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FINANCE, COMPETITIVENESS AND INNOVATION AND
MACROECONOMICS, TRADE AND INVESTMENT

EQUITABLE GROWTH, FINANCE & INSTITUTIONS INSIGHT

The Impacts of Disaster Risk on Sovereign Asset and Liability Management

August 31, 2021



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Statement on COVID-19

This report does not cover the impacts of COVID-19 on sovereign asset management and liabilities. However, some of the analysis of the challenges involved in identifying natural disaster-related impacts on sovereign asset management and liabilities will apply to the current situation—and indeed to any situation where governments seek to prepare for and respond to crises while facing declines in revenue and higher-than-expected expenditures.



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Abbreviations

ALM	Asset Liability Management
ARCC	Authority for the Reconstruction with Changes (Peru)
CERA	Canterbury Earthquake Recovery Authority
CERF	Canterbury Earthquake Recovery Fund
DRFI	Disaster Risk Financing and Insurance
DSGE	Dynamic Stochastic General Equilibrium
EQC	Earthquake Commission (New Zealand)
FEF	Stabilization Fund (Peru)
GDP	Gross Domestic Product
GIMF	Global Integrated Monetary and Fiscal Model
GST	Goods and Services Tax
IMF	International Monetary Fund
LTGM	Long-Term Growth Model
MEF	Ministry Of Economy and Finance (Peru)
MFMod	Macro-Fiscal Model
NDF	Natural Disaster Fund (New Zealand)
OCR	Official Cash Rate
SALM	Sovereign Asset and Liability Management
SOE	State-Owned Enterprise



Executive Summary

Implicit contingent liabilities, such as those generated by natural disasters, are often not quantified in the government balance sheet. However, when they materialize, they place pressure on government finances that may raise interest expenditures and financial risks. Understanding the impacts of disaster risk on sovereign assets and liabilities plays a key part in understanding the potential impact of sovereign disaster risk finance strategies which allow governments to reduce the costs and risks of disasters using prearranged financing and insurance methods.

Applying the Sovereign Asset and Liability Management (SALM) framework is a new and comprehensive way of looking at the potential impact of a disaster on the public sector balance sheet through assets and liabilities. Its implementation can help build key practical recommendations for understanding risk in its multiple dimensions (economic, fiscal, and financial).

This paper introduces a framework that identifies three channels through which natural disaster will impact SALM; (i) the impact on the value of public sector assets and liabilities e.g. depreciation in asset value due to direct damage incurred or changes in the market variables that increase the cost of debt; (ii) direct fiscal costs that are the actual costs incurred as a result of the disaster such as the cost to rebuild infrastructure, and triggering of contingent liabilities, such as loan guarantees to state-owned enterprises (SOEs); and (iii) indirect fiscal costs, such as the impact on government revenue and (non-disaster) expenditure, which arise from the disaster's impact on the national economy. This framework is applied in three case studies, Peru, Serbia and New Zealand to derive lessons about the potential impact of natural disasters on the sovereign balance sheet and highlight the importance of accounting for disaster impacts across public sector balance sheets.

Estimating the impact of a disaster on public assets and liabilities is skewed by the fact that the reconstruction is viewed as an investment, as such loss to net worth will occur only if the asset is completely destroyed. However, accrual accounting with a public sector balance sheet provides higher-quality information about the value of government assets that are susceptible to disaster risk and as such can be used to develop and implement disaster risk finance policies.

In practice, it can be difficult to identify the total direct cost of a disaster with any precision.

The Peru, Serbia, and New Zealand cases demonstrated that reconstruction can last for many years; there might be reallocation within existing budget baselines that is difficult to track, and replacement assets might be of a higher standard. Still, the establishment of specific institutions to oversee the response in Peru and New Zealand made it easier to track expenditure than otherwise would have been the case.

Assessing the indirect fiscal costs resulting from disasters is specific to each case depending on various factors, such as the relative size of the local economy that is impacted, damage to critical infrastructure, nature of supply chains, sector interdependencies, substitution, and other resilience measures. In the New Zealand case, the lack of national economic impact surprised most observers, but was at least partly attributed to minimal damage to agriculture, manufacturing, and transport.

The case studies demonstrate that estimating the potential impact of disasters on the national economy and the sovereign balance sheet is complex requiring significant data and modeling. However, they demonstrate that viable mechanisms to assist timely post disaster response and reconstruction can have very high payoffs, especially when assisted by an appropriate SALM framework, moreover, that the lack of these may be very costly.

Reserve funds were found to mitigate the need to borrow after the event, as demonstrated by both the Peru and New Zealand cases. In the case of New Zealand, the Natural Disaster Fund, in essence the capital of a government-run insurance scheme for households, covers the first tier of losses for most natural disasters. In Peru, the Stabilization Fund may be accessed to finance severe economic and disaster shocks.

Reinsurance can play a major role in reducing the economic impact of disaster. The New Zealand case study included the use of the global reinsurance market, both by the government scheme and private sector insurers; it showed that claims on foreign reinsurers improved the net international investment position of New Zealand by around eight percentage points of GDP. Without this, the government would have been required to borrow more, as the NDF was exhausted (for the first time in 70 years).

The application of SALM can increase countries' resilience to financial shocks posed by disaster risk through improved understanding of the impacts of disaster risk on both sides of the sovereign balance sheet. Going forward it could even be used to define a country's risk tolerance to disaster risk, monitor changes in this position and help to inform policy design on disaster risk and where needed support the introduction of financial instruments to manage disaster risk.



>>> Introduction

When sovereign disaster risk financing and insurance (DRFI) is limited or absent, governments act as insurer of last resort, and as such carry much of the financial burden of natural disasters. Consequently, the impacts posed by disaster risk can result in fiscal pressure which suggests that disasters could, and perhaps should, be considered contingent liabilities. In the event of a disaster, governments tend to rely on increased borrowing, increased taxation, or—most likely—budget reallocation, in which budgeted lines of public spending are reduced to release resources for the unbudgeted post-disaster categories that need to be increased. There is a growing body of literature on the need for pre-arranged finance to help manage these unforeseen expenditures, but there is a sizeable gap on the public financial management issues associated with this. By applying the Sovereign Asset and Liabilities Management (SALM) approach a new and comprehensive way of looking at the impacts of disasters on public assets and liabilities is presented. This can serve as a useful tool to design disaster risk finance policies to help create additional fiscal space when needed.

It is useful at the outset of this paper to distinguish between the impacts of natural disasters and climate change on government balance sheets. Natural disasters are probabilistic events, the risk of which can be transferred to insurance markets. For governments, natural disasters represent a fiscal risk or shock. By contrast, the impacts of climate change occur gradually over longer time periods. From a fiscal standpoint, climate change leads to fiscal pressure, as opposed to shocks, though it may increase the frequency or severity of shocks. This paper focuses on the problems posed by disaster shocks, setting aside the trend problems posed by climate change.

Implicit contingent liabilities, such as those generated by natural disasters, are often not quantified in the government balance sheet. However, when they materialize, they place pressure on government finances that may raise interest expenditures and financial risks. Understanding the impacts of disaster risk on sovereign assets and liabilities plays a key part in understanding



Peruvian seniors knitting
Image by kolibri5 from Pixabay

the potential impact of sovereign DRFI strategies which can allow governments to reduce the costs of disasters using prearranged financing and insurance methods. When governments understand the impacts from natural disasters including the increased risks posed by climate change, for example, they can link their debt and cash management strategies with their DRFI strategy by taking into account the country's risk profile.

