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Financial Protection of the State against Natural Disasters

A Primer

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Abstract

This paper has been prepared for policy makers interested in establishing or strengthening financial strategies to increase the financial response capacity of governments of developing countries in the aftermath of natural disasters, while protecting their long-term fiscal balances. It analyzes various aspects of emergency financing, including the types of instruments available, their relative costs and disbursement speeds, and how these can be combined to provide cost-effective financing for the different phases that follow a disaster. The paper explains why governments are usually better served by retaining most of their natural disaster risk while using risk transfer mechanisms to manage the excess volatility of their budgets or access immediate liquidity after a disaster. Finally, it discusses innovative approaches to disaster risk financing and provides examples of strategies that developing countries have implemented in recent years.

This paper—a joint product of the Hazard Risk Management Unit, Latin American and the Caribbean Region; the Non-Banking Financial Institutions Unit of the Global Capital Market Development Department, Finance and Private Sector Development Vice Presidency; and the Global Facility for Disaster Reduction and Recovery Unit, Sustainable Development Network Vice Presidency—is part of a larger effort in the departments to mainstream disaster risk financing in disaster risk management operations. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at omahul@worldbank.org. The authors are grateful to the participants at the Insurance Workshop of the National Bureau of Economic Research in Cambridge, MA in May 2010 for their suggestions and constructive comments.

Financial Protection of the State against Natural Disasters: A Primer

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Introduction

There has been increasing interest in recent years in the use of financial instruments to help developing countries cope with their financial needs resulting from natural disasters. Experience suggests that the government's policy of risk neutrality stated by Arrow and Lind (1970) does not hold for most developing countries: small islands are too small to diversify their risks; the high level of indebtedness of some countries does not allow them to access post-disaster credit and thus limits their ability to distribute losses between generations; budget processes in many countries do not allow governments to reallocate budget post-disaster, creating a liquidity crunch.[1] Various new instruments have become available that allow governments to more easily access the international financial markets, enabling them to transfer their risk in order to better manage the budget volatility resulting from natural disasters. Yet, a key lesson from the experience of the last decade is that there is no magic bullet. Governments interested in strengthening their response capacity will generally have to combine a number of financial instruments and policies that complement each other.

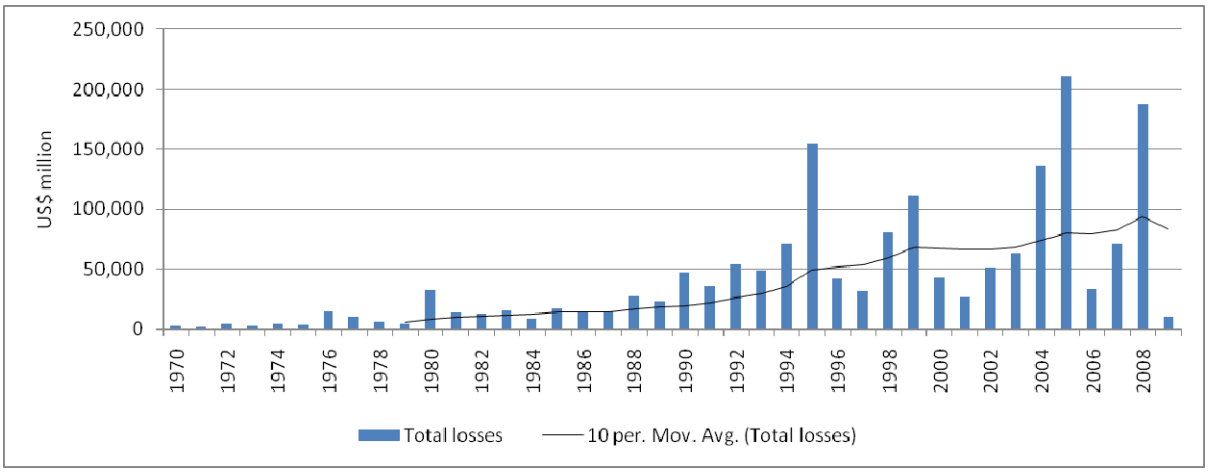
[1] Arrow and Lind (1970) demonstrate that when the risks are publicly borne, the social cost of risk-bearing is insignificant and, therefore, the government should ignore uncertainty in evaluating public investment because it can distribute the risk associated with any investment among a large number of people. However, a key assumption underlying this result is that returns from a given public investment are independent of other components of national income. In the context of the financing of natural disasters, this theory suggests that governments should act as risk neutral towards natural disasters and thus they should not invest in any risk financing strategies that are more expensive than the expected losses caused by a natural disaster.

This paper presents a simple framework to help policy makers devise financial protection strategies against natural disasters. It starts with a short analysis of the impact of disaster on government budget and fiscal balance. It presents various instruments available to governments interested in improving their response capacity in the aftermath of a disaster while protecting their long-term fiscal balance. It then provides a brief analysis of various dimensions to be considered in the establishment of a cost-effective financial protection strategy and provides a general framework to guide the establishment of such a strategy.

Why Should Developing Countries Develop Risk Financing Strategies?

Disaster losses are increasing all over the world. Figure 1 presents estimates of damage from natural disasters. This upward trend is principally due to increases in population and assets exposed to adverse natural events, a trend likely to worsen with growing urbanization, environmental degradation and expected increase in the number and intensity of hydro-meteorological events resulting from climate change.

Figure 1. Direct losses from natural disasters, worldwide



The estimated direct losses (in value of 2009 US$) from natural disasters (CRED definition). They exclude: epidemics, insect infestations, slides and wildfire.
Source: CRED EM-DAT database.

Developing countries are particularly vulnerable to adverse natural events. Advanced economies are generally able to dedicate increasing resources to reducing vulnerability, including enforcement of building codes and retrofitting of lifeline infrastructure. This is rarely the case in developing countries, many of which are going through rapid urbanization without the means to implement effective risk mitigation strategies. Emerging economies are particularly impacted, as they usually experience rapid growth in their asset base (growth in infrastructure and economic activities) before systems can be put in place to adopt appropriate building standards.

Disasters have a much more disruptive impact on the economy of less advanced economies. Although they still catch the attention of the general public, major disasters rarely impact the economy (and

budget) of advanced economies. In absolute terms, the costliest disasters mainly occur in developed countries where the concentration of assets, and thus potential losses, is the highest. However, in such economies, the damage as a proportion of GDP is limited to a few percentage points (see Table 1). Figure 2 shows the estimated average annual direct losses from natural disasters as a percentage of GDP for low-, middle- and high-income countries. Middle-income countries are particularly affected by natural disasters in terms of GDP, due to their growing asset base at risk.[2]

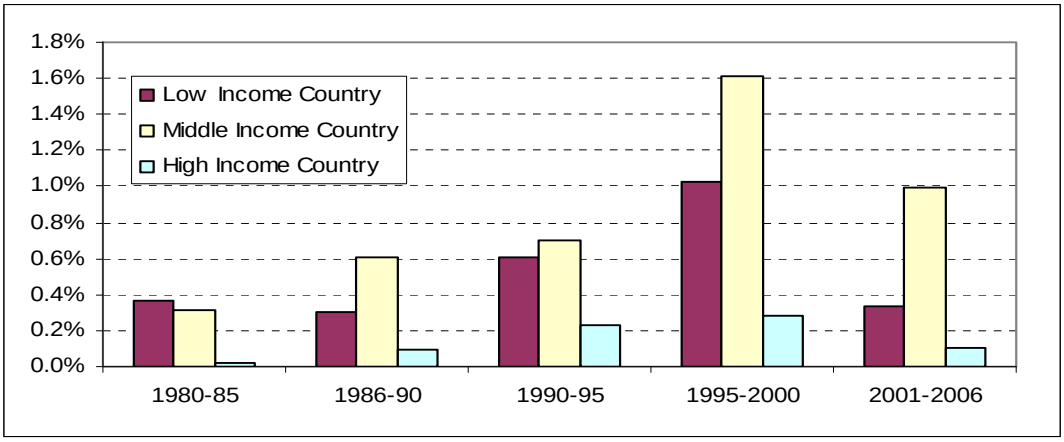
Table 1. Major disasters in the last 40 years

