenses an indemnity bond is a suboptimal choice. Industry loss bonds trigger a payment if an event exceeds predefined losses to the entire insurance industry, regardless of the sponsoring company's incurred losses. This approach is feasible in the U.S. where a third-party organization, Property Claims Services (PCS), tracks insured industry losses by event. In Mexico, no such organization exists which would preclude this type of bond. A third option is a modeled loss. This approach structures the bond to pay out based upon modeled losses to the portfolio meeting a pre-defined trigger amount. Under the modeled loss approach a commercial modeling company will recreate the parameters of an actual event and model the associated losses to the sponsor's portfolio. This approach is more rapid than the indemnity, but is not as transparent since the modeling firm is responsible for determining whether a bond's payout is triggered. The final type is a parametric bond. Although there are multiple types of parametric bonds in today's marketplace, the dominant solution available at the time the type was a first-generation parametric ("cat in a box"). This bond type, as the nickname suggests, is triggered when a catastrophe of a predefined intensity ("cat") occurs in a predefined geographic area ("box"). Parametric bonds have the advantage of high transparency and a payment can be determined quickly since the intensity and

location of an event is known rapidly after its occurrence. These benefits must be balanced against basis risk, or the possibility that a qualifying event does not occur, but the sponsor suffers large losses from an event that misses the trigger criteria.

The choice among these options is driven by different considerations, including their technical feasibility and their appeal to investors. In the structuring process for the bond the indemnity bond would not meet the requirement for a rapid payout. The industry loss bond is not viable since no agency is present in Mexico, and the modeled loss option was not preferred to investor preference for a more transparent payout. This leaves a parametric bond as the optimal choice for the structure. Nevertheless, substantial analysis and preparation is necessary to design the parametric bond such that basis risk is minimized.

Designing the Cat Bond

Significant work on the bond began in 2004 when discussion on the coverage and the risk analysis began. The goal of the bond, which would be released as CAT-Mex, was to rapidly provide funds to cover emergency loss expenses in the event of a large earthquake. Although Mexico is vulnerable to seismic events as well as tropical cyclones and flooding, commercial risk models were unavailable for Mexico's tropical cyclone risk at the time the bond preparations began. In addition Mexico's most recent catastrophic disaster was the 1985 Mexico City earthquake. These factors contributed to the bond's focus on earthquake risk. In order to execute the risk analysis, the Government of Mexico (GOM) worked in conjunction with commercial catastrophe risk modeler AIR Worldwide (AIR).

Seismic risk in Mexico arises from the subduction of the Cocos Plate against the North Atlantic Plate which occurs along the country's southwestern coast. Although this area is along the relatively less populated coastal states of Oaxaca and Chiapas, there is still great potential for large losses. This is due to the location of large, inland population centers such as Mexico City on soft soil which amplifies the ground motion. The 1985 earthquake had its epicenter along the subduction zone, but the damage in Mexico City was severe due the amplified seismic waves. The damage was further exacerbated by poor construction. In order to consider these relationships AIR executed the risk analysis using its Mexico earthquake model.

The AIR model which consists of three components: hazard, vulnerability, and loss. The hazard component considers the unique features of Mexico's seismicity to create a representative catalog of simulated earthquake events that may potentially strike Mexico in the future. To allow the maximum flexibility in structuring the bond, AIR divided the country into cells of 1° latitude by 1° longitude and isolated the areas generating the largest earthquakes. AIR then evaluated the occurrence rate of earthquakes of large magnitudes with epicenters in each cell and hypocenters shallower than a pre-defined depth to determine the nationwide losses that events could generate. Using this information, the GOM and its structuring agents could structure the bond so that the areas of highest risk were isolated.

Once the areas of seismic activity were isolated, losses were estimated by incorporating the vulnerability module. The vulnerability module takes into account the geographic distribution of assets as well as specific details about their construction and occupancy. The GOM provided AIR with census and other data that, after extensive and rigorous processing, led to the development of a detailed exposure database for residential, commercial, industrial, and public buildings at the municipality level (about 2,500 in the country). This allowed AIR to model asset damage at a high degree of resolution. Using peer-reviewed, engineering-based damage functions, AIR modeled the vulnerability to seismic waves of these structures in all municipalities.