When the impacts of disasters on balance sheets is unknown it is difficult to approach disaster risk comprehensively and to make adequate financial decisions on how to protect and restore public assets with finite public funds. Traditionally, many governments have treated the management of their assets and liabilities separately, usually with separate institutional responsibilities for different classes of assets and for different classes of liabilities. Taking no account of net positions, this approach can lead to inefficient management of risk and inefficient implementation of policy more generally.

The main objective of the SALM approach is to develop a comprehensive public sector balance sheet, and to use this to develop a coordinated management strategy that reflects government's various objectives.¹ An example of how this issue might be tackled is offered by Amante et al. (2019); they provide an overview of the strategic, operational, and institutional challenges involved, using Uruguay as an illustration.

In practice, even when governments set out to implement SALM, it has proved to be challenging, and the implementation has usually been partial in nature. It is often restricted to financial assets and liabilities and does not include physical assets (such as infrastructure) or the government's future revenue-generating capabilities.

In many applications, this has not been too problematic, since the risks under review - interest rate risk or exchange rate risk, for example - have no impact on physical assets and only muted ones on revenue capability. For natural disasters, however, the case is quite different. Hence extending SALM to incorporate natural disasters is likely to be even more challenging conceptually, in terms of both data requirements and modeling approaches.²

This paper will serve to build the body of evidence on the impacts of disaster risk on SALM and, in turn, support countries' efforts to mitigate the impact and occurrence of fiscal shocks. It seeks to increase countries' resilience to financial shocks from disaster risk through improved understanding of the impacts of disaster risk on both sides of the sovereign balance sheet. Going forward it could even be used to define a country's risk tolerance to disaster risk, monitor changes in this position and help to inform policy design on disaster risk. However, it should be noted that the application of SALM takes time and, dependent upon the existing accounting procedures in a country, it can take significant resources.

1. For an extended discussion, see for example Das et al. (2012) and IMF (2018a).

2. While this paper includes consideration of some very elaborate formal models, the terms "model" and "modeling" are taken to include any systematic framework for thinking through the problem at hand, including informal ones.



Public sector balance sheets and SALM

There has been growing awareness that the analysis of public sector (sovereign) balance sheets provides a valuable tool to improve the implementation of fiscal policy and management of public sector assets. For example, the International Monetary Fund (IMF 2018a) notes that standard fiscal analysis misses much government activity by focusing on flows—revenue, expenditure, and deficits—and debt. Furthermore, it can encourage illusory fiscal practices, such as establishing pay-as-you-go pension schemes for public employees, which may improve fiscal balance outcomes in the short run, but lead to an expanding liability that is not recognized in traditional fiscal measures.

An approach that takes account of the full public sector balance sheet can improve outcomes in a number of ways. First, by revealing the full extent of public sector assets, it shines a light on how effectively these are being managed. And they are large: an IMF (2018a) analysis of 31 countries covering 61 percent of the global economy estimates they are worth US\$101 trillion, or 219 percent of gross domestic product (GDP) in the sample. Even modest improvements in the return on these assets could yield significant fiscal benefits.

A second improvement to outcomes involves improved fiscal policy making. The balance sheet approach supports a more thorough and systematic evaluation of the impact of policies on public finances, recognizing the effects on both assets and liabilities in the long run. For example, cutting back on expenditure for maintenance and investment in building and infrastructure may reduce debt, but would also cause the value of assets to decline due to depreciation. This decline signals that higher expenditure lies in the future, if services are to be maintained.

The overall strength of a balance sheet, i.e., the level of net worth, can also support fiscal decision making. Research has shown that countries with stronger public sector balance sheets experience shallower recessions and recover faster from economic downturns (Yousefi 2019). This can be explained by there being more room for countercyclical fiscal policy when net worth is high than when it is low or negative. The third improvement is in the identification and management of financial and other risks. Examining both sides of the public sector balance sheet—which is a consolidation of central government and other entities—may reveal mismatches. Or it may show natural hedges across assets and liabilities in separate entities, reducing the need for risk management at the level of an individual entity. An example of a natural hedge would be where the public sector has foreign currency debt and foreign currency financial assets; the exposure to changes in exchange rates would be the net value of these positions. The currency mix of these assets and liabilities can be adjusted to minimize the exposure to individual foreign currencies.

Activity in this third area entails a SALM approach, which is based on the asset liability management (ALM) approach undertaken in the private sector, in particular by financial institutions, with the goal of maximizing return subject to an acceptable level of financial risk (such as currency, interest rate, and liquidity risks). The application of ALM to the public sector balance sheets has been a fairly recent development, perhaps reflecting the lack of information in most countries about the assets and liabilities that make up their balance sheet. The New Zealand government was an early adopter of SALM, as it published its first balance sheet in 1991 and applied ALM principles during the 1990s to guide the composition of public debt (Anderson 1999).

In applying the ALM approach to public sector balance sheets, SALM needs to reflect the unique nature of governments. The strength of a government's balance sheet (and indeed the government's creditworthiness) arises from the sovereign power to tax residents and citizens. At the same time, a significant share of public sector assets does not directly produce revenue, for example national parks, cultural assets,

and military equipment. This observation has led some authors and practitioners to include the present value of government expenditure and revenues in SALM. Das et al. (2012), in a review of the conceptual issues, note analysis that uses this broader definition of a balance sheet to shed light on economic policy, such as the smoothing of fiscal balances or tax rates over time.³ This blending of accounting and economic concepts has been dubbed the “intertemporal” balance sheet (IMF 2018a), or the “comprehensive” balance sheet (New Zealand Treasury 2018).⁴

In practice, the application of SALM has been to subsets of public sector assets and liabilities that are financial in nature and of material size, such as public debt, foreign currency reserves, and other financial asset portfolios. Amante et al. (2019) describe four situations, each with a number of country examples: (i) coordinated management of foreign currency reserves and foreign currency debt; (ii) management of asset levels to provide a buffer against adverse market conditions; (iii) transactions between the central bank and government that strengthen policy outcomes, reduce cost, and reduce risk; and (iv) analysis of the variables that drive government revenues and the fiscal balance to inform decisions about the composition of public debt. In addition, IMF (2018a) provides examples of using the balance sheet framework to conduct stress tests of fiscal sustainability.

One practical constraint in implementing SALM may be a lack of information. Unlike advanced economies (e.g., New Zealand, Australia, the United States, Canada), developing countries in general do not produce comprehensive balance sheets, which would require them to consolidate individual balance sheets of various public institutions. Many countries lack a complete inventory of nonfinancial assets. Furthermore, consistent pricing of financial and nonfinancial assets is complicated, since different accounting principles, accrual based or cash based budgeting, may be used (See Box 1 for more information). Producing a balance sheet based on accrual accounting is important to ensure that policy makers can assess and monitor effectively the mismatches between stocks of assets and liabilities.

3. For example, Barro (1995) notes that the structure of public debt matters for tax rate smoothing.

4. The New Zealand Treasury notes that the government's financial statements are compiled according to the rules of generally accepted accounting principles (GAAP). In order to analyze prospects for long-term fiscal policy and the impact of shocks, this is combined with the “fiscal balance sheet” to produce a “comprehensive balance sheet.”

Box 1: Key Differences in Cash Based and Accrual Accounting Systems

While accrual accounting has been the norm among private corporations, most governments (around 60% (Cavanagh et al 2017)) still prepare their budgets and report their accounts on a pure cash basis. The development of accrual based international standards for government fiscal and financial reporting including Government Finance Statistics Manual (GFSM) and International Public Sector Accounting Standards (IPSAS) has helped the recent spread of accrual accounting in the public sector.

