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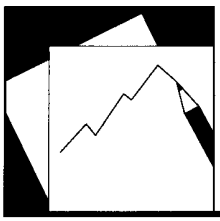

IMF Working Paper

Insuring Public Finances Against Natural Disasters—A Survey of Options and Recent Initiatives

David Hofman and Patricia Brukoff

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Policy Development and Review Department

Insuring Public Finances Against Natural Disasters— A Survey of Options and Recent Initiatives

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Abstract

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Natural disasters can put severe strain on public finances, in particular in developing and small countries. But catastrophe insurance markets increasingly offer opportunities for the transfer of such risks. Thus far, developing countries have only tepidly begun to tap these opportunities. More frequent and intensive use of insurance markets may be desirable because it could help introduce an important element of predictability in the post-disaster public finances of disaster-prone developing countries. Against this background, the paper surveys the various available insurance modalities and reviews recent initiatives in developing and emerging market countries. It also identifies some key challenges for the insurance community, donors, and international financial institutions (IFIs).

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I. INTRODUCTION

While natural disasters have taken their toll throughout history, there are strong indications that they have become more frequent and severe in recent decades and that this trend is to continue in the period ahead (Munich Re, 2006). In part, this is the result of an increasing concentration of population in vulnerable areas (Wisner and others, 2004). But it may also reflect changes in weather patterns—in particular associated with the rise in global surface temperatures—which appear to have caused an increase in the frequency and intensity of adverse weather events such as hurricanes, floods, and droughts (IPCC, 2001, Swiss Re, 2002, and Webster and others, 2005).

The catastrophic effects of adverse natural events can have far-reaching negative effects on macroeconomic conditions in affected countries, including on their public finances. And nowhere is this more the case than in developing and smaller countries. Developing countries are often unable to marshal the substantial resources needed in the aftermath of a major disaster. Smaller countries (such as the small island states in the Caribbean and the South Pacific) in addition face the special challenge of being unable to achieve the geographic redistribution of risk typically available to larger countries, which enjoy a natural hedge since they can subsidize the costs associated with catastrophic events by using revenues from unaffected regions.[2] In these countries, therefore, the costs associated with natural disasters can quickly overwhelm the public sector's ability to respond effectively.

There are various ex ante strategies for reducing the adverse impact of natural disasters on public finances. These include structural policies often referred to as *mitigation*—i.e., the reduction of the risk of adverse weather events themselves through improved land-use policies and environmental standards (see, e.g., Heller and Mani, 2002)—and *adaptation*—i.e., the restructuring of the economy away from disaster-prone activities and upgrading the physical infrastructure to withstand the impact of disasters (see, e.g., Freeman and others, 2003). Such strategies limit the impact of natural disasters and reduce the contingent liabilities faced by the government.

In terms of increasing the envelope of available resources to cope with the effects of natural disasters, key strategies also include *provisioning* through the saving and possible earmarking of resources to cope with potential future events (e.g., the FONDEN contingency fund in Mexico) or, more generally, *reducing government debt levels* so as to create fiscal room for maneuver. Such strategies essentially amount to intertemporal risk spreading within the country. However, small and developing countries may face resource constraints and, in many cases, already high levels of indebtedness that put these strategies out of reach. And even if such policies can be successfully implemented, considerable fiscal risks may remain

[2] To illustrate: when the Category-3-strength Hurricane Katrina hit the United States Gulf Coast in 2005—despite its catastrophic effects on the affected areas—it caused damage of less than 2 percent of national GDP and had only small effects on overall growth and public finances. By contrast, damage to tiny Grenada from Hurricane Ivan (also a Category-3 storm) amounted to 200 percent of GDP in 2004, causing GDP to fall by 3 percent that year, and forcing the government into default.

to the extent that the potential needs arising from natural disasters exceed the buffers that can be realistically attained.

Given the limitations and constraints inherent in traditional efforts aimed at disaster risk mitigation and resource mobilization, the *transfer* of disaster risk to outside parties better able to absorb it represents a potentially important complementary strategy for small and developing countries. To date, such transfer has typically taken the form of ex post donor financing of disaster relief, but there has recently been increasing attention given to the potential for sovereigns to transfer natural-disaster risks to their public finances through the purchase of insurance, so as to establish a form of ex ante risk financing.

The possibility of sovereigns insuring their public finances against weather and other natural risks has typically been included in various broader discussions of disaster management and related financing mechanisms (including those by Freeman and others, 2003; Rasmussen, 2004; and IMF, 2005). However, the range of potential insurance options and modalities is vast and several interesting initiatives have emerged in recent years. Against this background, this paper provides a taxonomy of disaster-insurance modalities and seeks to take stock of relevant recent initiatives in developing and emerging market countries. It is primarily intended to raise awareness and to prompt further consideration and discussion of possible insurance-based tools for alleviating fiscal distress in countries affected by natural disasters.

The paper is organized as follows. Section II discusses why natural disasters can lead to fiscal pressures and how insurance can help manage such pressures. Section III outlines the various modalities of insurance, both with respect to the element of risk transfer and the scope of coverage. This section also reviews a number of relevant existing disaster insurance schemes in low- and middle-income countries. Section IV identifies some key challenges to further progress on the application of insurance in this context. Section V offers some concluding remarks.

II. Fiscal Pressures and Insurance: Overview

Natural disasters can put considerable pressure on public finances through various channels. For instance, governments typically face a weakened revenue base following a disaster as the private sector writes off its losses and economic activity is subdued. In addition, tax administration and collection may be hampered by the many competing challenges faced by the government in the period following a catastrophe. At the same time, the government is also likely to face increased pressures on spending. Typically, the government will have to devote resources to short-term disaster relief operations in the direct aftermath of an event. And the government may have to restore public infrastructure (including roads and bridges, airports, harbors, and public buildings). Beyond these, the government may face pressures to provide compensation or financial support to (certain segments of) the population—and sometimes the business sector—in order to alleviate its plight when the private sector faces resource constraints. For example, oftentimes the government will be called upon—or even be bound by law—to restore damaged or destroyed housing.