Year	Natural Disaster	Country	Region	Estimated Direct Loss (US$ million)	Direct Loss (% of GDP)
Large Economies					
2005	Hurricane (Katrina)	USA	North America	125,000	1.1%
1995	Earthquake	Japan	East Asia	100,000	3.2%
1998	Flood	China	East Asia	30,000	0.7%
1992	Hurricane (Andrew)	USA	North America	26,500	0.4%
Small Island Economies					
1988	Hurricane (Gilbert)	St. Lucia	Caribbean	1,000	365%
1991	Cyclone (Val and Wasa)	Samoa	Oceania	278	248%
2004	Hurricane (Ivan)	Grenada	Caribbean	889	203%
1990	Cyclone (Ofa)	Samoa	Oceania	200	178%
1985	Cyclone (Eric and Nigel)	Vanuatu	Oceania	173	143%
2010	Earthquake	Haiti	Caribbean	8,000	114%
2009	Tsunami	Samoa	Oceania	120	22%

Source: Authors, from CRED EM-DAT database.

[2] It should be noted that most small island countries, highly exposed to natural disasters, are categorized as middle-income countries.

Figure 2. Average annual direct losses from natural disasters as a share of GDP



Source: Cummins and Mahul (2009).

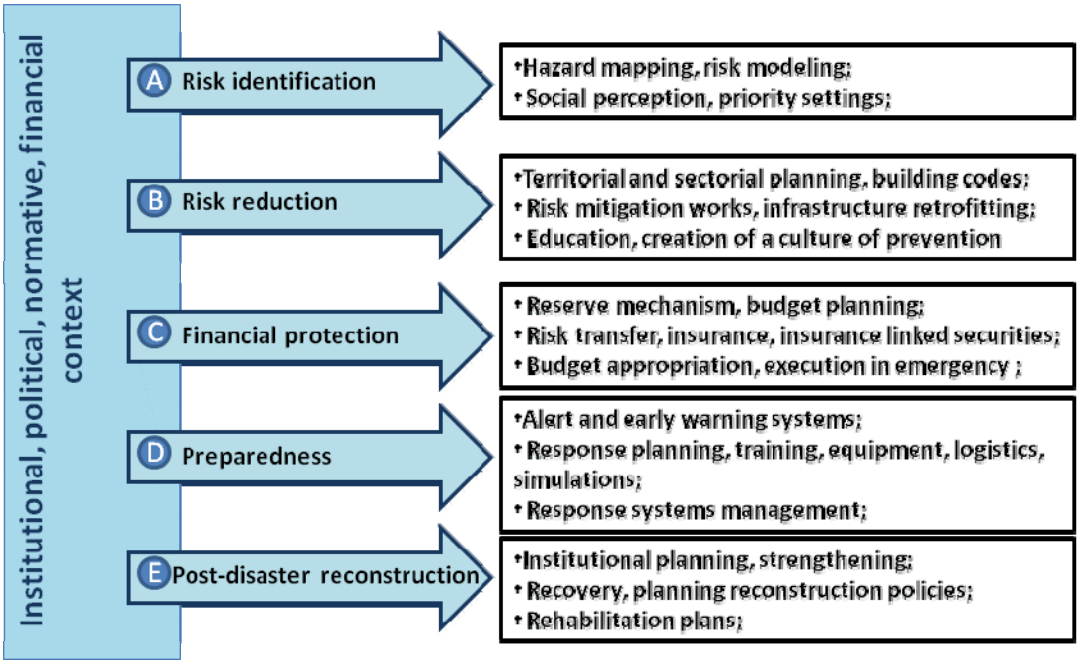
Finally, disasters have a particularly disruptive effect on the fiscal balances of developing countries.[3] The US$83 billion budget appropriation voted by Congress after Hurricane Katrina hardly registered on the scale of the United States budget. Most developing country governments, particularly in smaller and less advanced economies, cannot afford such largesse. Further compounding the recurrent lack of resources, developing countries' governments often lack the appropriate mechanisms to effectively mobilize resources in response to an emergency.

Financial Protection and Disaster Risk Management

It is often argued that financial protection strategies treat the symptoms but not the cause of disasters. Good strategies can help governments cope with the financial impact of calamities, but do little to shelter populations and assets from the destruction of cyclones and earthquakes. As such, it is important to underscore that financial protection is only one component of a comprehensive disaster risk management strategy. Financial protection will help governments mobilize resources in the immediate aftermath of a disaster, while buffering the long-term fiscal impact of disasters. However, a comprehensive risk management strategy should cover many other dimensions, including programs to better identify risks, reduce the impact of adverse events and strengthen emergency services (see Figure 3).

[3] Very little literature exists on the fiscal impact of natural disasters, that is, the effects of natural disasters on the (national and/or local) government budget. The main difficulty in analyzing these fiscal impacts results from the fact that budget processes in most countries do not record emergency expenditures in specific budget lines. Adding to this complexity, emergency relief and early recovery activities are generally financed out of the recurrent budget in the year of the disaster, while reconstruction activities are financed out of the capital expenditures of subsequent fiscal years.

Figure 3. Comprehensive disaster risk management strategy



Source: Authors.

Clearly, well-designed disaster risk financing strategies can create financial incentives for governments and/or households to further mitigate their risks. The simple fact that a Ministry of Finance is sensitized to a country's exposure can help mobilize resources beyond disaster response in support of risk mitigation. Insurance programs can also be designed to discourage – rather than promote – risky behaviors. While this paper touches upon some of these areas, it concentrates on systems that can be put in place to address the potential financial impact of risks that cannot be efficiently eliminated or transferred through other means.

The Different Dimensions of a Financial Protection Framework

This section reviews the sources of financing generally used by governments to finance immediate response (relief), recovery, and reconstruction post-disaster. It provides a brief analysis of the main characteristics of these sources of financing, including the relative cost of each instrument and the speed at which funds can be mobilized. It also briefly discusses the administrative and legal aspects of any efficient financial protection strategy, a dimension that is too often ignored, yet essential to an effective response in case of a disaster.