Cash-based budgeting system records receipts and outlays at the same time cash is received or paid, without regard to when the activity generating the revenue, consuming the resources, or increasing the liability occurs.

Accrual-based budgeting system records transactions in the period when the activity generating the revenue, increasing the liability, or consuming the resources occurs – regardless of when the associated cash is actually paid or received.

Governments that follow cash accounting tend not to maintain comprehensive and up-to-date records of the value of their assets and liabilities. Producing a balance sheet based on accrual accounting enables policy makers to effectively assess and monitor the mismatches between stocks of assets

and liabilities. There are also institutional and policy complexities in implementing SALM, as the public sector balance sheet is managed by separate entities to deliver a range of policy outcomes. Further, some of these entities have constitutional, statutory, or policy independence. For example, the assets and liabilities of a central bank accumulate in order to implement monetary policy and other objectives; often central banks are granted independence to pursue these. The governance of publicly managed financial asset portfolios (such as sovereign wealth funds, pension funds, and insurance companies) tend to emphasize granting boards and fund managers independence to pursue agreed objectives. This arrangement is designed to address historic under performance, for example from a lack of contestability, imposition of noncommercial objectives, and political interference in asset allocation. However, most countries include state-owned enterprises in the sovereign balance sheet, but only a minority also consider central banks, in some cases only international reserves and sovereign funds

and liabilities. The government's objectives of moving to accrual accounting can include strengthening monitoring and control of expenditure arrears, getting a clearer picture of the fiscal position of public entities outside the central government budget, or gaining a better understanding of the long-term sustainability of the public finance.

The implementation of accrual accounting is about much more than adopting new standards and principles. The biggest challenge is implementing them, which requires the collection of additional data, reforms to business processes, modernization of IT systems, and capacity building, both within and outside of the government. This takes significant time and at times, money. Many countries have taken more than ten years to implement an accrual-based system. The cost depends on different factors such as starting point, scope, and speed of the transition. Developing and low-income countries are likely to face higher implementation costs due to the greater need for capacity and IT systems.

Accrual accounting and a public sector balance sheet provide higher-quality information about the value of government assets that are at risk of damage from climate and disaster versus a cash accounting. Accrual based budgeting system enables financial steering using the SALM approach. Countries with cash accounting and no complete data set on government assets, face challenges in adopting and implementing the SALM approach. Countries that are only starting to consider SALM should start with simple analysis like monetary policy and debt analysis.

(World Bank, 2018). In the cases where a SALM framework is implemented, there are significant differences across countries. A survey of 28 countries found that the objective of countries who have developed a SALM framework is often limited to monitoring sovereign assets and liabilities rather than determining mismatches between them.

In this context, Amante et al. (2019) state that SALM can be carried out only through negotiation between central government and other entities, and may require a “meeting of minds” to pursue outcomes that are beneficial at the level of the entire public sector balance sheet. Accordingly, they define the objective of SALM as “to improve the efficiency of policy implementation in terms of reducing risk and/or cost, consistent with the objectives and policy frameworks of monetary and fiscal policies, conventional public debt management, state-owned enterprises (SOEs), and publicly managed financial-asset portfolios”.



How natural disasters impact sovereign balance sheets

A natural disaster will impact the public sector balance sheet through three channels:

1. Impact on the value of public sector assets and liabilities. For example:

- Loss of or damage to publicly owned infrastructure and buildings. For this loss or damage to be recognized, the value of these assets prior to the disaster needs to have been recorded. (The valuations would reflect the age and condition of the assets—i.e., they would be depreciated accordingly.)
- Changes in market variables (such as exchange rates and interest rates)—for example, an increase in the value of foreign currency public debt if the disaster triggers exchange rate depreciation.

2. Direct fiscal costs. These are the actual costs incurred as a result of the disaster. Examples include disaster relief and other financial support to citizens, cost to rebuild infrastructure, and triggering of contingent liabilities, such as loan guarantees to state-owned enterprises (SOEs) or subnational governments that are badly impacted by the disaster. The impact on the balance sheet will depend on the nature of the expenditure. Capital expenditure results in the creation of an asset, which increases net worth; if such expenditure is funded by debt, then the impact on net worth is neutral (the value of the debt and the new asset are equal initially). Operating expenses related to the disaster, such as grants and other assistance, would result in more borrowing than otherwise would have been the case, thereby decreasing net worth.

3. Indirect fiscal costs. These are the costs incurred by the disaster's impact on government revenue and (non-disaster) expenditure, which arise from the disaster's impact on the national economy.

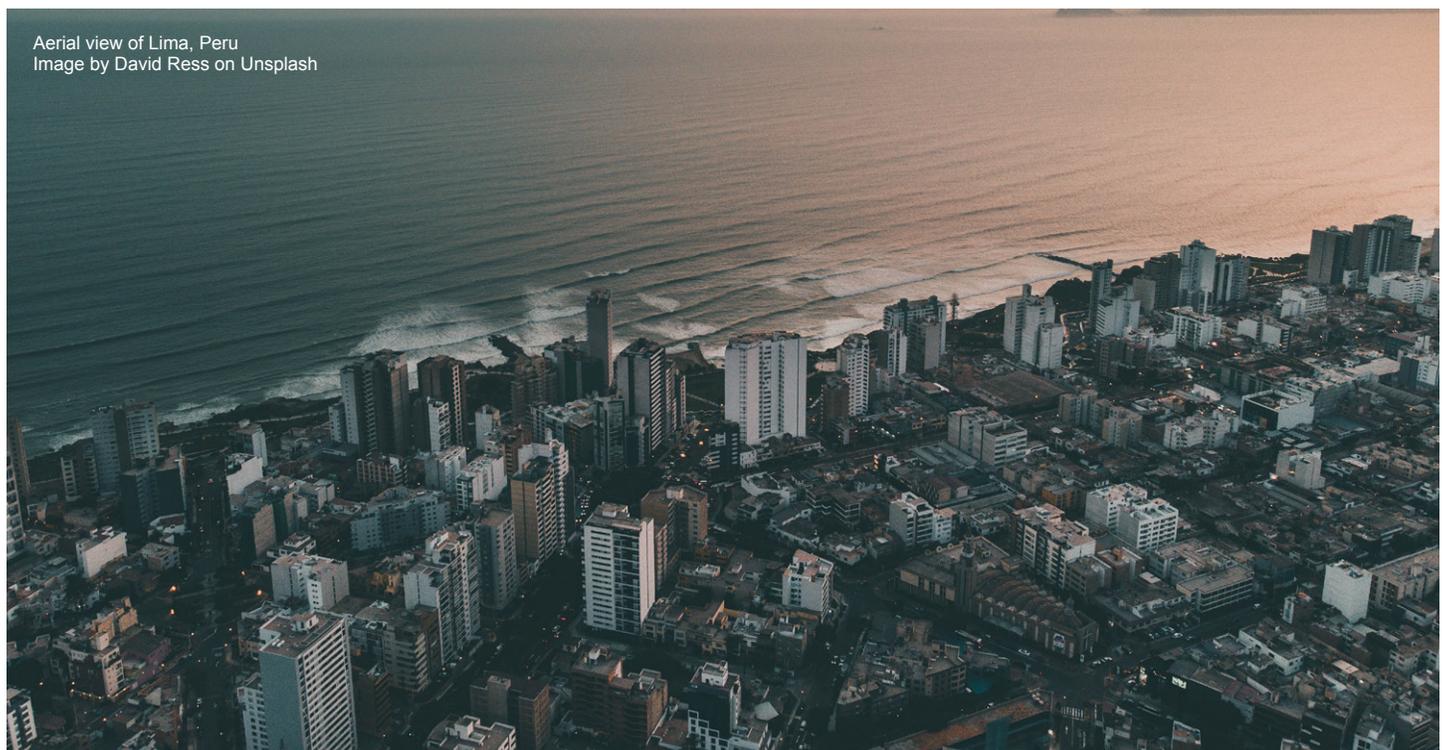
Figure 1 provides a summary of these impacts on the public sector balance sheet, as well as the analysis that is required to estimate the size of them. The availability of data on disaster risks and the assets exposed to perils will be a challenge in many countries. In particular, there will be a need for data on public sector assets, including infrastructure. Estimating the economic impact of disasters, and therefore the indirect fiscal costs, is also challenging.⁵

The impact on SALM could arise through rapid depletion of Government contingency funds and cash balances, increasing the liquidity risk faced by central government.