While insurance mechanisms can potentially help alleviate such budgetary pressures from natural disasters, their application in developing countries has been limited to date. Rather,

vulnerable countries tend to rely on ex post financing in particular in the form of grants and concessional loans from donors, support from international financial institutions (IFIs), and through emigrant remittances. Indeed, the anticipation of such external assistance if a disaster were to strike—and the moral difficulty for donors to withhold support after an event regardless of the receiving countries' prior policies (the so-called Samaritan's dilemma)—may be an important factor in explaining why countries tend to underinsure for disaster risks.

Ex post financing flows may sometimes be sufficient to recover the losses caused by natural disasters.[3] However, reliance on such flows has considerable disadvantages. In particular, it entails large uncertainty about financing in the wake of a disaster for at least two reasons. First, it can take considerable time before the foreign resources are committed and even more before they are actually made available. And second, it leaves countries highly dependent on the benevolence of foreign donors, thereby potentially facing "competition" from the simultaneous relief needs of other countries—a constraint that may become increasingly relevant as the incidence of natural disasters continues to rise.

Insurance, in contrast, would diminish the reliance on ex post donor resources and secure the needed resources in advance. Such insurance is not a remote theoretical prospect. The experience in high-income countries, in particular the United States and Japan, has shown that many natural perils are insurable, and markets for disaster risk insurance are well established in those countries.

Depending on the nature of the risks, trends in insurance pricing, and the available resources in the country involved, donor contributions may still be needed, ex ante, to contribute to the premiums. But such a shift from ex post to ex ante donor financing would still have important benefits for both parties involved.

From the perspective of the recipient:

- It would introduce some element of predictability into post-disaster public finance conditions. This could take the form of a predetermined amount of resources available for disaster relief, and also entail greater certainty about the timeframe in which those resources would become available.

From the perspective of donors:

- It would reduce the perverse incentives that recipient countries face in their dependence on post-event donor financing. Indeed, vulnerable countries currently often have little incentive to set aside fiscal savings needed to address the implications of natural disasters, since this would likely reduce the availability of

[3] Yang (2005) provides systematic evidence for the response of international financial flows to the destructive impact of hurricanes, and finds that four years after a hurricane, such flows (including remittances, official development assistance, foreign lending, and foreign direct investment) tend to have covered about 85 percent of the costs of the natural disaster.

donor support following an adverse event. With predictable insurance payouts, in contrast, countries would retain incentives for fiscal provisioning and preventive structural policies.

- It would help smooth donors' cash flow by converting "if and when" outlays into predictable insurance premia.

- It would give donors leverage over policies relevant to maximizing the effectiveness of the post-disaster assistance. Donors might condition their willingness to subsidize insurance on appropriate structural measures (such as building codes, thereby lowering the social costs of hurricanes), sensible fiscal provisioning for (moderate) disaster recovery, or on measures to address governance issues, to help ensure that budget support provided under the mechanism would be spent in an appropriate fashion.

III. MODALITIES OF INSURANCE

If a government wishes to shield its public finances from the impact of natural disasters by means of insurance, it faces at least three broad issues:

- *To whom could the risk be transferred?* Is the risk to be shared with other countries or transferred to either commercial insurers, reinsurers, or capital markets?

- *Who should be the insurance taker and what should be insured?* In particular, should the insurance take place at the private sector level or at the public sector level?

- *What type of insurance trigger should be applied?* Are traditional indemnity-based triggers appropriate, or should parametric triggers be considered (Table 1, Box 1)?

Table 1: Two Types of Insurance Triggers

Trigger Type	Basis	Used In	Advantage	Disadvantage
Indemnity-based triggers	Actual and verified size of the losses incurred.	Most private and commercial property insurance.	Precision: The insurance claim will be close to the actual loss incurred.	- Settling claims is time consuming and costly; - Moral hazard.
Parametric triggers	The occurrence of a pre-defined event.	Weather derivatives.	- Low transaction cost; - High speed of payout; - Allows for standard contracts, thereby facilitating risk transfer to capital markets.	Basis risk: Insurance claim may either exceed or undershoot the actual loss.

Box 1. Index Insurance

Index (or "parametric") insurance uses objective variables that are exogenous to the policy holder but have a strong correlation with losses against which insurance is desired. The payout is determined upfront and is conditional on the chosen exogenous variable reaching a preset threshold within a certain time period. An example of index insurance are so-called weather derivatives, which link payouts to the occurrence of a certain weather event (such as wind speeds exceeding, or precipitation falling short of, certain pre-agreed thresholds). Index insurance could be seen as essentially an informed bet against the elements. As such, index insurance contracts are kindred to the options and futures contracts traded on financial markets and distinct from traditional indemnity-based insurance.

In contrast to indemnity-based insurance, index insurance tends to have a benign incentives structure. Since payout and actual damage are not directly linked, moral hazard is limited and the insured party retains incentives for prevention and mitigation of risks.

Another key advantage of index insurance contracts is their relative simplicity and transparency. The use of an exogenous variable greatly reduces the information asymmetries associated with traditional insurance and eliminates the need for an assessment or verification of actual damage. Consequently, transaction costs are relatively low. A related advantage is the potential speed of payout, which, in contrast to indemnity-based insurance, can be a matter of weeks or even days after the contract is triggered.

In addition, since index insurance uses objective and often publicly available information, it allows for contract standardization, thereby facilitating risk transfer to international capital markets. Indeed, as more sophisticated systems (including satellite imagery) become available to monitor and measure natural events, index-based insurance contracts have the potential to become increasingly palatable to international capital markets. Moreover, such technological advances also increasingly facilitate the reliable monitoring of events in developing countries, thereby expanding their possibilities to successfully tap international insurance and capital markets.