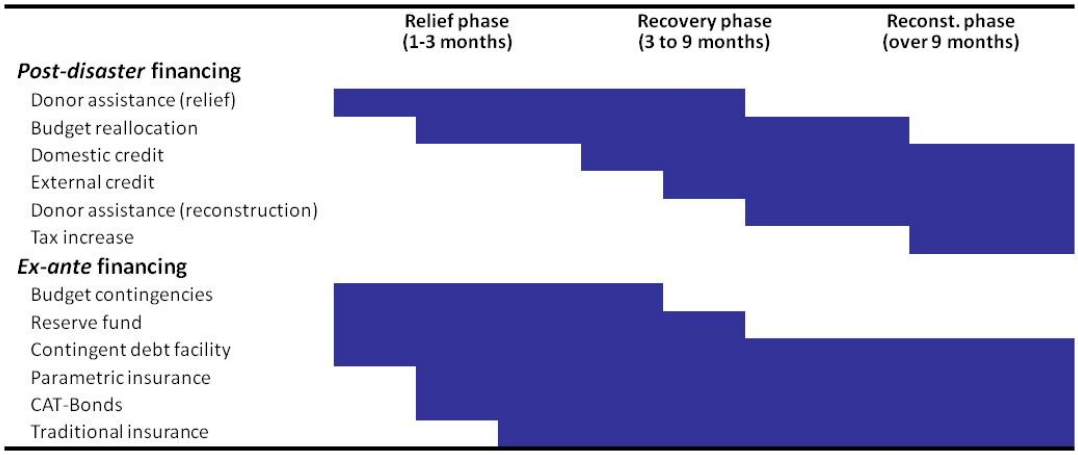
Sources of Financing Post-Disaster

Governments generally have access to various sources of financing following a disaster. These sources can be categorized as ex-post and ex-ante financing instruments. Ex-post instruments are sources that do not require advance planning. This includes budget reallocation, domestic credit, external credit, tax

increase, and donor assistance. Ex-ante risk financing instruments require pro-active advance planning and include reserves or calamity funds, budget contingencies, contingent debt facility and risk transfer mechanisms. Risk transfer instruments are instruments through which risk is ceded to a third party, such as traditional insurance and reinsurance, parametric insurance (where insurance payouts are triggered by pre-defined parameters such as the wind-speed of a hurricane) and Alternative Risk Transfer (ART) instruments such as catastrophe (CAT) bonds (see, for example, Caballero 2003; Freeman, Keen and Mani 2003; Gurenko and Lester 2004; Hofman and Brukoff 2006).

Figure 4 lists the instruments that can be used by governments to mobilize funding after a disaster. It also provides an assessment of the time necessary to mobilize funds through these instruments. The main advantage of ex-ante instruments is that they are secured before a disaster and thus allow for quick disbursement post disaster. On the contrary, ex-post instruments can take some time to mobilize. Of course, the quick disbursing characteristic of ex-ante instruments has a cost. This is discussed in the next section.

Figure 4. Sources of post-disaster financing

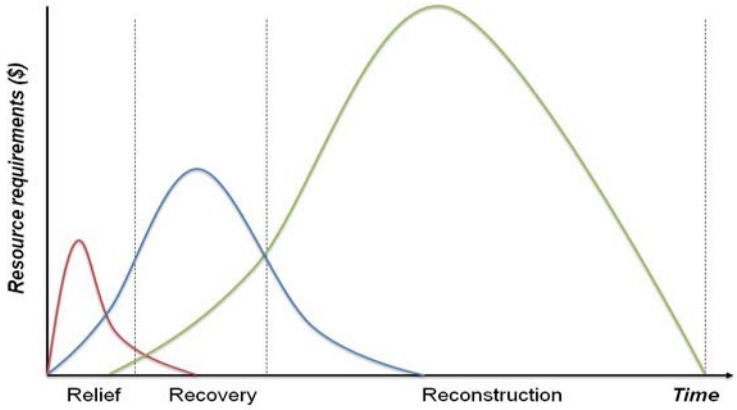


Source: Authors.

The Time Dimension

It is important to realize that a government facing a natural calamity will not require funding for its entire recovery and reconstruction program immediately following a disaster. While immediate resources will be needed to support relief operations, the bulk of the needed funds will only be required several months later when the actual reconstruction program starts. Indeed, the planning of reconstruction programs, the design of infrastructure to be rebuilt and the tender of major works can take several months if not years. The design of an efficient financial protection strategy must consider this time dimension to ensure that funding requirements are matched with the capacity to disburse funds when required (see Figure 5).

Figure 5. Main phases of post disaster funding needs



Source: Authors.

The Cost of Financial Instruments

Life would be easy for financial planners if financial instruments could be used without regard to cost. The truth of the matter is that the cost of financial instruments varies greatly. Table 2 provides indicative cost multipliers contrasted with the speed at which funds can be mobilized from each source of financing described above. The cost multiplier is defined as the ratio between the (opportunity) cost of the financial product (e.g., premium of an insurance product, expected net present value of a contingent debt facility) and the expected payout of that financial product. The multipliers are only indicative and aim to illustrate the cost comparison of the financial products. The speed at which funds can be obtained also varies greatly depending on legal and administrative processes that drive their use.

Obviously, grant financing from donors will always be the cheapest source of financing post disaster. Many donors have well-established humanitarian programs and can be quick to respond, particularly to support relief operations. Unfortunately, donor financing is plagued with limitations. First, it is often driven by media coverage, making donor assistance difficult to predict. For example, the catastrophic floods in Guyana in 2005 occurred just a few weeks after the major earthquake in Pakistan in October 2005, and had very limited media coverage resulting in limited international assistance. Second, mobilizing such funds and making the necessary arrangements to program and disburse them is a complex process that can take months to complete. Third, donor funding after an event sometimes comes at the expense of pre-established program and thus implies an opportunity cost. Moreover, these funds are generally earmarked to support pre-identified expenditures, reducing flexibility in their use. Finally, with limited resources, donors are rarely able to support larger reconstruction programs. Indeed, if only to safeguard their sovereignty, developing country governments are well advised not to rely solely on the generosity of their donor partners.

Governments' own reserves, budget contingencies, budget reallocations and emergency loans are the most common sources of post-disaster financing. Unfortunately, all also have limitations. Budget contingencies usually represent about 2 to 5 percent of government expenditures (such as in Vietnam,

Indonesia or Colombia) and are not earmarked only for natural disasters. Vietnam, for example, has experienced several cases where a major cyclone hit the country in November, when the contingency budget had already been fully exhausted. Governments, particularly in small states, are generally unable to accumulate sufficient reserves to respond to major events. Beyond the opportunity cost of short-term liquidity sitting in an account, competing demands and political considerations make it virtually impossible for governments to build reserves beyond a certain level. Systematic use of budget reallocations endangers development programs that have often required years of preparation. Emergency loans may take a long time to negotiate and do not allow for immediate resource mobilization. Yet, as seen in Table 2, beyond donor grants, they remain by far the cheapest means to finance disaster response.

To better support developing country governments affected by natural disasters, multilateral agencies such as the World Bank and the Inter-American Development Bank have recently created new instruments that provide middle-income countries with contingent credit that can be immediately accessed in case of an emergency. These allow for immediate access to liquidity in case of disasters, combining the benefits of low interest rates provided by multilateral credit with rapid and flexible access to resources (see Box 1).

Table 2. The cost of financial instruments

Instruments	Indicative Cost (multiplier)	Disbursement (months)	Amount of funds available
Donor support (relief)	0-1	1-6	Uncertain
Donor support (recovery & reconstruction)	0-2	4-9	Uncertain
Budget contingencies	1-2	0-9	Small
Reserves	1-2	0-1	Small
Budget reallocations	1-2	0-1	Small
Contingent debt facility (e.g., CAT DDO)	1-2	0-1	Medium
Domestic credit (bond issue)	1-2	3-9	Medium
External credit (e.g. emergency loans, bond issue)	1-2	3-6	Large
Parametric insurance	2 & up	1-2	Large
ART (e.g., CAT bonds, weather derivatives)	2 & up	1-2	Large
Traditional (indemnity based) insurance	2 & up	2-6	Large

Note: The cost multiplier represents the estimated cost of resources as a multiple of the average expected loss it finances. Donor Grants do not have a financial cost but are often reallocated from other ongoing projects and may have an opportunity cost. Reserves are generally held in short-term assets; their cost is the difference between the returns on long term investments and on short-term investments. Budget reallocations are funds reallocated from other programs and may have an opportunity cost; unless they affect the credit rating of a government, the cost of emergency loans is reflected in the interest rate applied; see discussion below on the cost of risk transfer instruments.
Source: Authors.