Additional borrowing by the government may be required

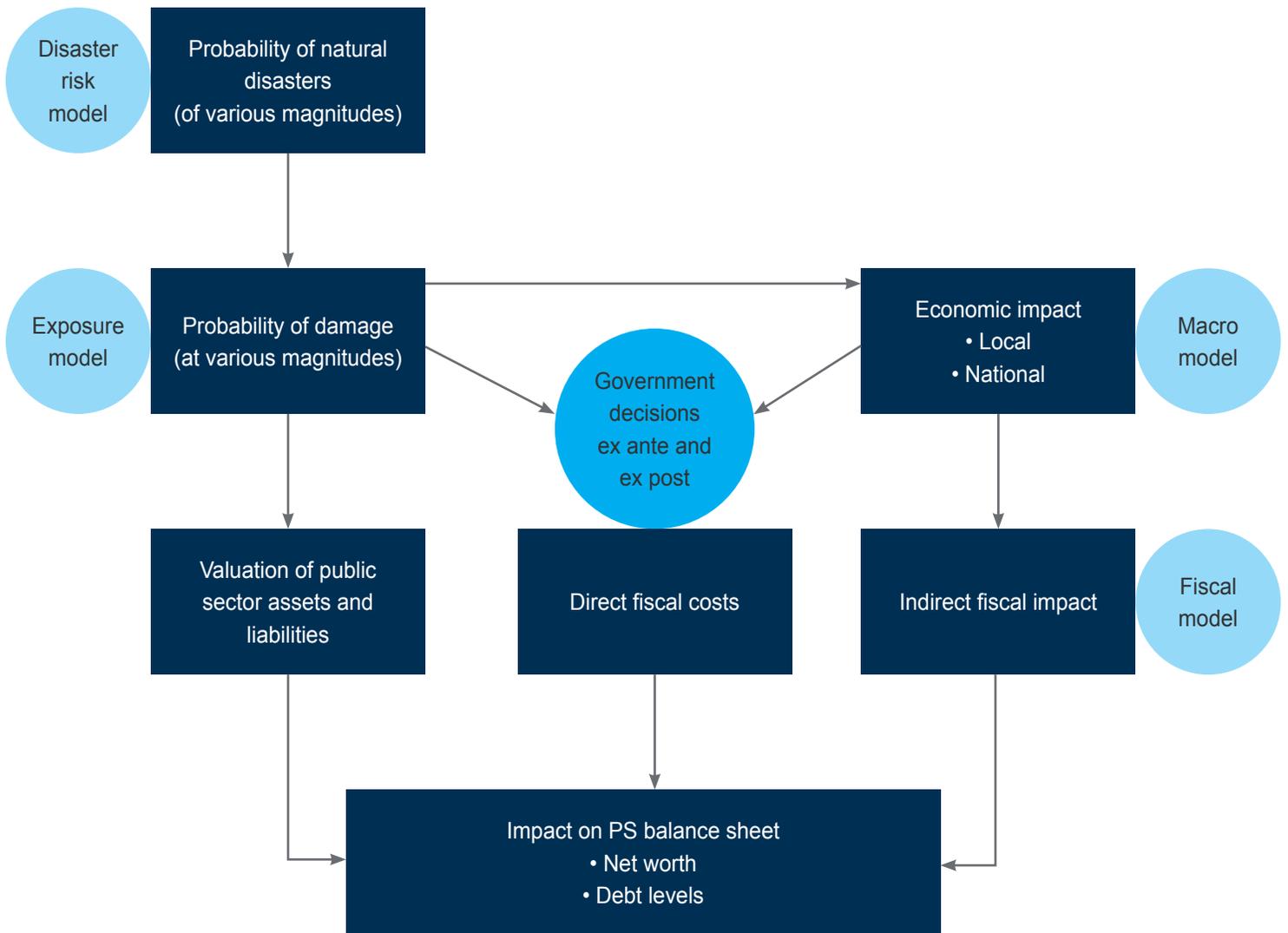
to meet the fiscal costs that cannot be fully financed in the local market, meaning that the government is forced to borrow externally. This may lead to increased currency risk in the debt portfolio, and interest rate risks in case debt is contracted at variable rates. In addition, a government that is limited to short-term borrowing from local markets would see increased refinancing risks.

The magnitude of these impacts can be mitigated by measures taken by the government before disaster strikes, and as a result many Ministries of Finance now view financial resilience as a core component of macro-fiscal policy. This formed a key discussion during the G20 Finance Ministers' and Central Bank Governors' Meeting in 2019. The discussion highlighted that a growing number of countries are developing financial protection strategies leveraging different financial instruments (such as contingency funds and risk transfer mechanisms such as catastrophe risk insurance, catastrophe bonds etc.) to secure timely and efficient access to funds for governments to respond to shocks (World Bank, 2019). More generally, the availability of "fiscal space" through prudent debt levels, as well as careful management of risks in the debt portfolio, can provide a buffer for natural disasters as well as other shocks.



5. Wouter Botzen, Deschenes, and Sanders (2019) provide a useful stock take of models and empirical studies and note shortfalls in existing approaches, particularly in relation to geographical and spatial detail.

FIGURE 1 - Framework for impacts of disasters on the public sector balance sheet



Source: World Bank
Note: PS = Public Sector



Current state of knowledge on the impact of natural disasters on public finances

There is a vast literature on the financial impacts of natural disasters and on SALM, although there is limited information on the interrelationships of the two. This section presents a sample of the empirical literature that addresses considerations of balance sheet management following a natural disaster and the impacts on the broader macro-fiscal context.

