

## Ex-ante evaluation of the cost of alternative sovereign DRFI strategies

- Daniel CLARKE, The World Bank Group / GFDRR.
- Olivier MAHUL, The World Bank Group / GFDRR.
- Richard POULTER, The World Bank Group / GFDRR.
- Tse-Ling TEH, The World Bank Group / GFDRR.

### Background

The increasing frequency and severity of climate extremes has forced governments to consider new ways of meeting the financial consequences of natural disasters, and there is a growing interest in implementing sovereign Disaster Risk Financing and Insurance (DRFI) programs in an attempt by governments to be financially prepared for when disasters occur. This has resulted in tremendous growth in the number and type of financial and budgetary instruments available, ranging from disaster reserve funds and lines of contingent credit to insurance instruments, but to date limited attention has been given to developing and implementing a coherent quantitative framework for appraising the true economic cost of these various instruments. Therefore at present, governments have no way of determining whether the programs and financial strategies they are employing are appropriate and efficient bearing in mind the risks they face.

.../... In post-disaster situations, the requirements for critical and rapid expenditures can lead to government using high-cost instruments, such as budget reallocations and borrowing on unfavorable terms (Benson and Clay, 2004). By comparison, sovereign DRFI instruments can protect the national budget and improve the speed at which capital is available and expenditure is undertaken, reducing the economic impact of natural disasters (Goes and Skees (2003), Linnerooth-Bayer and Mechler (2007)). Many developing countries and donors are taking steps to prepare against disasters, and are increasingly considering sovereign DRFI strategies as a way to improve their financial position in the event of a natural disaster. However, there exists very little evidence to guide how such strategies should be designed and compared.

The World Bank-GFDRR Disaster Risk Financing and Insurance (DRFI) Program<sup>1</sup> is a joint effort to mainstream disaster risk financing and insurance across the World Bank's development agenda. The program builds on a partnership between the Finance & Markets Global Practice (GFMDR) and the Global Facility for Disaster Reduction and Recovery (GFDRR), in close coordination with the World Bank Treasury. In 2013, the UK Department for International Development (DFID) and the DRFI Program partnered to launch the sovereign DRFI impact appraisal project. The three-year project is seeking to build the evidence base and develop a methodology to quantify the development impact of investments aimed at building financial protection against disasters. At its inception, the project highlighted the strong need for more evidence on the expected humanitarian and development impact of sovereign DRFI programs to ensure future investments are properly targeted and prioritized, and fulfil their potential in a development context.

Evaluating sovereign DRFI programs is a difficult exercise as it requires research and insights from a variety of different disciplines, including risk modelling, micro-, macro- and public economics, actuarial science and political economics. In order to make the overall problem more tractable it is necessary to first consider the key issues in isolation, before summarising these in a broader impact appraisal framework. The analysis in this paper restricts the environment under which governments make decisions regarding sovereign DRFI to provide a framework for evaluating the cost of alternative sovereign DRFI strategies. While simplifying assumptions are made, the analysis is able to provide powerful insights to guide policy-makers in making decisions regarding sovereign DRFI.

The DRFI Program introduce five ways in which sovereign DRFI can contribute to building financial resilience. While it is not possible to quantify the development impact of sovereign DRFI strategies in some of these areas (for example, it is not possible to assess the impact sovereign DRFI may have on increased discipline over budget mobilisation and execution), this analysis seeks to quantify the effects in two of these areas: the cost of capital and timeliness of instruments which can provide financing for relief, recovery and reconstruction after a disaster. While the results provided can provide important insights as to the cost implications of different financial instruments, it is important to appreciate that the cost and timeliness are only two elements in assessing the impact of decisions regarding sovereign DRFI strategies.

By assuming that a government's contingent liability to disasters is fixed, this analysis explores the questions of whether and how a government can choose an optimal combination of financial instruments to finance this liability. For many years the World Bank has been recommending to governments that using different financial instruments for different layers of risk

1. <http://www.worldbank.org/en/programs/disaster-risk-financing-and-insurance-program>



Source: GFDRR and World Bank Group. Financial protection against disasters: an operational framework for disaster risk financing and insurance. World Bank, 2014

is appropriate and cost effective (Gurenko and Mahul, 2003), but there has not been rigorous evidence to support this. This analysis first provides quantitative evidence that using different financial instruments in combination is indeed the most cost-efficient way to finance disaster losses. Furthermore, the proposed framework provides a methodology for selecting the sovereign DRFI strategy which minimizes the cost of financing the average annual loss, or the strategy which minimizes the cost of financing losses at a given return period. This allows the framework to provide useful insights for decision-makers who wish to minimize average costs, or for those who wish to minimize the cost of financing a disaster of particular magnitude.