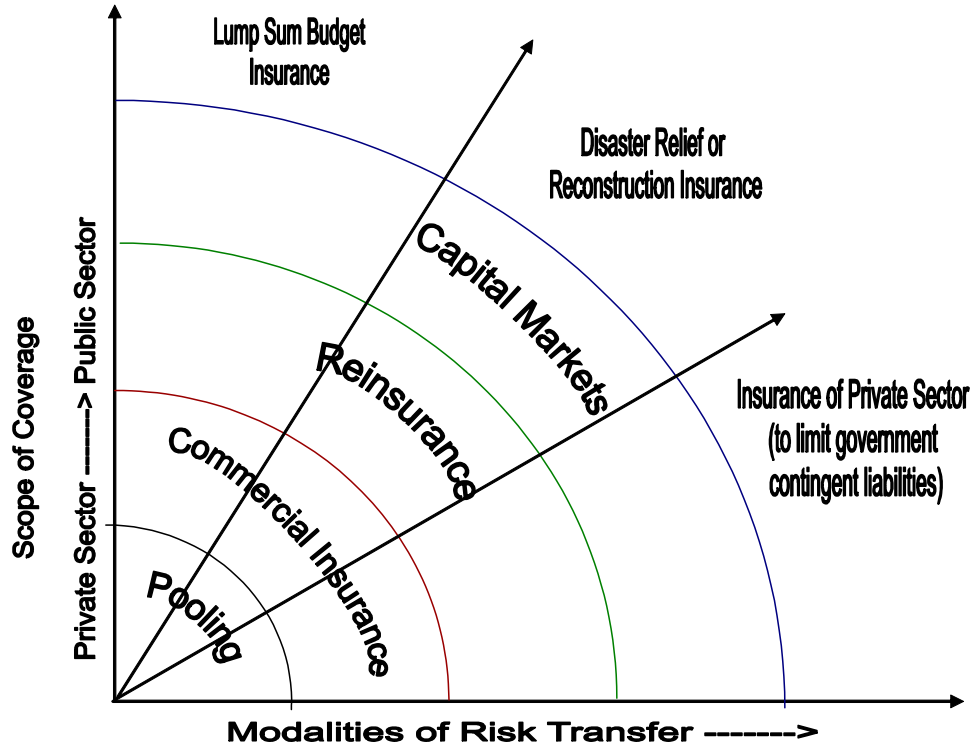
The main inherent disadvantage of weather derivatives is the so-called basis risk: since there is no relation (at least ex post) between the predetermined payout and actual damage, the insurance claim may either exceed or undershoot the actual loss. Refinements in loss modeling, however, can potentially reduce basis risk.

The other key challenge is the further development of the market for index insurance, which is still in its infancy at present.

For a detailed discussion of index insurance see, World Bank (2005a).

Figure 1 provides a schematic overview of the various possibilities for insuring against the budgetary costs of natural disasters. In many ways it represents the continuum of options which conceptually may be organized along two key dimensions: first, the link between public finances and insurance coverage; and second, the modalities of risk transfer. Both indemnity-based and parametric triggers can, in principle, be applied throughout this spectrum, although parametric triggers generally become more appropriate as the insurance pertains more directly to the budget (and the relationship with actual damage is weaker), and as risks are transferred to capital markets.

Figure 1. Modalities for Insuring Against Budgetary Pressures from Natural Disasters



A. Modalities of Risk Transfer

As indicated above, one key choice with respect to insurance-based solutions for managing disaster risks pertains to the *degree to which the risk is transferred* and the *entities that ultimately come to bear the risk*. The various modalities differ crucially in the size of the pool of risk capital among which the risk is spread. There are several options.

Pooling

At one end of the spectrum, countries can choose to pool their disaster risk with other countries—thus creating a rudimentary form of cooperative insurance. Such a mechanism can be effective and sufficient when the number of countries sharing the risk is large enough and the correlation of risks between the participating countries is relatively low. However, in many instances, disaster risks have regional dimensions (e.g., hurricanes in the Caribbean or floods in Europe) that may make regional pooling less effective.

Commercial Insurance

Commercial insurance companies, by contrast, may be better placed to absorb risks because they typically seek to maintain a well-diversified portfolio of risks. Therefore, transferring risks to (international) commercial insurance markets could in principle be a useful strategy to prepare for natural disasters. There are well-established markets for catastrophe insurance, and their size is increasing rapidly (Box 2). Whether individual (often domestic) insurance

Box 2. The Rise of Catastrophe Insurance

Commercial insurance against natural catastrophes has been around for a long time. But the industry has grown rapidly over the past two decades. The table below shows the estimated overall losses from natural disasters as well as insured losses since the 1950s. While overall losses have risen manifold over time—reflecting both increasing prosperity and the uptick in the number and severity of disaster events—the amount of insured losses has gone up even faster, reflecting increasing insurance market penetration. Insurance coverage has been heavily concentrated, though, in advanced economies, with North America, Japan, and Western Europe accounting for the lion's share of the market.

Natural Catastrophes and Estimated Losses, 1950–2005

(Billions of U.S. dollars; constant 2005 prices unless otherwise indicated)

	1950–59	1960–69	1970–79	1980–89	1990–99	Last 10 Years
Number of events	21	27	47	63	91	57
Overall losses	48.1	87.5	151.7	247.0	728.8	575.2
Insured losses	1.6	7.1	14.6	29.9	137.7	176.0
Percentage insured	3.3	8.1	9.6	12.1	18.9	30.6

Source: Munich Re (2005), and IMF staff calculations.

companies are capable of absorbing larger natural disaster risks ultimately depends on their degree of capitalization and potential size of payouts should the insured event occur. However, second tier insurance is available that allows insurance companies to pass on risks that exceed their absorptive capacity (see below).

Reinsurance

Catastrophic risks differ from other risks covered by insurance companies. Traditionally, insurance tends to rely on the "law of large numbers." That is, households are insured against risks (e.g., fire or car damage) that are unpredictable at the level of each individual household, but that become much steadier and predictable on the aggregated level of a large portfolio of households. For such perils, insurance companies can thus make reliable projections for the expected losses of their portfolio for any given year, and the variance of actual losses tends to be relatively small.

For catastrophic risks, on the other hand, insurers typically cannot benefit from such aggregation because they tend to affect many parties simultaneously. Moreover, the overall number and severity of natural disasters varies substantially from year to year. Thus, on its catastrophe portfolio, an insurance company may face very few claims in most years, but sudden outsized claims in any year when a major disaster hits. As a consequence of the relatively high variance of catastrophe insurance claims, insurers and their reinsurers need to maintain much higher capital reserves against their catastrophe portfolios than for other risks.

Because of the peculiar loss-distribution and associated capital requirements, primary insurers have often chosen to transfer considerable parts of their catastrophe exposure to

reinsurers. These reinsurers act as the insurers of the insurance companies and serve to diversify the risks that individual insurance companies cannot offset internally.