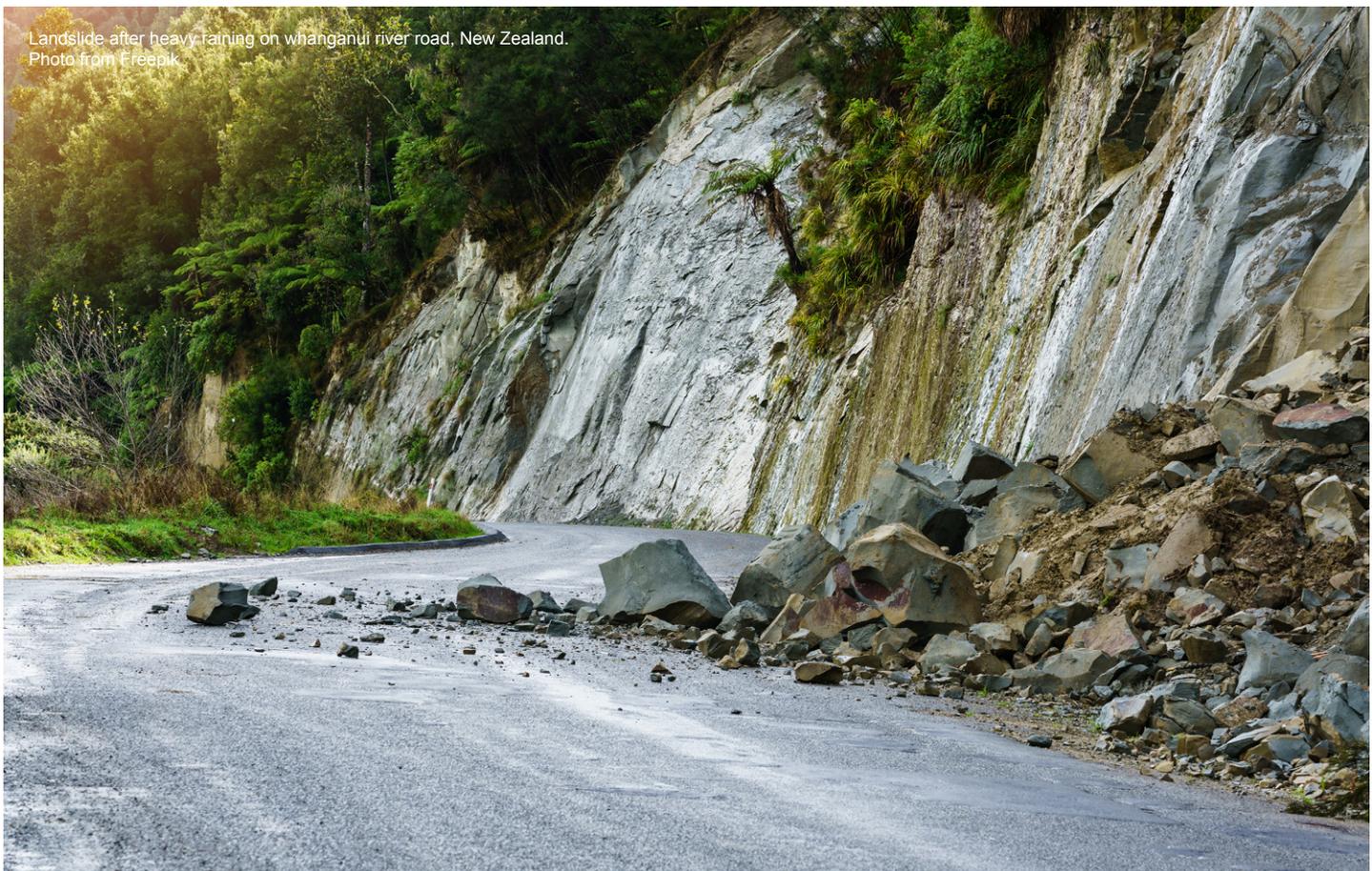
In the past, the idea of any relationship between macro-fiscal risk and disaster risk was often dismissed. However, with the emergence of sustainable finance, the literature on these links is increasing. Feyen et al. (2020) discuss the implications of disaster risk posed by climate change for balance sheet and macro-financial management. They find that the two forms of risk may be correlated, so that many countries face a form of “double jeopardy.” Further, the current COVID-19 pandemic serves to demonstrate that countries may face a triple shock—to health, economic, and financial risk; disasters will further compound this risk. Two studies published by the World Bank go further, examining how resilience might be increased by appropriate fiscal policy (Forni, Catalano, and Pezzolla 2019) and how the fiscal risks associated with natural disasters might be managed (Schuler et al. 2019). These studies show that early, preventive action to address disaster risk—for example, ensuring that public spending in risk reduction (or adaptation) is complemented with public debt reduction, or the accumulation of savings in a reserve fund—is always superior to late, remedial action. Investing in adaptation increases the resilience of the capital stock, while containing or reducing the debt burden improves financial sustainability and eases future borrowing constraints.

In trying to build an understanding of natural disasters' impact on public expenditures, and how this impact might be valued, Bevan and Cook (2015) make some suggestions toward developing an operational framework to address these issues, while stressing that the available evidence is extremely incomplete. They also provide a demonstration of the problems with the Cobb-Douglas assumption and show that outcomes may be very different if the assumption of complementarity between public and private capital is made instead. To identify the budgetary savings required to create fiscal buffers for self-insurance, Nishizawa, Roger, and Zhang (2019) use estimates of revenue loss and increased spending pressures from disasters combined with information on frequency; they find an average annual fiscal cost of 1–1.5 percent of GDP for an event that occurs approximately every 14 years. This cost would then need to be financed by the budget and additional financial instruments, including external borrowing, to meet the associated costs of the disaster.

Many governments have moved toward proactive risk management and seek to prearrange financial instruments so that finance can be released immediately after a disaster. IMF (2019 a), which examines ways of building resilience to large natural disasters, proposes a three-pillar strategy emphasizing in turn structural, financial, and post-disaster resilience, and

then goes on to outline a framework for coordinated action. Clarke et al. (2016) take this one step further and propose a framework to help governments choose between different financial instruments, or combinations of instruments, to fund disaster losses in an efficient way. They favor a tiered approach, with different instruments being utilized in sequence as shocks increase in severity. When combining instruments, prearranged financing is key, whether this finance is domestic or from the international donor community. Both Cantelmo, Melina, and Papageorgiou (2019) and Marto, Papageorgiou, and Kluyev (2018) find that it is more cost-effective for donors to contribute to the financing of resilience before a disaster than to disburse aid afterward. They also find, however, that welfare gains to countries that self-finance investments in resilient public infrastructure are negligible, and international aid must be sizable to alter this.

The concept of public balance sheet strength was introduced by Yousefi (2019), whose empirical work suggests that financial markets take into account government assets and net worth in addition to their liabilities when pricing sovereign bonds. Moreover, given that countries with a strong balance sheet recover faster in the aftermath of shocks, they have incentives to improve their financial resilience in addition to their handling of SALM.





Preparedness: What countries can do to understand the potential impact of natural disasters on the sovereign balance sheet

The previous section provided a brief summary of the literature on the impact of natural disasters on public finances, based mostly on empirical analysis. But how can a country obtain an understanding of the potential impact of natural disasters on its economy and public finances, given that each has a unique risk profile? This section canvases the issues relevant to this question, in particular the alternatives for modeling and stress testing and the challenges that arise from lack of data.

Modeling issues

It is clear that natural disasters have impacts on the real economy and have fiscal and financing implications. To examine these thoroughly would require a pretty comprehensive modeling approach, or more plausibly several complementary approaches. The reason for the latter is that different aspects of the analysis require quite varied features, including a disaggregated model of the real economy, capable of addressing structural issues as well as fiscal interactions with these; a model capable of tracking financial links with the macro economy; and a model capable of addressing public and private responses, ex ante and ex post, to a set of surprises and other matters requiring revision of expectations in a stochastic world. The economics profession simply has not developed an integrated model capable of handling all this; it will not do so any time soon, and perhaps should not attempt to do so.

The current study does not aim to develop purpose-designed models, so it will have to use what is currently available, from two sources. The first is whatever set of models is currently being utilized in a case study country. This may include computable general equilibrium (CGE) models utilizing input-output information and social accounting matrixes, econometric models, and dynamic stochastic general equilibrium (DSGE) models, among others. These models are usually located in different institutions (for the above trio, typically in academic institutions, the ministry of finance, and the central bank respectively); accessing the full set may therefore be complicated. The other source involves adaptation of one or more of the “generic” models that have been developed by international agencies, suitably adapted and calibrated to the country in question. Both the World Bank and the IMF have developed generic models that can be adapted in this way. They have both strengths and weaknesses and are also complex; only the briefest descriptions are provided here.