Once the physical damage for each potential event was computed for each asset at each municipality and then aggregated, regionally varying replacement cost data were used to estimate the financial losses for the event. The loss module calculates losses from all events in the catalog, which are then aggregated into a loss distribution. This distribution provides the probability of equaling or exceeding a given loss amount. For CAT-Mex, the distribution of emergency losses was then empirically estimated based on data from past events in Mexico and Central America. This result allowed the GOM to understand its earthquake risk and the amount of emergency losses it may incur after a large event. Such losses include, but are not limited to, expenses for debris removal, medical care and relief supplies.

These steps of the risk analysis allowed AIR, the GOM and its agents to gain an understanding of the distribution of potential earthquake losses in Mexico, their frequency and the characteristics associated with large loss producing events. The next step in the analysis process is to translate this information into a parametric structure that effectively achieves the desired coverage. This is done through an extensive optimization process, one of whose goals is to minimize the bond's basis risk. Basis risk in this case typically refers to negative basis risk – that is the risk that an event fails to meet the parametric criteria but still causes sizeable losses. Positive basis risk – the possibility that an event meets parametric criteria but causes minimal losses is also possible, but less of a concern. Finally, a key number in designing the parametric trigger criteria is the Expected Loss (EL) to the bond. This number, stated as a percentage, is the probability that an investor will lose his principal. The EL holds important implications for the bond's rating. It is also particularly important since a first-generation parametric bond is a binary trigger. Unlike other types of cat bonds which can incorporate a scaled payout (loss of principal from the investor perspective) the first generation parametric is an all or nothing payout. Thus, in designing the bond it was necessary to take into account the resulting EL and the desired emergency loss coverage. These were determined during the risk analysis and structuring process.

After the conclusion of the risk analysis and the optimization process the bond was issued to cover losses from events in three seismic zones (Figure 1). The bond was divided into two classes of notes. Class A covered Zone B (blue) which is triggered by an earthquake with a magnitude greater than or equal to 8.0 and a hypocenter depth shallower than 200km. The Class B notes covered Zones A (red) and C (green). The Class B notes could be triggered by an earthquake with a magnitude greater than or equal to 8.0 and a hypocenter depth of 200km or shallower in Zone A or an earthquake of magnitude 7.5 or greater with a hypocenter depth of 150km or shallower in Zone C. Zones A, B and C are illustrated in the figure below. It is important to note that the zones denote the region in which the event occurs and are insensitive to the geographic distribution of losses. Class A notes raised \$150 million of capital and the Class B notes raised \$10 million. The bond was issued on May 11th, 2006 and matured on May 19th, 2009.