Even with the biggest systemic risks generally passed on to reinsurers, the need for substantial capital reserves in the context of catastrophic risk insurance still has two important consequences for traditional catastrophe insurance pricing:

- *Disaster coverage tends to be expensive in comparison to other insurance*. Average premia for catastrophe coverage tend to lie well above the actuarially fair price, so as to cover the costs of maintaining the required capital reserves (Mechler, 2005; Froot and O'Connel, 1999).

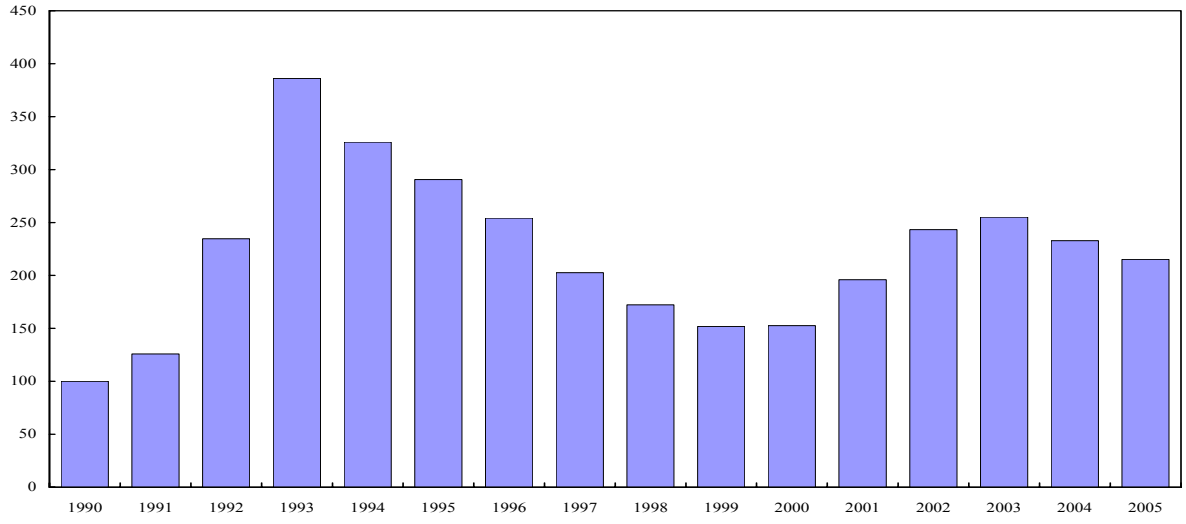
- *Reinsurance premia for disaster risks are very volatile* (Box 3). Because of the onslaught that catastrophes—when they occur—make on capital reserves, reinsurance capacity tends to contract sharply in the aftermath of major disasters. As a result, premia typically spike in such periods.

Box 3. Catastrophe Reinsurance Premium Volatility

The insurance capacity of reinsurers is very sensitive to the incurrence of big insurance losses from (natural) disasters that reduce reinsurers' capital base. As a result, catastrophe insurance pricing tends to be quite volatile.

Insurance pricing is usually measured in the so called rate-on-line. This is the premium paid over and above the expected annual loss. As such, the rate-on-line reflects the operational and capital costs faced by insurance firms, their profit margin, as well as a risk premium (analogous to the risk premium in the pricing of other financial contracts). The figure below shows the average rate-on-line for catastrophe reinsurance since 1990. Between 1990 and 1993, reinsurance premia rose almost fourfold, mostly in response to the impact of Hurricane Andrew in 1992, which was the most expensive disaster up to that moment causing an insurance loss of US$20 billion and bankrupting about 60 insurance firms. In the years following Hurricane Andrew, premia fell gradually as the industry rebuild capacity, only to rise again following the September 11, 2001 terrorist attacks on the United States.

Catastrophe Insurance Rate-on-Line, 1990-2005
(Index, 1990=100)



Source: Guy Carpenter & Co., Inc.

Capital Markets

Where primary insurers have traditionally been able to rely on reinsurers to balance their risks, with the increase in catastrophe losses over time the losses have become very large relative to the reinsurers too. Prompted by Hurricane Andrew in 1992, reinsurers have therefore progressively sought to manage their own exposure by securitizing risks and selling them in the international capital markets. This has given rise to a steadily expanding market for insurance-linked securities, the most important of which are "cat bonds."

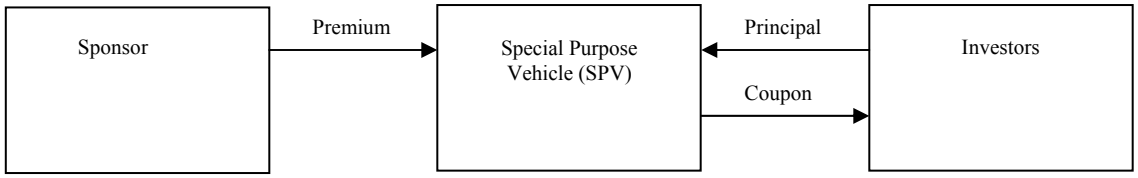
A catastrophe bond (or *cat bond*) is a tradable instrument that facilitates a transfer of the risk of a catastrophic event to capital markets (Box 4). Cat bonds were originally developed

Box 4. Cat Bonds—How Do They Work?

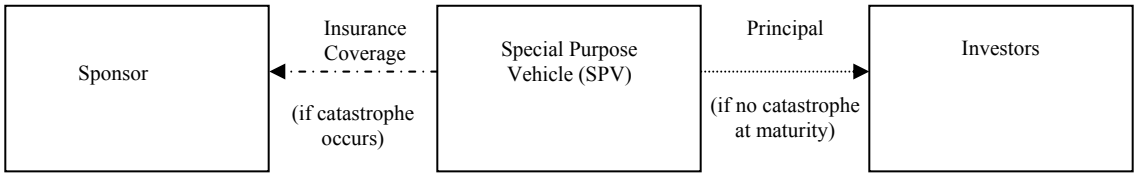
The typical cat bond issue involves the establishment, by the "sponsor" (usually a reinsurance company, but conceivably another entity), of a Special Purpose Vehicle (SPV). The task of this SPV is to issue the bond and to invest the capital in low-risk securities (e.g., treasuries).[1] The return on these investments are paid to the holders of the bonds, together with a premium that is paid by the sponsor (see figure below, panel A). If the bonds mature without the prespecified event having taken place, the principal is repaid to the investors, similar to regular bonds (panel B). However, in the event that the prespecified catastrophe does occur within the life time of the bond, investors agree to forfeit part or all of their claim, and the SPV will pay out to the sponsor instead. The catastrophe risk is thus transferred to the investors.