World Bank models

There are two World Bank models of interest in the current context, the Macro-Fiscal Model (MFMod) and the Long-Term Growth Model (LTGM).⁶

MFMod consists of individual country models for (currently) 181 countries, which are used by the World Bank’s country economists to generate forecasts and simulate various policies. The models share a similar structure and functional form, but with parameters estimated at the country level. The approach is to estimate a structural econometric model of the type that was popular up to a quarter of a century ago, then fell out of favor, and is now making something of a comeback. The estimation follows an error correction approach. There are at least two potential problems in the present context. The first concerns how well suited this history-based approach is to studying the impact of rare shocks and future stochastic change. The second concerns the underlying Cobb-Douglas production function, which may underestimate the consequences of damage to capital, and the difficulty of structural change.

MFMod is being extended to compare the economic impact of different policy options for building fiscal resilience to hurricanes in Caribbean countries. The model assumes a shock to productive capital and abstracts from other forms of economic disruption. It compares four types of prior management options: adapting toward more resilient capital,

using insurance, building a domestic contingency fund, and drawing down pre-shock indebtedness. The dynamics of GDP, potential GDP, consumption, and debt are examined, and welfare conclusions are drawn. The results of this exercise are still preliminary and are currently being discussed within the World Bank (World Bank, forthcoming).

Addressing disaster risk involves a long horizon, and recovery from a major natural disaster may also be protracted, which makes it sensible to utilize some form of growth model. One option is the LTGM, which is an Excel-based tool based on the Solow-Swan model that seeks to provide an accessible way of studying the relation between investment, savings, and growth. The extended version, LTGM-PC, differentiates private and public capital rather than treating them as perfect substitutes. The treatment of public capital is quite sophisticated, allowing for a degree of congestibility as well as inefficiency. While the model was designed to examine the consequences of different investment paths, it could equally well be used to study capital losses from natural disasters and subsequent recovery and rehabilitation; however, while there are two capital stocks in addition to effective labor, the specification of production is again Cobb-Douglas.

In addition to these economic models, the World Bank has also been involved in developing an extended nonlinear certainty equivalent approximation method (ENLCEQ), which can handle large-scale dynamic stochastic problems by repeated iteration.⁷ One limitation is that the approach cannot handle Epstein-Zin preferences where risk aversion and the intertemporal elasticity of substitution are separated.

IMF models

The IMF has a wide range of models. These are typically DSGE models, with the dynamics largely driven by consumers with perfect foresight or, in the stochastic case, rational expectations. In the present context, three may be particularly relevant.

The Global Integrated Monetary and Fiscal Model (GIMF) has an overlapping generation (OLG) modeling of the household sector, with some households being credit-constrained or otherwise hand-to-mouth consumers. These features mean that the model has non-Ricardian properties and so can be used to study fiscal policies, from the perspective of either short-run stimulus or long-run sustainability; and this has been done in a number of country studies (Kumhof et al. 2010).

6. For the former, see Burns et al. (2019); and Burns and Jooste (2019). For the latter, see Pennings (2018), and for a version extended to cover public capital (LTGM-PC), see Devadas and Pennings (2018).

7. Cai et al. (2020) illustrate this with an application to natural resource allocation, but the model could be applied to macro-fiscal management of natural disasters and climate change.

Tractable aggregate consumption optimality conditions exist only for perfect foresight or, in the stochastic case, first-order approximations. The GIMF uses a variety of constant elasticity of substitution (CES) production relations, so there is no reliance on the Cobb-Douglas form. One oddity is that, while private agents (firms and some households) are capable of highly sophisticated intertemporal optimization, the government itself follows relatively simple fiscal and monetary rules.

Because of the complexity of GIMF, a simpler version, the Flexible System of Global Models (FSGM), has been introduced (Andrle et al. 2015). This also derives private consumption and investment from micro-foundations, but includes other relations (for example, those involving trade, labor supply, and inflation) that have reduced form representations. The properties of the model are displayed under a wide range of experiments, including monetary, financial, demand, supply, fiscal, and international shocks.

The IMF has also been exploring a sequence of models attempting to address debt sustainability in a more comprehensive way; see Zanna et al. (2019) for a recent example. These models allow financing schemes that mix concessional, external commercial, and domestic debt, while taking into account the impact of public investment on growth and constraints on the speed and magnitude of fiscal adjustment. While they were developed primarily to examine the feasibility of “big pushes” in investment, they are also well-suited to examine recovery programs following asset damage due to natural disasters.

Risk analysis and stress testing

There is now a substantial literature on the analysis of risk and the development of appropriate scenarios within which to conduct stress tests. Much of the focus has been on financial risks (e.g., Adrian, Morsink, and Schumacher 2020), but attention has more recently been devoted to fiscal risks, as in the approach to fiscal risk analysis and management developed by IMF (2016). This methodology looks at the impact of shocks on fiscal flows and balance sheet aggregates, including fiscal solvency, government liquidity, and the government financing burden.

As regards debt, the World Bank and IMF framework for debt sustainability analysis has been upgraded recently; it now takes a much more systematic approach to incorporating risk into the analysis and pays greater attention to country specifics. In particular, it recommends deeper and more extensive analysis for countries that appear to be in most danger of debt sustainability problems (IMF 2013). The new debt sustainability analysis

framework for low-income countries, implemented in July 2018, includes stress scenarios for natural disasters (IMF 2018b).

In the present context, developing appropriate scenarios is particularly difficult. Much of the existing work on natural disasters postulates that the economy starts in an unshocked steady state (or more often, some balanced growth path) and is then hit by a shock of some severity early in the simulation, with no further shocks occurring within the simulation horizon. The exercise can then be repeated for single shocks of different magnitudes, and the implications of different combinations of financing instruments (ex post and ex ante) can be examined over the recovery period. In forward-looking models, it is assumed that the shock was unanticipated but that perfect foresight then prevails. While convenient and tractable, these assumptions are hardly plausible. The economy’s initial state is likely to be characterized by an awareness that there is some probability distribution of future shocks, and it may already be in recovery from an earlier shock. Also, suffering one shock does not preclude further shocks within the simulation horizon.

Data issues

Problems of inadequate data loom large in the present context. Two aspects of this problem are the paucity of information about very rare events, and the lack of information about an uncertain future evolution, exacerbated by climate change. There are also the familiar issues of incomplete information about production relationships, and about the relationship between economic observables and population well-being. The discussion here, however, focuses on data problems specific to the public sector.

On the side of public expenditure, the main problem is one of tracking relevant changes, both in composition and in levels. In many countries, there is a mismatch between what is budgeted and what gets spent, even in the absence of major shocks. This may reflect technical implementation problems, a lack of proper budgetary controls, or a political imbalance where some spending departments are raided by other more powerful ones. This means that, post-shock, it may not be possible to infer reallocations by comparing outcomes with budget. Further, budget categories may not be well aligned with the economic activity of interest. For example, it may be difficult to infer the true level of maintenance spending from the budgetary codes. Even when doing so is possible, it may be impossible to infer how much of this spending involves post-shock rehabilitation as opposed to routine maintenance. In principle, there are ways of solving these problems, but they are likely to take a very long time to implement.

On the side of revenue, there is the problem of gauging to what extent revenues were affected at given tax rates, and another of assessing the revenue consequences of any changes in these rates. Disentangling these from the record is challenging. Using this information on a forward-looking basis also involves some judgment as to what changes in rates might be feasible and desirable.

To the extent that the deficit was altered, partly as a consequence of the shock itself, and partly as a result of policy responses, there will also have been changes in financing. These may have been ex ante, such as a decision to carry extra precautionary foreign exchange reserves or take out sovereign insurance; or they may have been ex post, such as increased domestic or international borrowing. For the ex post changes, there will also be the question of the extent to which interest premiums rose.