Finally, governments have recently taken a closer look at instruments available in the financial markets such as traditional insurance, parametric insurance and ART mechanisms (CAT-Bonds in particular). Traditional insurance is already in use in many countries to insure public and private assets. When properly designed, traditional insurance can provide tailored coverage for specific assets and perils. More importantly, governments in many parts of the world have been able to reduce the impact of disasters on their budget and to increase the resilience of their economy by promoting insurance penetration in the private sector. Parametric insurance has also been used in innovative programs such as the Caribbean Catastrophe Risk Insurance Facility (see Box 7). Finally, some countries, like Mexico, have recently ventured into the use of CAT Bonds to cover specific needs.

Nevertheless, the use of insurance and ART remains a relatively expensive proposition for governments (see Box 2), and their use has remained limited to specific cases discussed later in this paper.

Box 1. Reducing the moral Hazard of post-disaster assistance

The Development Policy Loan (DPL) with Catastrophe Risk Deferred Drawdown Option, DPL with CAT DDO, is a financial instrument that offers IBRD-eligible countries immediate liquidity of up to USD$500 million or 0.25 percent of GDP (whichever is less) in case of a natural disaster (Per World Bank Operational Policy/Bank Policy 8.60). The instrument was designed by the World Bank to provide affected countries with bridge financing while other sources of funding are being mobilized.

The CAT DDO was created first and foremost to encourage investment in risk reduction. Indeed, to have access to this contingent credit, countries must show that they have engaged in a comprehensive disaster management program. As such, the DPL with CAT DDO is the first financial instrument offered by the donor community that aims at addressing the problem of moral hazard in donor funding for disaster recovery.

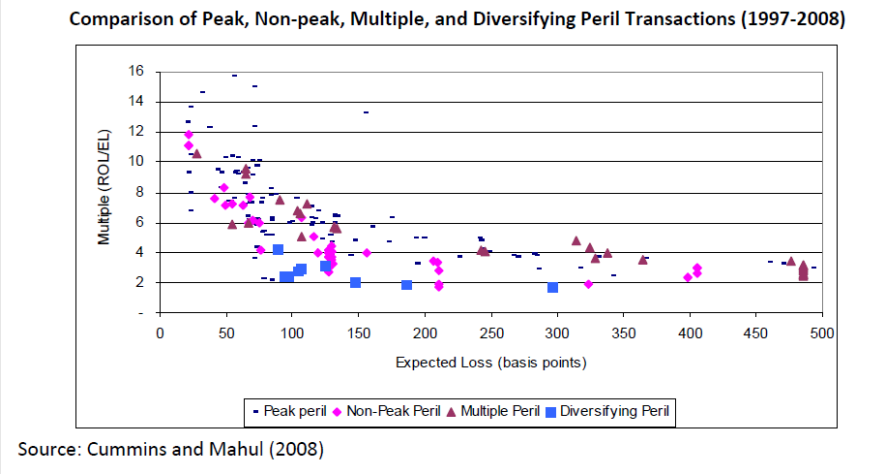
The first DPL with CAT DDO was approved by the World Bank's Board of Executive Directors in September 2008. The US$65 million contingent loan to the Government of Costa Rica aims to enhance the government's capacity to "implement a Disaster Risk Management Program for natural disasters." This program was described in the loan document and agreed upon before signing.

Following the 6.2 magnitude earthquake that hit Costa Rica on January 8, 2009, the Government of Costa Rica drew down approximately US$15 million of this loan. DPLs with CAT DDO have since been signed with Colombia and Guatemala and are currently under preparation in various other countries.

Box 2. The catastrophe load and the cost of transferring risk

The role of insurance is to serve as a recipient of risks and to diversify the risks by pooling losses among many policyholders. The statistical foundation of insurance is the Law of Large Numbers. Intuitively, the observed average loss (per policy) gets closer to the statistical expected loss (per policy) as the size of the insured population increases. In other words, an insurer can almost predict the average loss (per policy) and thus charge the policyholder accordingly. This result is valid when a large number of small independent risks are involved, such as in the case of automobile insurance.

Unfortunately, the risks of natural disasters such as earthquakes and hurricanes are not easily diversifiable because many policyholders are affected at the same time. Moreover, the premium collected every year is generally small compared to a potential payout. As a result, insurers have to maintain risk capital provisions far beyond their expected annual loss to ensure that they will be able to disburse large indemnity payouts after a catastrophic event. These provisions generate substantial costs to the insurer and are passed to the policyholder (a catastrophe load is added the expected annual loss). The higher the capital reserves and/or the opportunity cost of capital, the higher the premium. For low-frequency risks, say 1 in 100 years, the market will often charge over four times the actuarial cost (the expected annual loss). Even for more frequent risks (say, 1 in 10 years), the multiple is still close to twice the expected loss. (Source: Lane and Mahul 2009)



Source: Cummins and Mahul (2008)

Beyond the cost of financing instruments, the amount of funds available can vary by financial instrument (see Table 2). Donor support post-disaster is uncertain and depends on the generosity of the international community. Governments can set aside reserves but their amount is limited by political considerations and by other pressing needs. Contingent credit can provide governments with additional financial capacity in the aftermath of a disaster, but its amount is constrained by the borrowing capacity of the country; this is the case of many small island states that already have high debt levels and very limited borrowing capacity.

Finally, one should also consider how the funds are fungible. While reserves or budget contingencies can be used for many purposes (as long as they comply with the budget laws), post-disaster donor assistance is often provided in kind (e.g., food or material for relief), while reconstruction assistance is usually earmarked to specific projects. For example, it is estimated that only 2 percent of the immediate post-disaster assistance to Haiti following the devastating earthquake in January 2010 was in the form of cash for the government. Consequently, it is sometimes difficult for an affected government

to ensure the continuity of its public services or to service its debt obligations, circumstances that may exacerbate already difficult post-disaster situations.

The Administrative and Legal Dimension

The administrative and legal dimension of risk financing is often overlooked. Yet, it is essential to an effective and timely response. There is no point in mobilizing resources after a disaster if no mechanisms exist to execute these resources in an emergency. In too many cases, efforts to make resources available quickly are rendered fruitless by the multiple steps required to appropriate and to execute these resources. Worse, in an emergency, control over the use of resources is often waived, leading to significant leakage when public finance is already scarce. For example, in some countries emergency appropriation can only be done with the parliament's approval, a procedure that is often cumbersome and plagued with delays. To circumvent this problem, some governments have bought insurance, only to discover that insurance payouts would be treated as non-tax revenue and thus would be transferred to the Treasury first, generating delays in the use of funds for recovery operations. This paper argues that the administrative and legal dimension of risk financing should be at the core of any risk financing strategy. Box 3 presents some of the key legal and administrative dimensions that need to be considered.

Box 3. Legal and administrative aspects of sovereign disaster risk financing

Legal Aspects

- Legal framework for emergencies – Who declares an emergency? Under what circumstances? Who is in charge?
- Appropriation and execution – Who appropriates the budget? How is it done? How are the funds transferred? What controls and safeguards exist to ensure that funds are used efficiently and effectively?
- What norms, standards and safeguards exist to guide interventions?

Administrative Aspects

- Execution – Who coordinates interventions and how are interventions coordinated? How are line ministries involved? How is progress reported?
- Fiduciary controls – Who is responsible? What are the procurement policies to be applied? How are waivers, if any, processed? How will the use of funds be tracked? When are audits conducted?
- Being pro-active – Can specific emergencies be predicted and contracts be tendered in advance (this is often the case for re-opening roads and re-establishing power distribution)? Can the government ask suppliers to hold minimum amounts of supplies that will be purchased at a set price?