Structural Overview of Cat Bond Issuance

A. Transaction



B. Possible end positions



Source: Adapted from Chacko and others (2004).

Since assets and liabilities related to the bond issue are allocated with the SPV, cat bond structures as described above function as a pure insurance arrangement from the perspective of the sponsor, and are not debt creating. The key advantage of cat bonds to the sponsor is that it can break up and transfer risks to a large group of investors in cases where insurance with a single counter party might not be available or be more expensive.

From the perspective of the investor, cat bonds yield above-market rates (since a premium is paid on top of the low-risk/risk-free return), while offering a unique possibility for portfolio diversification as a catastrophe risks tend to be uncorrelated with trends in stock or bond markets.

[1] The actual proceeds of the low-risk investments are typically swapped with a highly rated third party for a fixed stream of revenue so as to further reduce interest rate risk.

in the mid-1990s to help reinsurance companies cope with so called peak risks—i.e., risks too large to be absorbed by a single (re)insurance provider. Cat bonds tend to target layers of risk with very low annual loss probabilities (less than 1 percent per annum) and usually have a maturity of around three years.

After an initial slow start following the first catastrophe bond issue in 1994, activity in the market picked up considerably from 1997 onward. Since that year, some 69 cat bonds have been issued, with the average size of issues rising substantially (Figure 2, Box 5). By 2005, the total market size has grown to almost US$5 billion (Guy Carpenter, 2006). And Swiss-Re, a large player in this market, predicted some time ago that the market could well reach US$10 billion by 2010.

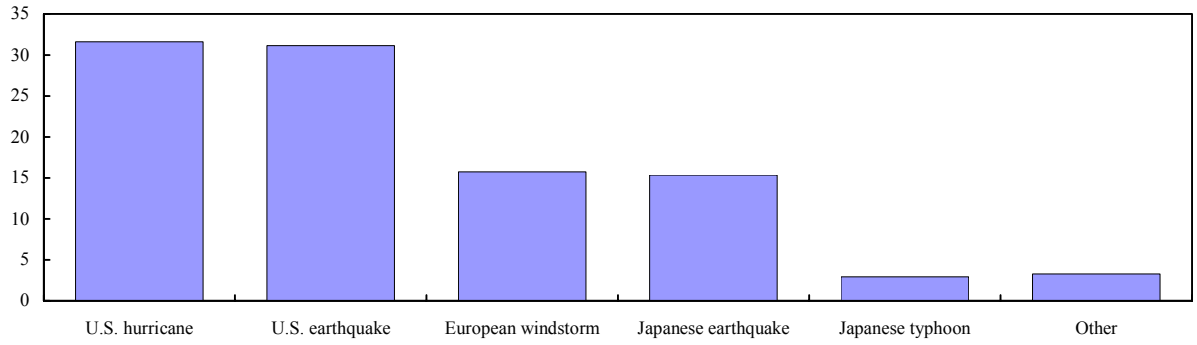
Perhaps surprisingly, the cat bond market appears to have held up well in the face of the unusually severe 2004 and 2005 Atlantic hurricane seasons. Indeed, 2005 saw a record

Box 5. Cat Bonds—Who Are the Issuers and Investors?

Cat bonds have thus far primarily been issued by reinsurance companies to cover traditional reinsurance risk segments such as U.S. hurricane risk and Japanese earthquake risk (see figure below). However, their use need not be limited to these markets. Indeed, governments can issue bonds themselves as a means of purchasing insurance against country-specific risks. This possibility was first seized by Taiwan Province of China in 2003, recently followed by the government of Mexico (see also Box 6).

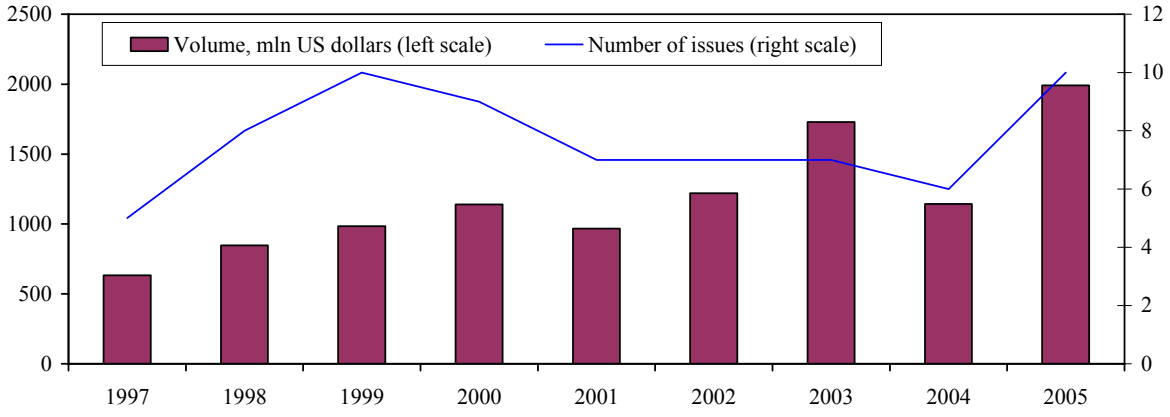
In 2004, there were more than 50 firms that were regularly investing in cat bonds, including hedge funds, institutional money managers, commercial banks, pension funds, and insurance companies. And new investors are reported to continue to enter the market. Indeed, there appears to be a considerable appetite for catastrophe risk. Some cat bond investors, in order to satisfy unmet demand for catastrophe risk, have also started to enter the reinsurance market through other channels, including by capitalizing their own reinsurance companies (Guy Carpenter, 2005).