This framework and analysis will be published as a package of two academic research papers to be published through the sovereign DRFI impact appraisal project. The first will be an economic theory paper, outlining the proposed methodology and calculations; the second will be a paper highlighting case studies and practical applications of the framework for policy-makers. While the main theoretical results of the framework are provided, this policy brief mainly provides a summary of the second of the re-

search papers, and is therefore focussed on the potential policy implications of the framework and analysis.

## ► Theoretical framework

The proposed framework evaluates the cost of funding disaster losses through alternative sovereign DRFI strategies. The model is based on key assumption that a government's contingent liability to disasters is known, and this liability can be financed using a combination of the following instruments:

- Reserves, contingency funds or ex-ante budget allocation of ring-fenced funds
- Contingent credit at concessional interest rates, such as the World Bank Development Policy Loan with Catastrophe Deferred Draw-down Option (CAT DDO)
- Risk transfer such as indemnity or parametric insurance, reinsurance, and catastrophe bonds or swaps
- Post-disaster budget reallocations
- Post-disaster borrowing

Formulae are proposed for calculating the economic cost of each of these financial instruments, with the following two key results:

1. *The findings provide evidence that a tiered approach to sovereign DRFI (where different financial instruments are used for different layers of risk) is the most cost-efficient method of financing disaster losses.*
2. *It is possible to define the sovereign DRFI strategy which will minimize the long term average cost of financing disaster losses based on the calculated marginal opportunity cost of each financial instrument.*

## ► Case studies

The theoretical framework is applied to two case studies, with results calculated based on country-specific risk profiles and economic assumptions. The two countries considered are described as follows:

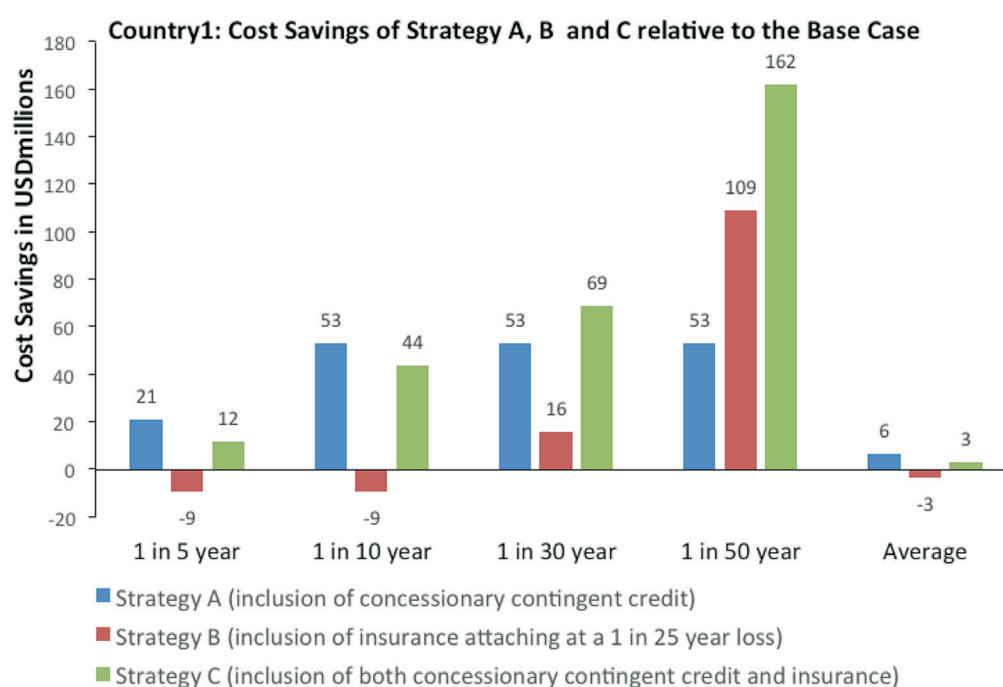
**Country 1** is a country with a large diversified economy and very high recurrent risk of disasters from both earthquakes and tropical cyclones. The country has very high borrowing capacity and does not face any delays or increased cost of borrowing in the commercial market following disaster events.