An exercise rarely done by governments but extremely useful is to conduct a disaster simulation with the various parties involved in post-disaster financing and assistance, including the budget office. Such simulation invariably helps identify bottlenecks and weaknesses in existing budget processes, emergency procurement, contract monitoring, and payment systems, among other aspects. It also helps sensitize public officials, particularly in finance ministries, who are rarely confronted with disaster emergencies, and helps improve preparedness at all levels of the government structure.

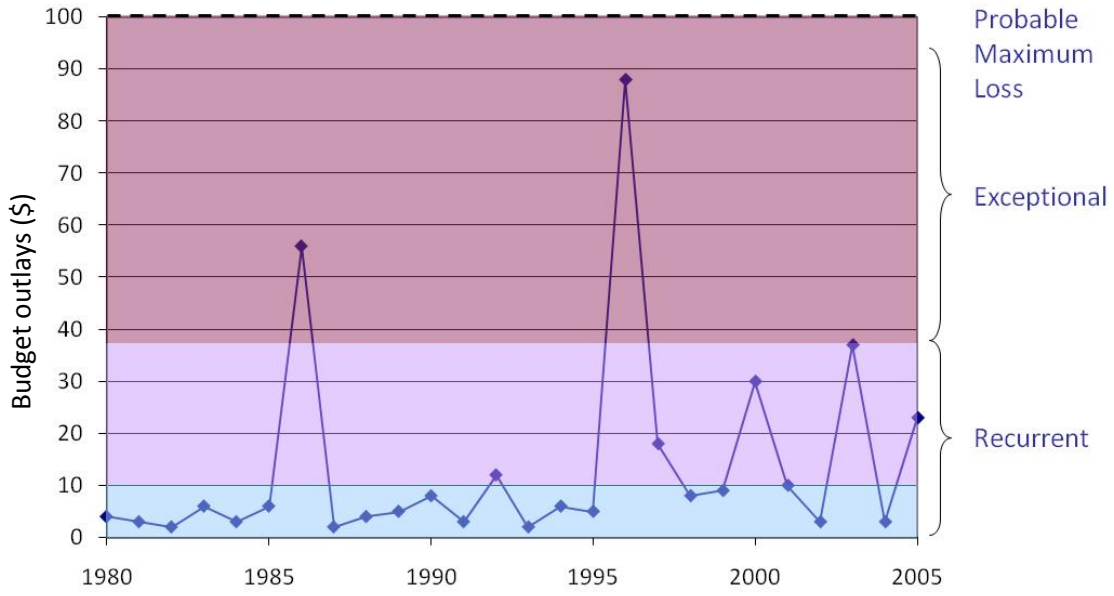
Financial Exposure and Funding Gap Analysis

A financial exposure and funding gap analysis aims to identify situations where needs would exceed available resources, in the case of disasters. A first step in such analysis consists of analyzing the likely funding needs resulting from natural disasters. These potential funding needs are then contrasted with available resources to identify potential gaps or inefficiencies.

Assessing Exposure of the Government Budget

The analysis of potential funding needs (financial exposure) can be conducted by looking at historical fiscal needs resulting from natural disasters. A hypothetical example is provided in Figure 6, where recurrent losses, defined as losses incurred in most years, are contrasted with peak losses occurring less frequently. It is interesting to note that recurrent losses are increasing in most countries, a trend resulting from increasing population and number of assets exposed. Historical analyses can be complemented with more detailed studies relying on probabilistic risk modeling, a technique initially developed by the insurance industry to assess the potential loss on a portfolio of assets (see Box 5).

Figure 6. Evaluation of financial exposure based on an analysis of historical needs



It is important to note that the analysis of a country's financial exposure requires the identification of implicit and explicit contingent liabilities (see Box 4). Post-disaster government intervention varies greatly from one country to the next. Tradition and practice must be taken into account beyond what is stipulated in a country's legislation. In Vietnam, for example, the law stipulates that rural households can receive a lump sum for the destruction of their house by a natural disaster. This amount is generally considered insufficient and the government of Vietnam often increases this amount after a disaster.

Likewise, in Colombia, the government is not required by law to provide financial assistance for the reconstruction of private dwellings, but does so in practice.

In fact, a clear policy defining the responsibility of the state can help reduce the government's contingent liability. By defining how far it is willing to go to support its constituents in case of disaster, a government will provide a signal on the part of the risk that will not be covered, encouraging those bearing that risk to take precautionary measures. A clear policy framework will also limit the usual compensation creep that can be observed from one disaster to another, where the level of compensation in one disaster becomes the minimum expected by the affected population when the next disaster hits.

Box 4. Government contingent liability and fiscal instability

In accounting terms, a government's financial exposure could be considered a contingent liability. *Contingent liabilities* are obligations that may be triggered by an uncertain event. Relative to government policies, the probability of occurrence of a contingency and the magnitude of the required public outlay are exogenous (such as a natural disaster) or endogenous (such as implications of market institutions and government programs for moral hazard in markets). *Explicit liabilities* are specific government obligations defined by law or contract. The government is legally mandated to settle such an obligation when it becomes due. *Implicit liabilities* represent a moral obligation or expected burden for the government not in the legal sense, but based on public expectations and political pressures (Polackova, 1989).

Natural disasters can create major explicit or implicit contingent liabilities for the government budget. In some countries, the law requires the government to bear some of the costs (that is, explicit contingent liabilities). However, political and social pressures may lead the government to accept additional liabilities after the occurrence of the disaster (implicit contingent liabilities). Implicit contingent liabilities often pose the greatest fiscal risk to governments. The event triggering the liability is uncertain, the value at risk is difficult to evaluate, and the extent of government involvement is difficult to predict.

Assessing a government's financial exposure is different from a macro-economic analysis of the impact of disasters (see, for example, Rasmussen 2004). A macro-economic analysis aims to identify and to quantify the economic impact of natural disasters in terms of direct and indirect losses borne by an economy. On the contrary, a fiscal analysis aims to assess the impact of potential disaster events on the government finances, both in terms of additional expenditures and foregone fiscal revenues borne by the government. The analysis of financial exposure is a subset of the overall macro-economic analysis.

Box 5. Probabilistic catastrophe risk modeling

A government's financial exposure can be developed using input from probabilistic catastrophe risk models. This technique was originally developed by the insurance industry to assess the risk on a portfolio of assets and is increasingly used by governments to assess their exposure to adverse natural events. A typical risk model is made of the following modules:

Hazard module: This module defines the frequency and severity of potential perils (e.g. earthquake, tropical cyclone) at specific locations within the region of interest. This is done by analyzing historical frequencies and reviewing scientific studies performed on the severity and frequencies in the region of interest. This module then generates thousands of stochastic events based on historical data and experts' opinions.

Exposure module: This is a geo-referenced database of assets at risk, assigning a list of attributes (e.g., exact location, contraction type, number of stories) for each asset. This information is used to determine the area's vulnerability, captured though vulnerability functions. At a larger scale, for example when analyzing an entire country, proxies are used to define the vulnerability of entire neighborhoods or even cities.

Loss module: This module combines the hazard module and the exposure module to calculate different risk metrics, such as the *annual expected loss*, which is an expression of the long-term (for example, 1,000 years) average annual loss, and the probable maximum loss for a given return period, which represents the expected loss severity based on likely occurrence, such as the 1-in-50-year loss or the 1-in-100-year loss.

Risk matrices generated by probabilistic risk models can be used to complement historical analysis and are particularly useful to policy makers in assessing the probability of losses and the maximum loss that could be generated by major events (e.g. an earthquake affecting a major city or a cyclone affecting a major port).