Cat Bond Risk Capital by Peril, 1997–2004 1/
(In percent of total risk capital)



Source: Guy Carpenter & Co., Inc.
1/ "Other" includes the peril categories European hail, Monaco earthquake, Puerto Rico hurricane, and Taiwan earthquake.

Figure 2. Cat Bonds: New Issues by Volume, 1997–2005



Source: MMC Securities

US$2 billion cat bond issuance, which represented a 74 percent increase over the previous year, even as 2005 also saw the first significant loss to a publicly disclosed cat bond (cat bonds are private placement investments, so information is relatively scarce). At the same time, despite the turmoil, cat bond prices are reported to have come down (Box 6).

Analysts seem to agree that 2006 is set to be another year of expansion for the cat bond market (see, e.g., Lane Financial, 2006; FT, 2006; and Geoghegan, 2006). Clearly, the recent rough hurricane seasons have not yet led investors to shy away from taking on catastrophe risks. But they have further increased the urgency for reinsurers to involve capital markets in sharing their peak risks, thus likely providing strengthened impetus to cat bond supply.

Box 6. Cat Bond Pricing

Since insured risks differ, both in their expected loss and in levels of uncertainty surrounding the insured event, cat bond pricing varies relatively widely, and comparing the pricing of separate bond issues is fraught with difficulties. This said, evidence from the developed markets suggests that for catastrophes with a probability of around 1 percent, over all issues to date, premiums have ranged from about 2½ to 8 times the expected annual loss (Guy Carpenter, 2005). In other words, for a policy that provides insurance against a once-in-a-century event with a maximum coverage of US$100 million, the typical annual premium (i.e., the spread paid over the risk-free yield) would be between US$2½ million and US$8 million a year.

However, likely reflecting the increasing investor acceptance of, and appetite for, cat bonds, prices are reported to have come down in recent years (Guy Carpenter, 2005). This seems to be confirmed by the recent example of Mexico, which issued a US$160 million cat bond in 2006 to cover the event of a major earthquake. The spread of about 2½ percent over LIBOR that is paid by Mexico on the cat bond is among the very lowest for cat bonds with a similar risk (in this case, a loss probability of 0.93 percent). Apparently, investors welcomed the opportunity to invest in earthquake risk outside the main traditional areas (California, Japan)—a signal that could bode well for other nontraditional countries that are seeking to transfer disaster risk to capital markets.

B. Scope of Coverage and Recent Initiatives

The modalities of risk transfer aside, governments seeking to shield their budgets from the impact of natural disasters face the fundamental choice of *who* should be the insurance taker and *what* should be insured. Since the inability of the private sector to cope with the impact of a disaster is often a key source of budgetary pressures following a disaster, one useful strategy involves promoting, facilitating, and/or subsidizing the purchase of insurance by private sector parties (for instance, property insurance for homeowners or crop insurance for farmers) so as to limit the government's contingent liabilities. Alternatively, or as a complementary strategy, a government can also seek to insure itself directly against certain prespecified disaster-related outlays, or against budgetary pressures more broadly.

In recent years, there have been promising initiatives in low- and middle-income countries that aim to provide for disaster risks through insurance at various levels. These initiatives cover a considerable range of approaches and instruments and provide useful reference for further exploration. The main schemes of interest are summarized in Table 2. They can be divided into three broad categories.

(i) ***Schemes aimed at limiting government contingent liabilities***. Schemes that target the private sector so as to reduce the need for government support following disasters, thereby reducing potential budgetary pressures, are numerous in both developed and developing countries. In the developing country context, key recent initiatives include the Turkish catastrophe insurance pool and associated compulsory earthquake insurance scheme (Box 7) and the 2003 World Bank and IFC project that offers drought insurance to farmers in southern India. In the developed country context, the residential earthquake insurance pool of Taiwan Province of China is another example. Typically, under such schemes the government helps organize—and sometimes subsidizes—insurance for the private sector by pooling the resources of domestic insurance companies and/or by providing guarantees or reinsurance. As an example of the latter, the government of Taiwan Province of China issued a cat bond in 2003 to reinsure its residential insurance pool.

Box 7. Turkish Catastrophe Insurance Pool (TCIP)

With a view to reducing the economic impact stemming from relatively frequent natural disaster and low insurance penetration, the Turkish government mandated in September 2000 the purchase of standard, indemnity-based property insurance and created an insurance pool, the TCIP, to offer this insurance (Yazici, 2005). Simultaneously, the government abolished its requirement under previous legislation to extend credit and construct buildings for the victims of earthquakes.

The TCIP is intended to offer insurance coverage at reasonable premiums, to alleviate the financial burden of earthquakes on the government budget (particularly related to post-disaster housing construction), to ensure risk sharing by residents, to encourage standard building practices, and to establish long-term reserves for financing future earthquake losses. The scheme covers all residential buildings that fall within municipality boundaries.

As of end-2004, approximately 16 percent of the total dwellings that fall within the compulsory scheme had obtained the required coverage. Operational management has been contracted out to a leading Turkish reinsurance company, and a large amount of the risk is being ceded to international reinsurance markets until sufficient financial resources are accumulated within the TCIP.

Table 2. Comparison of Selected Disaster Risk Management Projects

	Turkey	India	Ethiopia	Mexico	Caribbean
Purpose:	Insure Turkish homeowners against the effects of frequent earthquakes.	Insure Indian farmers against the effects of catastrophic drought.	Provide funds for emergency relief to Ethiopian households in the case of catastrophic drought.	Provide funds to local governments to cover damage to infrastructure due to natural disasters.	Provide resources for budget support to governments in the Caribbean basin following a pre-specified catastrophic weather event.
Insured event:	Actual damage caused by earthquake.	Pre-specified shortfall of precipitation.	Pre-specified shortfall of precipitation.	Actual damage caused by natural disaster.	Pre-specified natural catastrophe (to be determined).
Insurance method:	Indemity-based property insurance.	Weather derivative.	Weather derivative.	Domestic contingency fund, backed by cat bond.	Weather derivative.
Transfer of risk:	Risk transferred to local commercial insurer and largely passed on to international reinsurance markets.	Risk transferred to local commercial insurer and passed on to leading international reinsurance company.	Risk transferred to commercial insurers or retained by donors.	Risk largely retained within public sector, except for certain layer of risk that is transferred to a leading reinsurer and to international capital markets (with cat bond).	Risk pooled among Caribbean countries through creation of a reserve fund consisting of country-paid premia and donor resources, partially reinsured with commercial parties.
Counterparty to risk transfer:	Individual Turkish homeowners.	Individual Indian farmers.	World Food Program.	Local governments.	Governments of affected countries.
Intl. Organization Involvement	N.A.	World Bank, IFC.	World Food Program.	N.A.	World Bank.
Donor contribution:	N.A.	N.A.	Donors either pay the premium price or retain the risk themselves on the same terms as the derivative contract.	N.A.	Donors contribute to a pool of shared contingency resources.
Project status:	In effect.	In effect.	Pilot in effect. Weather derivative for 2006 Agricultural season has been succesfully tendered.	In effect.	In preparation. The aim is for the facility to be implemented in 2007.