Coping with inadequate models and data

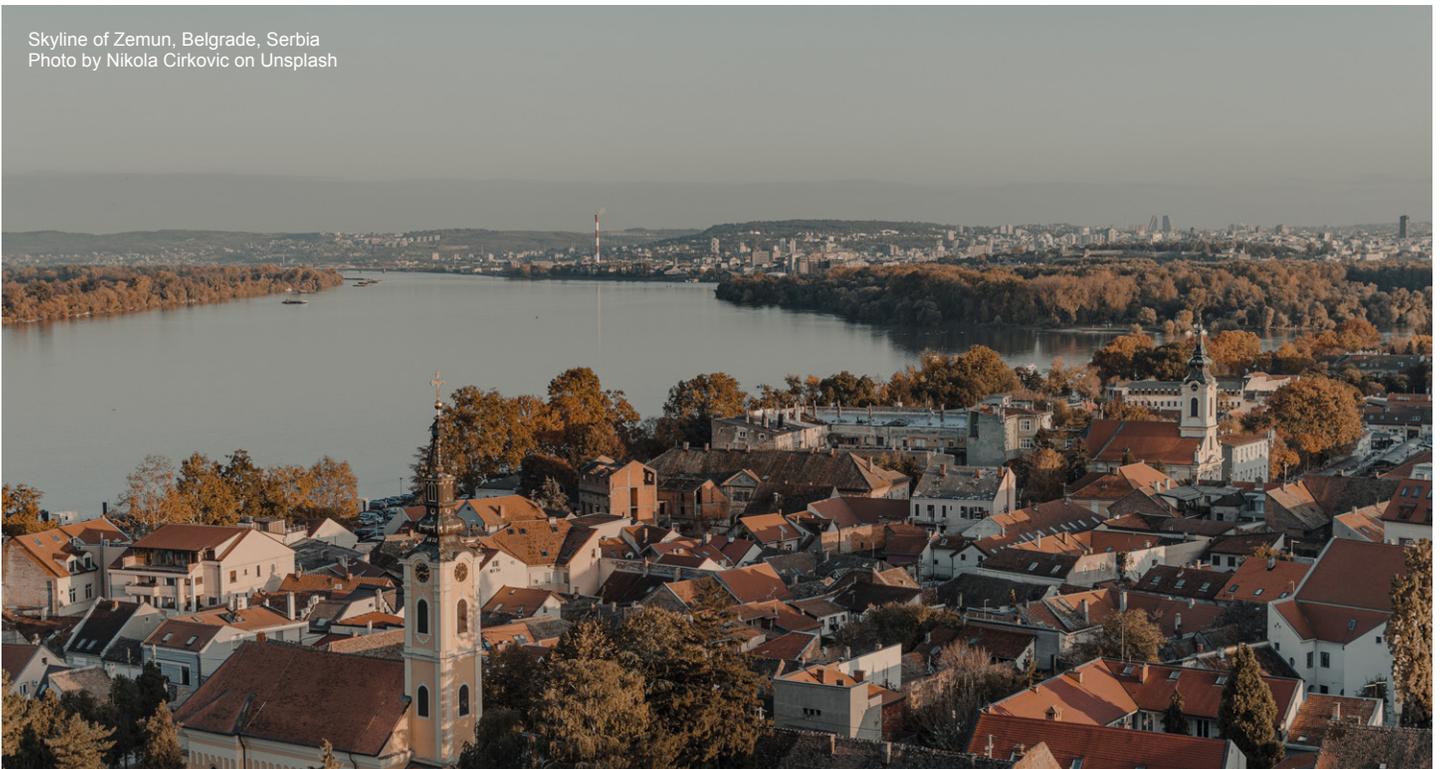
If available models are seen as complicated but still inadequate, it may be hard to interpret the results they generate. They may suggest some general equilibrium feedback that is unexpectedly powerful or unexpectedly weak, and the underlying mechanisms may be quite opaque. It is then difficult to decide whether this result is an artifact of the

model design or a genuine insight. The best rule of thumb in these circumstances is not to rely on a model's output unless it is possible to provide a plausible (verbal) analytic explanation of what is happening. If we are to accept results that are not intuitive, we need to gain some understanding of why our intuition is wrong.

When this sort of difficulty arises, it may be appropriate to supplement the analysis using a very simple model, possibly a part of the larger model, focusing on the direct impacts only. Regarding inadequate data, there are broadly two ways to proceed. The first procedure is to have some mechanism for generating a substitute for the missing information. This is central to the "calibration" exercises that accompany much modeling, frequently with reference to "the literature." Either empirical data are borrowed from other countries, or recourse is had to theoretical priors. Though far from ideal, this may not be too problematic provided the missing information is not too extensive; but it becomes more problematic when the missing information covers much of the model's required input. The second way to proceed is to reconfigure the model so that it does not require the missing data. Once again, this might involve using only part of a larger model.

Given the challenges presented by the existing theoretical frameworks, several case studies were conducted to understand what can now be inferred from the application of existing data in country. These case studies are discussed in the next section.

Skyline of Zemun, Belgrade, Serbia
Photo by Nikola Cirkovic on Unsplash





Preparedness: What countries can do to understand the potential impact of natural disasters on the sovereign balance sheet

In light of the channels through which natural disasters impact sovereign balance sheets (outlined in section 3) and the insights from the literature (sections 4 and 5), three cases are examined. The objective is to derive lessons from these cases that may help other countries understand and prepare for the potential impact of natural disasters on the sovereign balance sheet.

New Zealand earthquakes

Situated on the Pacific Ring of Fire, New Zealand is particularly prone to disasters that are caused by forces at a tectonic plate boundary, namely earthquakes, tsunamis, and volcanoes. The New Zealand case study is in two parts. The first part describes the impact of the 2010–11 Canterbury earthquake series on the government's finances and balance sheet. The second part focuses on the potential impact of a larger event, an earthquake centered in the capital city, Wellington.

A. Canterbury earthquake series 2010–11

The Canterbury region of New Zealand was impacted by a series of destructive earthquakes between September 2010 and December 2011. Although technically an aftershock, the most damaging and deadly tremor was in February 2011, which resulted in 185 deaths and considerable destruction in the city of Christ church, near where it was centered.

The cost of the damage caused by the earthquakes has been estimated at around NZD 40 billion, equivalent to around 20 percent of GDP and 7 percent of the nation's building stock at the time.⁸ There are uncertainties associated with this estimate and it does not include items such as interruption to business, which is an insurable risk, and central government expenditure to provide support for citizens through a range of measures. On the other hand, uncertainty also arises from differences between the value of the assets destroyed and value of replacements—for example, the additional value of rebuilding to a higher standard or other discretionary improvements (Parker and Steenkamp 2012).

The insurance liability for the Canterbury earthquakes totaled just over NZ\$32 billion. Private sector insurers bore NZ\$22 billion and the government-backed scheme for households—the Earthquake Commission (EQC) (see box 1)—bore around

NZ\$11.4 billion (Insurance Council of New Zealand 2020; New Zealand EQC 2019). The level of insurance relative to losses at around 75 percent was high compared to earthquakes in other high-income countries – for example one study surveyed events in Japan, Chile, and the United States, and observed coverage ranging from 3 percent to 35 percent of damage (Wood, Noy, and Parker 2016). Both the EQC and private sector insurers had substantial reinsurance in the international markets. Claims on foreign reinsurers improved the net international investment position of New Zealand by around eight percentage points of GDP, although this unwound as payments were made (Parker and Steenkamp 2012).