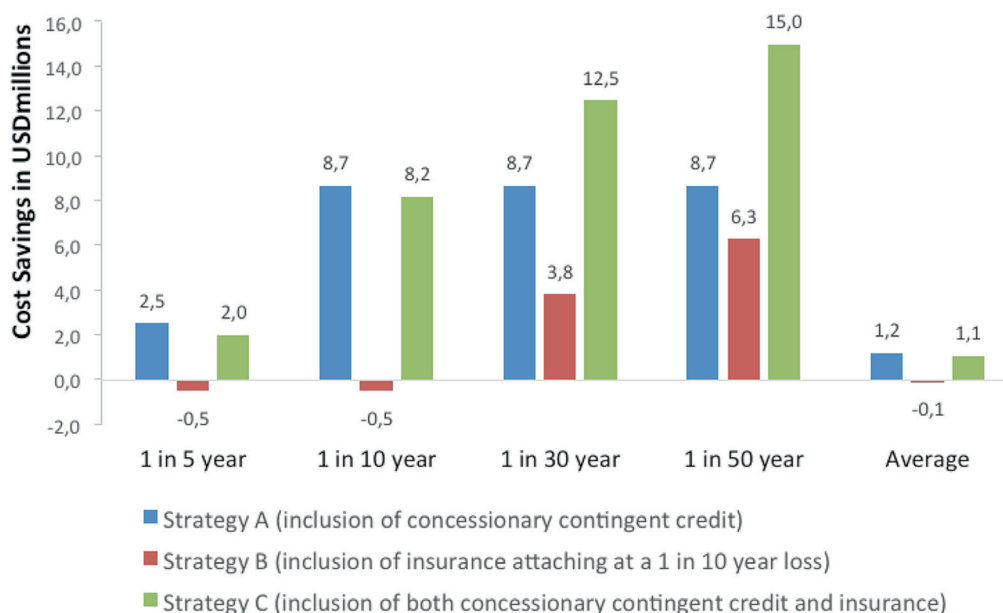
**Country 2** is a small-island country with a small service-based economy heavily reliant on tourism. The country has relatively low recurrent risk but is highly exposed to catastrophic tropical cyclone events. While the country has the ability to borrow easily in a non-disaster environment, following a disaster it is both timely

and expensive for the country to borrow in the commercial market.

In both cases we consider the current sovereign DRFI strategy which involves a mixture of reserves, post-disaster budget reallocations and emergency borrowing after the disaster event. We then consider three alternative strategies of the country utilizing a concessionary contingent credit facility from the World Bank<sup>2</sup> (Strategy A), purchasing market-based parametric insurance (Strategy B), or both (Strategy C).

2. The instrument considered here is the World Bank Development Policy Loan with Catastrophe Deferred Drawdown Option (CAT DDO). This facility is a pre-arranged line of credit that a country can draw upon in the aftermath of a natural disaster. Amounts drawn down are subject to repayment at the same (concessionary) interest rates as amounts borrowed through existing World Bank Development Policy Loans. The Cat DDO has a "soft trigger" (as opposed to a parametric trigger), where funds become available for disbursement after the declaration of a state of emergency due to a natural disaster. See here for my information: [http://treasury.worldbank.org/bdm/pdf/Handouts\\_Finance/CatDDO\\_Product\\_Note.pdf](http://treasury.worldbank.org/bdm/pdf/Handouts_Finance/CatDDO_Product_Note.pdf)



**Country 2: Cost Savings of Strategies A, B and C relative to the Base Case**

### Country 1 results

The diagram above shows that:

- Financing losses through contingent credit at concessional rates is cheaper on average. The inclusion of a concessional contingent credit facility (Strategy A) results in a saving of \$6m on average, or \$53m when funding losses more extreme than a 1-in-10 year loss.
- When insurance is considered as part of the strategy (Strategy B), we see higher costs on average (increased costs of \$3m), but the savings at extreme return periods are very significant. If a Government is concerned about financing frequent events (e.g. anything above 1 in 10 year losses) then insurance is expensive and will result in a higher cost on average. However if the government is concerned about more extreme events then insurance will be beneficial from a cost perspective.
- When both instruments are combined, we see savings range from \$3m on average to \$162m when financing a 1-in-50 year loss. If you use both concessional contingent credit and insurance together then the government re-

ceives the benefit of the concessional credit at the low return periods, and even greater savings at more extreme return periods when compared to using insurance alone. This supports the concept that a tiered DRFI strategy is the most cost effective way of financing disasters.

### Country 2 results

The diagram above shows that:

- Financing losses through contingent credit at concessional rates is again cheaper on average, resulting in a saving of \$1.2m on average, or \$8.7m when funding losses more extreme than a 1-in-10 year loss.
- Insurance also has a similar effect as in country 1, with higher costs on average (increased costs of \$0.1m), but the savings of \$6.3m for a 1-in-50 year loss. However, when we consider these savings relative to the sizes of the losses being financed we find that the effect of insurance has a greater impact for Country 2 than Country 1. Due to the high cost of borrowing faced by country 2 after a disaster, including ex-ante

instruments within the DRFI strategy results in much greater relative savings than country 1.