(ii) ***Schemes to provide resources for disaster relief and reconstruction***. In this setup, the government provides for earmarked resources to cover the relief operations in the event of a catastrophe. An example is the project of the World Food Program (WFP) in Ethiopia that uses a weather derivative to ensure resources in the case of a catastrophic drought (Box 8). In this project, the potential insurance money is to be spent by the government and the WFP through predefined channels to relieve the plight of affected farmers. A second example is the FONDEN fund in Mexico (Box 9). This fund started as a means of earmarking resources, to be spent by local governments, for future disaster relief on an as-needed basis. More recently, the fund got on more secure financial footing when the Mexican government issued a cat bond with a view to securing sufficient funds in the event of a major earthquake.

(iii) ***Schemes to provide lump sum support to the government budget***. Instead of purchasing insurance against specific outlays, governments can seek general, lump-sum support conditional on a certain disaster taking place. Such funds could then be spent at the government's discretion. Schemes of this type are less common. However, the World Bank is currently planning to implement a scheme along these lines in the Caribbean (Box 10).

Box 8. Ethiopia: Drought Insurance

In 2005, the World Food Program initiated a pilot project for ex ante management of weather-related risks in developing countries involving governments, donors, and private sector international risk markets (WFP, 2005). In an effort to hedge against potential drought effects for Ethiopia's 2006 agricultural season, the pilot transfers the risk using a small weather derivative contract, which was issued for competitive tender for the purpose of premium price discovery (and was awarded to Axa Re).

The weather derivative contract utilizes an index or parametric trigger: quantification of the drought risk will be based on an index that relates catastrophic shortfalls in precipitation to an estimated level of funding necessary for the associated aid response. Payout will occur when the modeled level of the necessary aid response associated with a measured shortfall in precipitation meets or exceeds the trigger level of the contract. WFP will be the counterparty to the risk transfer: if the small experimental hedge is triggered by a severe to catastrophic national drought in 2006, the resulting payout will be made available to the government and implemented in consultation with WFP through the established channels. The insurance money should reach the affected farmers within weeks after the contract has been triggered, which would reportedly represent a gain of four months over existing relief mechanisms.

Box 9. Mexico: Natural Disasters Fund (FONDEN)

In an effort to increase its capacity to respond to the effects of natural disasters without large disruption to state and local budgets, the Mexican government created the Natural Disasters Fund (FONDEN) in 1996. The fund is essentially an open-ended budgetary obligation of the federal government to provide fast-disbursing support to areas damaged by natural disasters. The insurance provided by FONDEN is indemnity-based: payout is made to other public sector entities based on ex post evaluation and quantification of the damages caused by the disaster to all types of infrastructure.

In 2006, in a move to change FONDEN from a reactive system to a preventive one, the Mexican government followed Taiwan Province of China's example and issued a US$160 million cat bond to insure the fund against the risk of a major earthquake. The cat bond issue, which was underwritten by Swiss Re, was complemented with insurance contracts providing a total coverage of US$450 million over a three-year period.

Box 10. Caribbean Catastrophe Risk Insurance Facility

The World Bank is currently studying the viability of a Caribbean Catastrophe Risk Insurance Facility aimed at allowing Caribbean countries to pool natural disaster risks and to facilitate the purchase of commercial insurance against adverse natural events (World Bank, 2006, 2005b). The primary aim of the insurance would be to allow for immediate budget support to the participating countries in the aftermath of a natural disaster, providing governments with (partial) coverage for associated operating and recovery expenses.

The envisaged facility would entail the creation of a reserve pool of risk capital, consisting of donor contributions and paid-in premia from participating countries and the purchase of additional risk capital through multi-year reinsurance or issuance of financial coverage instruments (e.g., cat bonds). The pooling of risk and economies of scale (a larger and better diversified portfolio) is expected to help in securing competitive insurance coverage to participating countries. The underlying insurance contract would pay claims depending on parametric triggers. These would be based on the objective measurement of the intensity of a predefined natural event in an agreed area over a certain period, up to a preset limit per year. The intensity of actual events would be determined by an independent agency (such as the National Hurricane Center of the U.S. National Oceanic and Atmospheric Agency).

IV. CHALLENGES AHEAD

The existing schemes described in the previous section span a wide area. Insurance takers vary from private sector parties (Turkey, India), via local governments (Mexico), to the central government (Caribbean), and both indemnity- and index-based triggers are applied. In addition, the schemes demonstrate a variety of risk management options including elements of self insurance (Mexico) and pooling (Caribbean), and risk transfer to either commercial insurers (India), reinsurers (Ethiopia), or to capital markets (Mexico, Taiwan Province of China).

Amid this variety, the key promising area where explorations have only recently begun is the transfer of risk to capital markets. Thus far, only Mexico and Taiwan Province of China have directly tapped the international capital market with cat bond issues. However, the WFP scheme in Ethiopia also made important progress in packaging the risks faced by Ethiopian farmers in an instrument that is potentially tradable in international capital markets, even though in the event it was sold wholesale to a traditional reinsurer. In their use of innovative instruments the Mexican and Ethiopian schemes clearly represent the cutting edge of insurance-based disaster risk solutions in the low- and middle-income context at the present juncture. Possibly, the World Bank scheme for the Caribbean—for which the precise modalities for the transfer of risk are still to be decided—will continue on this road if it is implemented as envisaged in 2007.