Funding Gap Analysis

Once a risk profile has been developed, potential funding needs can be contrasted with available resources. As discussed in previous sections, the time dimension must also be considered. Relief and recovery operations will require resources that can be mobilized immediately after a disaster, while reconstruction needs will generally require major resources in the medium term to the longer term (one year or more), respectively. Contrasting potential resource requirements with resource availability will help the identification and the quantification of potential ***disaster funding gaps*** during the relief, recovery and reconstruction phase. The Inter-American Development Bank (IADB) Disaster Deficit Index (see Box 6) was a first attempt at developing a standard methodology to identify potential funding gap among Latin American and Caribbean countries (IADB, 2000).[4]

A dynamic disaster funding gap analysis was recently conducted in Vietnam (World Bank 2010). The recovery funding surplus (gap) is defined as the difference between the resources available during the fiscal year and the post-disaster emergency assistance and recovery expenditures, if positive (negative). The reconstruction surplus (gap) is defined as the difference between the reconstruction resources made available for investment in infrastructure rehabilitation (usually through reallocation of capital expenditures) and the post-disaster reconstruction needs. In the case of Vietnam, it showed that while no recovery funding gap was observed over 2000-09, major disasters would create a substantial recovery funding gap. It also showed that reconstruction funding gaps have been recurrent over the last

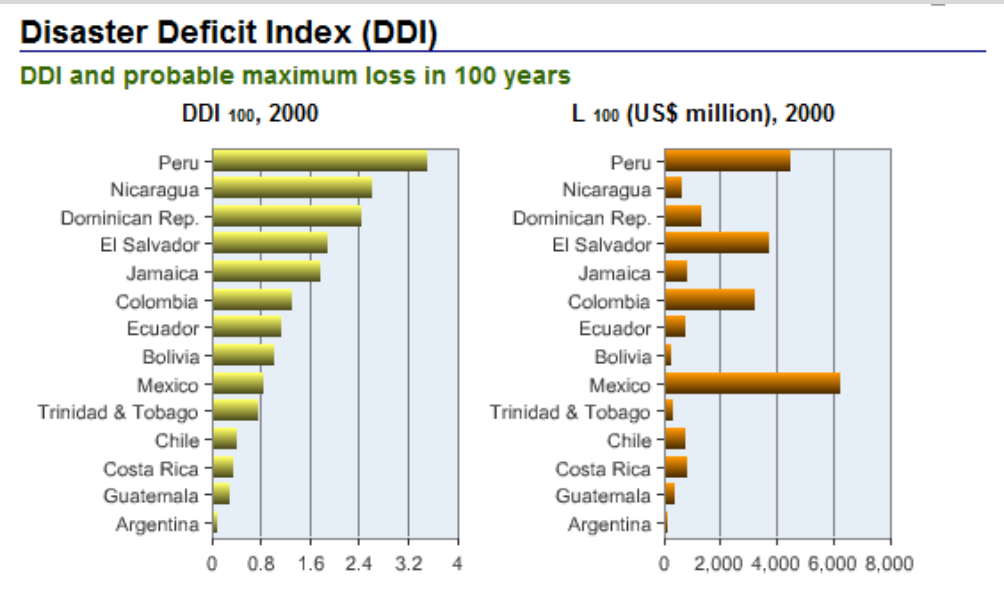
[4] This index does not account for the time dimension: immediate post-disaster resources (e.g., emergency assistance) are mixed with longer term resources (e.g., reconstruction).

10 years. This type of funding gap analysis can be used to identify potential funding gaps to be addressed by the risk financing strategy.

Box 6. IADB's Disaster Deficit Index

The DDI captures the relationship between the demand for economic resources to cover losses that a government would have to assume and the nation's economic resilience, that is, its ability to generate internal and external funds to replace the affected infrastructure and goods. A DDI greater than 1.0 reflects the country's inability to cope with major disasters, even by going into as much debt as possible. The greater the DDI is, the greater the gap between losses and the country's ability to face them. Government responsibility was restricted to the sum of losses associated with public sector buildings and housing for the lowest income population.

The left side of the figure below shows the DDI calculated in 2000 for a Maximum Considered event (MCE) with 100 years of return period (five percent probability of occurrence in ten years). The right side of the figure shows the maximum loss, L, for the government during the same period. The table shows that access to external resources would be critical for eight of the fourteen countries studied. Peru, with a DDI of 3.5, is in the most critical situation, with the loss of a 1-in-100 year event estimated at more than US$4 billion.



Source: IADB 2007

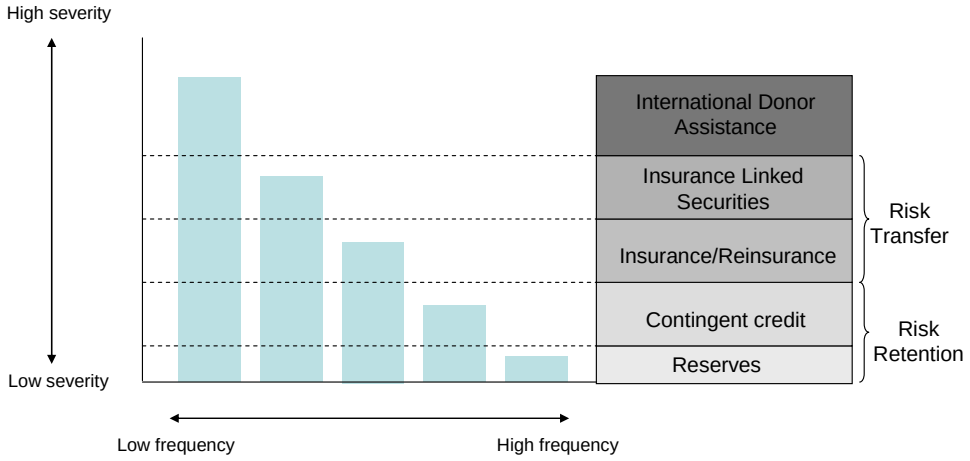
Bringing it All Together

How does it all come together and how can we combine the various instruments described above in an efficient and effective financial protection strategy for governments? The obvious choice is to ensure that cheaper sources are used first, with the more expensive instruments used only in particular circumstances.

Combining Financial Instruments

Catastrophe risk layering can be used to design a risk financing strategy (see Figure 7). Budget contingencies together with reserves are the cheapest source of ex-ante risk financing and will generally be used to cover the recurrent losses. Other sources of financing such as contingent credit, emergency loans and possibly insurance should enter into play only once reserves and budget contingencies are exhausted or cannot be accessed fast enough. A "bottom-up" approach is recommended: the government first secures funds for recurrent disaster events and then increases its post-disaster financial capacity to finance less frequent but more severe events. The level of fiscal resilience to natural disasters, which drives the optimal financial strategies against natural disasters, is a decision to be taken by the government based on economic and social considerations.

Figure 7. Catastrophe risk layering



Source: Authors.

It is important to remember that resource requirements will evolve with time after a disaster. Two problems of a very different nature therefore need to be addressed. The first problem is the need for immediate liquidity to ensure that relief and recovery are not delayed. The second is the need to mobilize sufficient resources for reconstruction. Amounts needed for reconstruction generally dwarf liquidity needs but are not bound by the same time constraints.

Emergency Risk Financing: Covering Immediate Liquidity Needs

Risk transfer remains an expensive proposition for governments that otherwise have access to sovereign financing. Nevertheless, the swiftness at which risk transfer instruments can sometimes provide liquidity without requiring access to credit makes them attractive to some governments. This is particularly the case for small states that do not generally have sufficient capacity to build reserves and are restricted in their access to credit due to already high debt ratios. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) provides an example where small island states acted together to create a regional reserve mechanism to secure access to immediate liquidity in case of a major disaster (see Box 7).