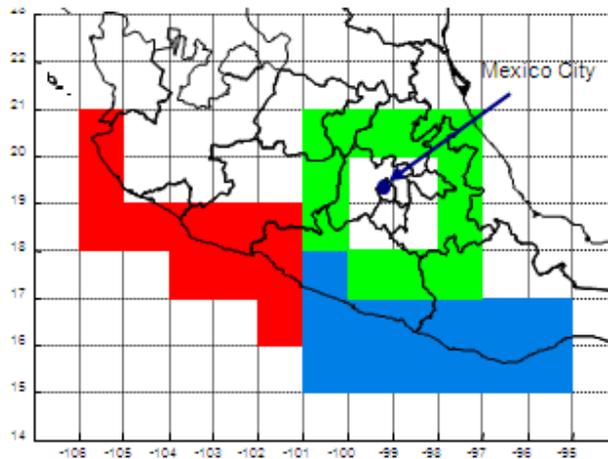


Figure 1: CAT-Mex Zones

The Impact for Developing Countries

In considering the impact for developing countries, there are factors from the Mexico case that offer useful guidance for future sovereign risk transfer efforts. These include such issues as raising political awareness of the benefits of catastrophe risk hedging, understanding timeline considerations that may impact the implementation of risk hedging strategies, evaluating transaction costs, and executing a thorough risk analysis. Obviously, the starting point in applying the CAT-Mex experience is whether it is a useful risk hedging alternative for other nations. Although developing nations share some commonalities, each is unique in its risk exposure, risk tolerance and catastrophe risk financing needs. Thus, when considering a catastrophe bond as a viable risk hedging option it is necessary to consider many factors. First among these is the goal of the hedge. The funds for CAT-Mex are intended for emergency loss expenses and not intended to cover the actual incurred losses and reconstruction costs. In this respect, most countries should see cat bonds as a tool to provide for emergency expense funding and as part of a broader risk management strategy. For most countries, even the largest cat bond issued to date (which raised approximately \$1 billion of capital) is too small to fully cover losses from a catastrophic event, which would likely be larger. Nevertheless, it is worth mentioning that for smaller nations whose estimated catastrophe losses from a 1 in 100 year event (or an event with an annual 1% probability of occurrence) fall under \$1 bn that a cat bond could cover a significant portion of their potential catastrophe losses.

Another important factor to consider is the transaction costs associated with a cat bond. Cat bonds involve a significantly higher transaction cost than other form of risk transfer such as reinsurance. In the private sector components of the cat bond issuance are paid for directly by the issuer. These include legal, investment banking and risk modeling fees among others. While some costs may be fixed regardless of issuance size, others may be a fixed percentage of the issuance size and will increase non-linearly as the size of the bond increases. Thus, cost is a key consideration. In some instance this may be reduced by partnering with an international multi-lateral institution or increasing the coverage to neighboring nations and splitting the cost with regional partners. While private sector issues must contract third party lawyers, accountants and financiers, sovereigns already have local staff with detailed knowledge of the local business environment. Their skills could be leveraged in a potential cost savings.

A key step in risk transfer to the capital markets is an independent risk assessment. As the use of commercial catastrophe models becomes more integrated into the insurance and capital markets a thorough risk analysis is increasingly important. Since the issuance of CAT-Mex, modelers have continued to develop new models for key perils affecting many of the nations in regions such as Latin America, the Caribbean and Southeast Asia. The lack of existing models is no longer the impediment to sovereign issuances it used to be. As multi-lateral institutions have increased funding for disaster reduction, nations could seek to leverage these resources to partner with commercial modeling vendors and develop the necessary models. Indeed, some nations already have local providers of catastrophe models, however these models are untested in cat bond issuances and it remains to be seen whether investors will have confidence in a local model's EL instead of an independent modeler.

Developing nations who are considering cat bonds as a risk hedge, should consider that a well designed bond will likely be attractive to investors due to its diversification value. At present the majority of cat bonds cover a similar concentration of region-perils such as U.S. hurricane and earthquake, Europe winterstorm and Japan typhoon and earthquake. Bonds which provide diversification (e.g. South America earthquake, southeast Asia typhoon, etc.) offer increased value to investors. Bonds whose risk correlates to frequently modeled regions (e.g. Caribbean hurricane to U.S. hurricane) may still generate substantial interest, but nations should bear in mind their correlation to investor portfolios and other market investment options.

CAT-Mex also offers a useful timescale against which to benchmark future issuance. For comparative purposes, two to three years is likely a reasonable estimate. Prospective sovereign issuers will need to consider legal authority issues and observe government procurement guidelines when selecting third parties to participate in the transaction. In some nations, the current constitution may prohibit the government from issuing a cat bond, or the authority may not be explicitly defined. In both cases legislative steps are likely required to pave the way for the bond to proceed. Future sovereign issuances will likely attract interest from many parties in the private sector. Time will be required to request and consider all proposals and agree upon contracts with the third parties. All of these steps are merely laying the groundwork for the actual bond design and risk analysis which may require a significant time investment.

In conclusion, the Mexican experience offers a useful example of catastrophe risk financing to developing nations. The Mexican case should not be over-generalized, as each nation faces its own set of challenges which merit specific solutions (Cummins and Mahul, 2008). Nevertheless, the Mexican experience presents a relatively lengthy timeline of catastrophe risk management in the developing world. Nations which are currently considering catastrophe risk financing options can benchmark their own path and circumstances against the Mexican case. Moreover, catastrophe risk management in Mexico is dynamic. As Mexico continues to innovate and apply catastrophe risk financing techniques the scope for knowledge transfer continues to expand.

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