Transferring risks to international capital markets has substantial benefits because it would greatly expand the pool of insurance capital available to developing countries, thereby increasing the insurability of large disaster risks. Of course, to benefit from these advantages countries need not necessarily sell their catastrophe risks in these markets themselves. Pooling of catastrophe risks by reinsurance companies, before transferring the risk to capital markets, may under certain circumstances be more efficient and cost effective. However, other factors may also weigh in. For example, even though Taiwan Province of China found that it had to pay a slightly higher price for its cat bond than if it had transferred the risk to a

reinsurer, it still opted for the bond because it provided a fixed price over its three-year maturity, thus shielding the pool from the volatility of reinsurance premia, which are determined on an annual basis. Against this background, further exploration of possibilities seems warranted by all players involved in order to develop practice-tested models that allow a greater role for capital markets in the absorption of developing country natural-disaster risk in the most effective manner.

That said, there are a number of uncertainties and challenges associated with the insurance of natural disaster risk. Crucially, even though there are well-established markets for insuring certain catastrophe risks, it is not assured that all natural disaster risks can be insured in the market at an affordable cost. In general, the catastrophe insurance market faces two sources of uncertainty:

The first is *global warming* and its possible effect on the frequency and intensity of natural disasters. While the insurance industry has generally been able to cope so far, the record insurance losses in the past two years, including the record-breaking US$45 billion losses from Hurricane Katrina, have raised doubts about the way forward. [4] Indeed, on the doorstep of what is predicted to be yet another bad hurricane season, A.M. Best (a rating agency for the insurance sector) has warned that it is only a matter of time before the industry will face events with losses past the US$100 billion mark and that such events could seriously hurt the industry. Against the background of such worries the insurance industry is paying increasing attention to climate change (e.g., Lloyd's, 2006; Munich Re, 2005; and Swiss Re, 2002) and the implications thereof for their risk modeling and risk management more broadly.

While the effects of such reassessments on insurers' policies are yet to crystallize, some may already be visible. For instance, there are reports that some U.S. insurance companies (including Allstate and State Farm) are withdrawing from selected coastal regions in the United States (The Economist, 2006). If this trend continues, it may be a bad omen for, say, Caribbean countries seeking to cover their hurricane risks. More broadly, it seems likely that, with appreciable uncertainty about the accuracy of the underlying risk models, insurers will want to err on the side of caution, with an upward effect on catastrophe insurance premia.

A second source of uncertainty regards the *appetite for catastrophe risk* in international capital markets. As was detailed in the previous section, reinsurers have had relatively little problems in selling the innovative and relatively risky cat bonds to international investors. However, the apparent success of these new instruments coincided with very favorable global liquidity conditions and a quest for yield on the part of investors, which seemed to lead to a decline in risk premia. It may well be that cat bonds—much like emerging market sovereign debt—have benefited from these conditions and that investors withdraw as liquidity conditions tighten (see Geoghegan, 2006).

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[4] Insured losses amounted to an already record-breaking US$49 billion in 2004, but this figure was subsequently topped by losses to the tune of US$94 billion in 2005, about half of which were associated with Hurricane Katrina—the single most expensive natural disaster in history.

These issues aside, affordability of catastrophe insurance for developing countries may remain an issue even under the more favorable scenarios. Indeed, in light of the potentially high costs of insurance and the high volatility in insurance premia, the viability of insurance mechanisms for developing countries may in many instances crucially depend on the contribution of donors.

Mobilizing donors to contribute to disaster insurance schemes is therefore another key challenge. There have been some encouraging signs in this respect. In particular, the WFP scheme in Ethiopia is a promising example of donor involvement. However, donor support is not assured. While the donor involvement in the WFP project is encouraging, it is not clear whether donors will be willing to engage increasingly in structural support arrangements at the expense of post-disaster relief. Indeed, the latter form of assistance may offer greater benefits to donors in terms of public recognition and in satisfying the urge to show support *after* a catastrophe has taken place. Accordingly, the development of a sustainable model for collaboration among donors and recipients in disaster insurance schemes will be imperative.

Against this background, there may remain a role for IFIs in designing and facilitating structures of donor and recipient collaboration, as in the World Bank, IFC, and WFP projects described above. In addition, IFIs may play a key role as intermediaries or in terms of technical assistance because a lack of acquaintance with risk markets is another hurdle for developing countries. In the short run, there is clearly value in overcoming initial coordination problems in order to demonstrate the viability of the insurance approach. In the longer term, it remains to be seen to what extent these projects will become self-sustaining or require continued IFI intervention to take hold.

V. CONCLUDING REMARKS

Natural disasters can put severe strain on public finances of developing and small countries. But recent developments in international insurance and capital markets offer welcome opportunities for the transfer of (parts of) this risk. In recent periods, some disaster-prone developing countries have tepidly begun tapping these opportunities, frequently aided by IFIs such as the World Bank, and sometimes with donor assistance. These examples deserve to be followed by others, since such initiatives can help alleviate the periodic fiscal disruptions from natural disasters experienced by many developing countries.

This said, it is also clear that the sustainability and further development of natural disaster insurance markets is not to be taken for granted. Variable risk appetite on the part of investors is one element that may particularly affect the catastrophic risk market and introduce another element of cyclicality, next to the volatility in reinsurance capacity that characterized the more traditional catastrophe insurance market. More important perhaps, the effects of climate change may have a fundamental impact on the catastrophe insurance industry.

To be sustainable, it will be key that the insurance industry finds ways to keep their risk models up to date with changing weather and disaster patterns, so as to keep uncertainty and risk premia within manageable boundaries. At the same time, further increases in disaster

damage will likely spur demand for catastrophe coverage, thus possibly providing increasing momentum for this segment of the insurance market.

Meanwhile, IFIs and the donor community face a challenge of their own. Building on the lessons of recent initiatives, they should work toward a sustainable model for collaboration among donors and recipients that facilitates a shift from ad hoc after-the-event relief, toward more reliable and predictable ex ante provisioning based on commercial insurance. While natural disasters will remain a painful and destructive fact of life, such a shift would at least help reduce the fiscal second-round effects, thereby limiting economic disruption and facilitating faster recovery.

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