New risk transfer instruments have also proven attractive to governments that wish to circumvent slow budget appropriation processes. The CAT bond recently issued by Mexico provides an example of creative use of risk transfer instruments (see Box 8). The issuance of a CAT bond by the Government of Mexico is the result of a multi-year effort to design a comprehensive disaster risk financing strategy. The Government of Mexico, through the reserve fund for public assets FONDEN, first created a reserve fund built up from an annual budget allocation. The reserves of the fund were considered insufficient to cover a liquidity needs in case of a major disaster and, therefore, FONDEN choose to increase its financial capacity by purchasing parametric insurance and issuing a CAT bond.

Box 7. The Caribbean Catastrophe Risk Insurance Facility

The World Bank recently assisted CARICOM in establishing the Caribbean Catastrophe Risk Insurance Facility (CCRIF), a joint reserve facility that offers liquidity coverage, akin to business interruption insurance, to 16 Caribbean Countries exposed to earthquakes and hurricanes.

The CCRIF was capitalized with support from participating countries and donor partners. It combines the benefits of pooled reserves with the capacity of the international financial markets. To do so, it retains the first loss through its own reserves while transferring the excess risk to the international capital markets.

The Facility became operational on June 1, 2007, and can count on its own reserves of over US$90 million and reinsurance of US$110 million. This provides the Facility with US$200 million of risk capital at very competitive rates. The reinsurance strategy of the CCRIF is designed to sustain a series of major natural disaster events (each with a probability of occurrence lower than 0.1 percent), achieving a higher level of resilience than international standards.

Drawing on the lessons of the CCRIF, the Pacific island states are exploring the creation of the Pacific Disaster Reserve Fund, a joint reserve mechanism against natural disasters for the Pacific island countries.

Box 8. Catastrophe bonds

CAT bonds are part of a broader class of assets known as *event-linked bonds*, which trigger payments on the occurrence of a specified event. Most event-linked bonds issued to date have been linked to catastrophes such as hurricanes and earthquakes, although bonds also have been issued that respond to mortality events.

Capital raised by issuing the bond is invested in safe securities such as Treasury bonds, which are held by a special-purpose vehicle (SPV). The bond issuer holds a call option on the principal in the SPV with triggers spelled out in a bond contract. Those can be expressed in terms of the issuer's losses from a predefined catastrophic event, by hazard event characteristics, or by hazard event location. If the defined catastrophic event occurs, the bond issuer can withdraw funds from the SPV to pay claims, and part or all of interest and principal payments are forgiven. If the defined catastrophic event does not occur, the investors receive their principal plus interest equal to the risk-free rate, for example, London Inter-Bank Offered Rate (LIBOR), plus a spread above LIBOR. The typical maturity of CAT bonds is 1–5 years, with an average maturity of 3 years.

The CAT bond market has been growing steadily since its creation in the mid 1990s until 2008. As a consequence of the 2008 financial crisis, the market stopped issuing CAT bonds in the third and fourth quarters of 2008, leading to a 65 percent drop in new issuance in the non-life bond sector, from US$7 billion in 2007 to US$2.7 billion in 2008. The CAT bond market recovered slightly in 2009, with a new issuance of US$3 billion.

In October 2009, Mexico issued a US$290 million series of notes, which was well received and oversubscribed in the market, through the World Bank MultiCat platform. The notes provide coverage over three years for three perils – earthquakes (three areas around Mexico City), Pacific hurricanes (two

areas) and Atlantic hurricanes (area around Cancun). The Government of Mexico recognizes that $290 million would hardly cover 10 percent of the needs arising from the type of event likely to trigger a payout. Nevertheless, this amount, in addition to reserves held in FONDEN, is likely to be sufficient to cover the resources needed during the first three to six months after a disaster and until additional post-disaster funds can be mobilized.

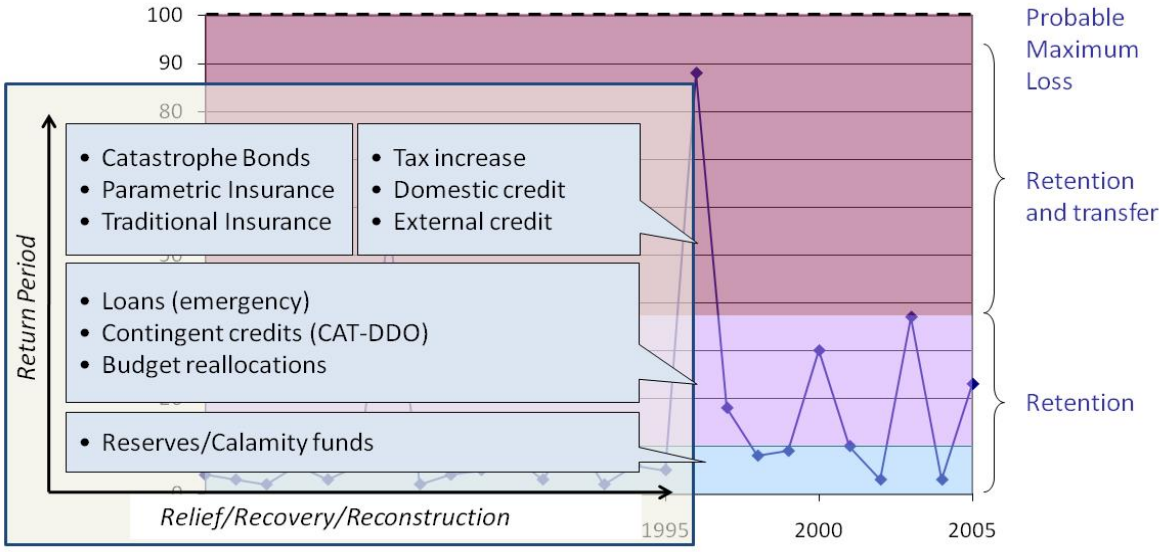
Financing Recovery and Reconstruction

As discussed earlier, the resources required for larger reconstruction programs are rarely required in the immediate aftermath of a disaster. Reconstruction planning takes time, engineers need to design new infrastructure, projects have to be tendered and contractors have to mobilize. It is not rare that actual reconstruction operations start six months or more after a disaster. Large infrastructure rehabilitation may sometimes take several years, with a large share of reconstruction contracts due at completion.

This delay gives time for governments to reallocate planned capital expenditures in their future budget and access additional credit on the domestic or international markets. Programs that made sense before a disaster are sometimes rendered irrelevant by the disaster itself. Resources from less urgent projects can often be redirected to the affected area. With sufficient time, Ministries of Finance can also prepare bond issuances and negotiate emergency loans with multilateral and other financial institutions. Finally, governments will sometimes establish special taxes to support reconstruction. This was the case in Colombia, where the government established a special tax to support FOREC, a fiduciary entity established to finance the reconstruction of the coffee region after it was devastated by an earthquake in 1998.

Figure 8 provides a graphical representation of a possible combination of financial instruments to protect the fiscal balance of the state.

Figure 8. Combining financial instrument to cover various layers of risks



Source: Authors

Recent Experience Using Traditional Property Catastrophe Insurance

The promotion of property catastrophe insurance by governments can be considered as a risk reduction strategy rather than a risk financing strategy from the government's perspective. Various programs developed over the last decade have helped governments reduce their fiscal exposure to disasters by deepening the use of private insurance in key sectors of their economies, thus reducing the government's contingent liability due to natural disasters. Although this topic goes beyond the scope of this paper, this section briefly presents property catastrophe insurance programs in Turkey and Costa Rica.