- When both instruments are combined, we see savings range from \$1.1m on average to \$15.0m when financing a 1-in-50 year loss. This again supports the concept that a tiered DRFI strategy is the most cost effective way of financing disasters.

The observations from both case studies are consistent with the theoretical results from the framework. In both cases a tiered strategy of different financing instruments offers the greatest savings when compared to the base case of reliance on only financing disaster losses through post-disaster borrowing. Ex-ante financing instruments lead to greater savings at higher return periods for the small-island country due to the high cost of borrowing in a post-disaster environment.

## ► Conclusion

The proposed framework looks at evaluating the cost and timing of alternative sovereign DRFI strategies, which is a key (but not the only) factor for governments to consider when setting appropriate strategies to ensure financial resilience to disasters. The results of the analysis can therefore assist in the decision-making process regarding which financial instruments are best suited to different layers of risk, although there are other considerations (such as political economy aspects) which are not captured by the analysis.

The results are intuitive and fairly robust to parameter assumptions, and are consistent across the case studies where the framework has been applied. The framework provides evidence to support the tiered approach to sovereign DRFI, and provides a methodology for selecting the strategy which minimizes the long term average cost of financing disaster losses.

A key assumption in this framework is that a government's contingent liability is known. In order to understand the full costs and benefits of different sovereign DRFI strategies this analysis must be considered in the context of other components of the sovereign DRFI Impact Appraisal Project where this assumption is relaxed.



## ► References

- **Benson, C.** and **E. Clay.** 2004. *Understanding the Economic and Financial Impacts of Natural Disasters.* World Bank.
- **Bevan, D.** and **S. Cook.** 2014. "Public expenditure following disasters". SDRFI Impact Appraisal Project.
- **Clarke, D.** and **R. Hill.** 2013. "Cost-benefit analysis of the African risk capacity facility. Technical Report" 1292, *International Food Policy Research Institute.*
- **Clarke, D.** and **O. Mahul.** 2011. "Disaster Risk Financing and Contingent Credit: A Dynamic Analysis." *World Bank Policy Research Working Paper* 5693.
- **Clarke, D.** and **R. Poulter.** 2014. "A methodology for calculating the opportunity cost of layered sovereign DRFI strategies." *SDRFI Impact Appraisal Project.*
- **Dana, J.** and **S. von Dahlen.** 2014. "An overview of potential pathways to appraising impact of sovereign DRFI: Where should we be looking to assess benefits?" *SDRFI Impact Appraisal Project.*
- **de Janvry, A.** 2014. "Quantifying through ex-post assessments the micro-level impacts of sovereign disaster risk financing and insurance programs." *SDRFI Impact Appraisal Project.*
- **Freeman, P., L. Martin, R. Mechler,** and **K. Warner.** 2002. "Catastrophes and development integrating natural catastrophes into development planning." *Technical report, World Bank.*
- **GFDRR and World Bank Group.** 2014. *Financial protection against disasters: an operational framework for disaster risk financing and insurance.* World Bank.
- **Goes, A.** and **J. Skees.** 2003. "Financing natural disaster risk using charity contributions and ex ante index insurance." American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association), 2003 Annual meeting, July 27-30, Montreal, Canada.
- **Gurenko, E.** and **O. Mahul.** 2003. "Combining insurance, contingent debt and self-retention an optimal corporate risk financing strategy." *World Bank Working Paper* 3167.
- **Grenham, D.** 2014. "Actuarial approaches to assumption setting." *SDRFI Impact Appraisal Project.*
- **Grenham, D.** and **N. Foster.** 2014. "Review, challenge and use of impact appraisals by decision makers." *SDRFI Impact Appraisal Project.*
- **Hallegatte, S.** 2014. "The indirect cost of natural disasters and an economic definition of macroeconomic resilience." *SDRFI Impact Appraisal Project.*
- **Hinds, R.** 2013. "Sovereign insurance and risk finance schemes for disaster management." *Technical Report 903, GSDRC University of Birmingham.*
- **Linnerooth-Bayer, J.** and **R. Mechler.** 2007. "Disaster safety nets for developing countries: Extending public-private partnerships." *Environmental Hazards*, 7:54–61.
- **Teh, T.** 2015. "Sovereign disaster risk financing and insurance (SDRFI) impact appraisal." *SDRFI Impact Appraisal Project.*



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### **Contact**

[www.ferdi.fr](http://www.ferdi.fr)

[contact@ferdi.fr](mailto:contact@ferdi.fr)

+33 (0)4 73 17 75 30

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