Insuring Private Assets

The establishment of the Turkish Catastrophe Insurance Pool (TCIP) helped the Government of Turkey reduce its contingent liability by promoting domestic property catastrophe insurance for private dwellings (see Box 9). Making it possible for homeowners to purchase insurance, the Government of Turkey has increased the number of citizens who would be compensated by the private sector in case of an earthquake. In addition, by making insurance compulsory for middle- and high-income urban households, the Government of Turkey has significantly reduced the number of homeowners likely to require financial assistance after a disaster.

The provision of property catastrophe insurance requires both technical capacity (in product design, rating and loss adjustment) and financial capacity (as catastrophe insurance is highly capital intensive), as well as a strong regulatory framework. Therefore, these market-based solutions can be considered

only when the domestic non-life insurance market is relatively well developed. The development of catastrophe insurance markets will thus require dedicated efforts from developing country governments to promote the use of insurance but also to ensure appropriate regulation and controls.

Box 9. The Turkish Catastrophe Insurance Program

The Turkish Catastrophe Insurance Pool, TCIP, was established in the aftermath of the Marmara earthquake in 2000, with assistance from the World Bank. Traditionally, Turkey's private insurance market was unable to provide adequate capacity for catastrophe property insurance against earthquake risk, and the Government of Turkey faced major financial exposure in the post-disaster reconstruction of private property. Consequently, the Government of Turkey's objectives for TCIP were to:

- Ensure that all property tax-paying dwellings have earthquake insurance cover;
- Reduce government fiscal exposure to the impact of earthquakes;
- Transfer catastrophe risk to the international reinsurance market;
- Encourage physical risk mitigation through insurance.

TCIP was established in 2000 as a public sector insurance company, managed on sound technical and commercial insurance principles. The company's initial capital was supplemented by a World Bank contingent loan. TCIP purchases commercial reinsurance and the Government of Turkey acts as a catastrophe reinsurer of last resort for claims arising out of an earthquake with a return period of greater than 300 years.

The TCIP Policy was designed as a stand-alone property earthquake policy with a maximum sum insured per policy of US$65,000 and an average yearly premium of US$46 and a 2% deductible. Premium rates are based on the construction type (two types are possible) and property location (five earthquake risk zones were identified) and vary from less than 0.05% for a concrete reinforced house in a low risk zone to 0.60% for a house located in the highest risk zone.

The policy is distributed by about thirty existing Turkish insurance companies, which receive a commission. The government invested heavily in insurance awareness campaigns and made earthquake insurance compulsory for home-owners on registered land in urban areas. Cover is voluntary for homeowners in rural areas.

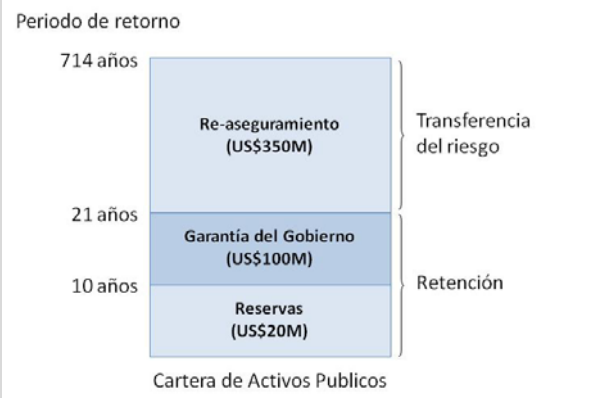
The program is reinsured by international reinsurers. Since its inception in 2000, TCIP has achieved an average penetration rate of about 20% of domestic dwellings (about three million dwellings). Romania is about to study the possibility of establishing a similar pool for earthquakes and floods.

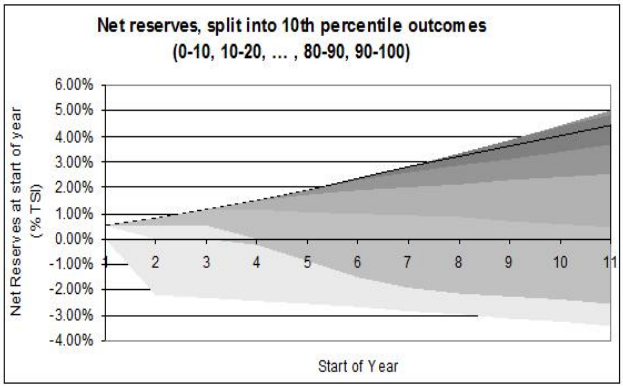
Insuring Public Assets

If insurance is expensive compared to other risk financing instruments, one may ask why some governments insist on insuring their public assets or promoting private sector insurance? It should be noted that, in both developed and developing countries, public programs are often self-insured, and governments are in fact transferring only limited amounts to the private markets. Private-public partnerships can sometimes be put in place to facilitate efficient management of risk born by public assets. The work done by the *Instituto Nacionla de Seguros* (INS) in Costa Rica, with the assistance of the World Bank, is a good example of how such programs can be established to provide for more efficient coverage of public sector risk (see Box 10).

Box 10. Insuring Public Assets in Costa Rica

A clear benefit of insurance is that it allows for risk to be structured and allocated efficiently. As such, numerous governments require managers of public assets to buy insurance for the assets under their purview. In Costa Rica, the World Bank has been working with the public insurance company (INS) to design a dedicated vehicle to insure public assets at lower cost than currently available. The proposed vehicle allows for the Government of Costa Rica to retain most of the risk while transferring only excess losses to international financial markets. By retaining the lower risk layers through reserves, complemented by a simple guarantee or through a contingent line of credit, the Costa Rican Government takes a calculated and limited risk while ceding the part of the exposure that it is not willing to assume. Preliminary analyses show that the proposed vehicle would improve coverage with a net savings of at least US$5 million every year.





Conclusion

A sovereign risk financing strategy aims at strengthening the capacity of the government to respond after a natural disaster while protecting its fiscal balance. A number of instruments are available to build such a strategy, each with its own cost structure and other characteristics. An effective financial strategy against natural disasters relies on a combination of these instruments, taking into consideration the country's fiscal risk profile, the cost of available instruments and the likely disbursement profile after a disaster.

This paper provides policy makers with a framework to devise financial strategies for the fiscal protection of the state against natural disasters. This framework builds on basic financial risk management principles used in the private sector and adapts them to the case of sovereign risk financing. It can be seen as part of the overall public debt and fiscal risk management framework, where natural disasters are exogenous shocks that affect budget stability and increase debt. Contrary to other fiscal risks, such as currency risk or commodity price risk, major natural disaster risk tends to be less frequent and more severe and thus requires a specific risk financing strategy.

This paper argues that a conservative fiscal policy remains the most efficient way to manage financial risk resulting from natural disasters. Own resources and post-disaster debt instruments are usually the cheapest source of financing for governments. Contingent lines of credit available through various multilateral development banks provide a flexible mechanism to manage risk at relatively low cost.

Risk transfer instruments have become increasingly available and can provide efficient mechanisms to access immediate financing after a disaster. They can be used as budget instruments to help buffer resource needs until other sources of funds can be mobilized. As such, these instruments are generally used to help manage budget instability resulting from a natural disaster. They can also be used to increase financial discipline in the risk management of public assets.

A variety of programs launched in recent years have helped build efficient risk management vehicles where the government retains the first losses and transfers only the excess risk. Such programs may become more important in the future by providing partial solutions to the increased variability of losses resulting from climate change.

Finally, financial protection would not be efficient without a suitable legal and administrative framework that ensures that resources can be used effectively in the aftermath of a disaster to mitigate the impact of natural disasters on the affected population and restore the economy of the country.

This paper offers a framework for further applied research and case studies on sovereign disaster risk financing in developing countries, which will guide policy makers in the design of cost-effective financial strategies for the protection of the state against the impacts of natural disasters. Such strategies complement other disaster risk management activities, and contribute to the reduction of the poverty impact of natural disasters.

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