Despite damage estimated at 20 percent of GDP, the Canterbury earthquake had very little negative impact on the national macro-economy in the short run.⁹ A number of factors have been identified as to why the impact was muted: (i) the relatively high level of insurance cover relative to comparable cases in high-income countries; (ii) the nature of supply networks in the region and the central role of agriculture, which were largely undisturbed; (iii) the region's manufacturing hub escaped significant damage; (iv) transportation was largely unaffected – the local port recommenced activity within four days and volumes reached their previous peak within a few months, supporting exports; (v) the monetary easing by the central bank shortly after largest earthquake may also have buffered the impact (Doyle and Noy 2015, Parker and Steenkamp 2012).

Box 2: New Zealand's Earthquake Commission

The Earthquake Commission (EQC) is a New Zealand government entity that provides disaster risk insurance to residential property owners; it also invests in natural disaster research and education. It provides cover for damage caused by earthquakes, natural land-slips, volcanic eruptions, hydrothermal activity, and tsunamis. For residential land, there is also cover (within limits) against damage caused by storms and floods.

The EQC was founded in 1945 as the Earthquake and War Damages Commission, following destructive earthquakes in 1929, 1931, and 1942. Recovery and reconstruction after these events had been funded by government support to

citizens, as commercial insurance against earthquakes was expensive at that time and not taken up by many households. Since its establishment, the EQC has undergone a number of changes, including the entities and perils that are covered.

The EQC is funded by a levy added to fire insurance, provided by private insurers. At present the levy is 0.2 percent for a maximum coverage of NZ\$150,000. For disaster cover beyond this amount, households rely on their private sector insurers.

The levies collected by EQC are used to (i) fund its operations; (ii) contribute to the National Disaster Fund managed by EQC; and (iii) purchase reinsurance in the international market. If the EQC is unable to meet all claims as a result of a very large event, it can fall back on the unlimited guarantee provided by government to make up the shortfall. The EQC pays a fee for this guarantee.

8. The New Zealand Treasury (2013), the Insurance Council of New Zealand (2020), and Wood, Noy, and Parker(2016) use this figure.

9. To provide perspective on the scale of the Canterbury earthquakes, the world's most expensive natural disaster, the Great East Japan (Tōhoku) Earthquake of 2011, had estimated damage of US\$ 210 billion, equivalent to around 3.5 percent of GDP (Ranghieri and Ishiwatari 2014).

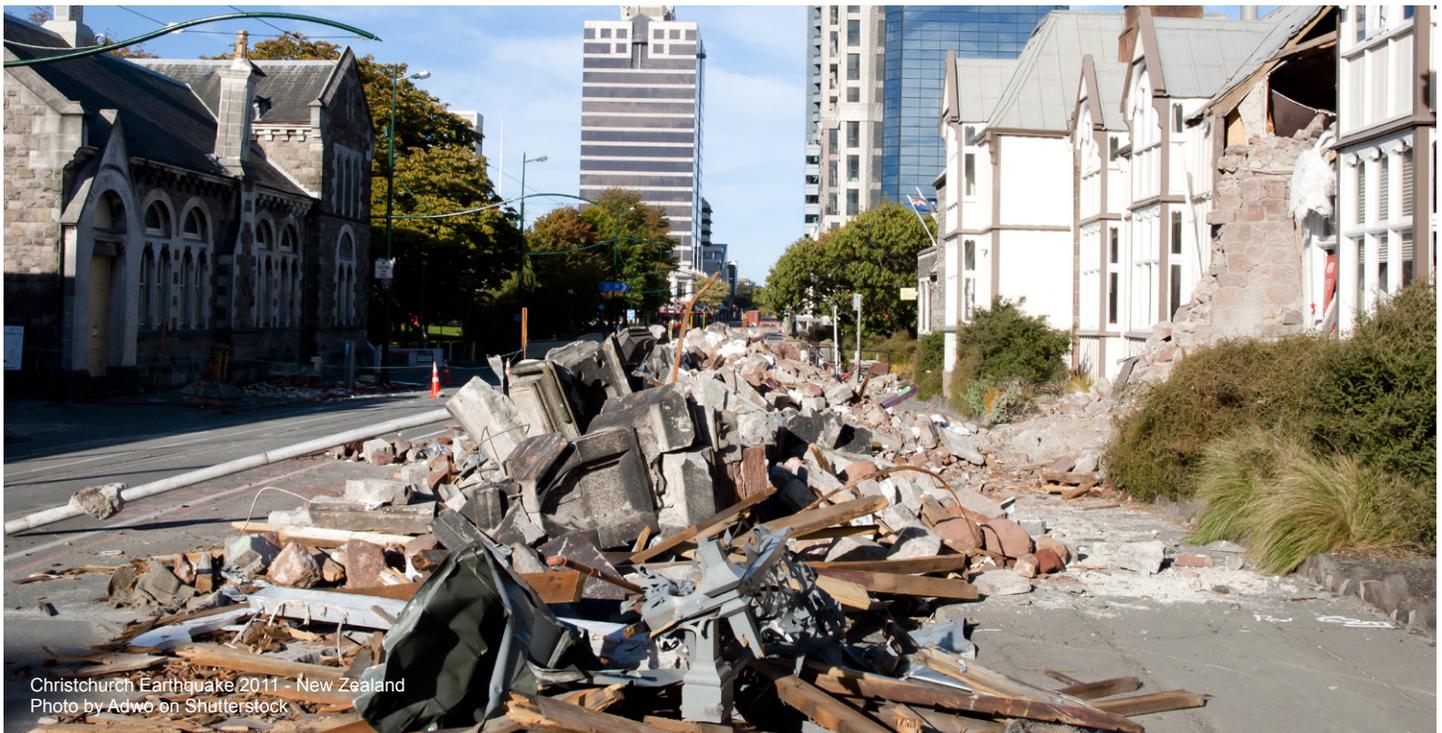
As would be expected after a disaster of this nature, there was a rebound in activity once reconstruction started. Based on a total cost of NZD 40 billion, one study estimated that rate of rebuilding activity would average around 1.5 percent of potential GDP from 2012 to beyond 2020, peaking at just below 2 percent of potential GDP in 2014 (Wood, Noy, and Parker 2016). However, official forecasts cautioned that it was difficult to isolate the effect of the earthquakes from other factors during both the short-run and long-run (New Zealand Treasury 2011c, 2012a, 2013, 2014, 2015). At the time of the earthquakes, the economy was still recovering slowly from the global financial crisis of 2008-2009 (GFC) and the Eurozone crisis was intensifying; on the other hand New Zealand's terms of trade were improving. During the period of reconstruction, the economy was also benefiting from a surge in tourism, strong inward migration, near-record terms of trade, and strong labor income growth.

In the Canterbury region, building activity rose by 150 percent from pre-earthquake levels by 2016, compared to 20 percent in the rest of New Zealand, and nominal GDP growth surged to 10.5 percent in 2014 (Wood, Noy, and Parker 2016). The recovery of small and medium-size enterprises can be tracked from goods and services tax (a value-added tax), which rose from 11.6 percent of the national total in 2011 to 13.4 percent by 2015 (New Zealand Inland Revenue Department 2015), this indicates that Canterbury's share of the national total is

higher relative to the rest of the country.¹⁰ Overall, therefore, the impacts of the earthquakes on the economy were relatively localized and then further offset through reconstruction gains.

The disaster had a sizable impact on the government's finances. By June 2017, the amount recognized in the government's financial statements, including both operating and capital expenditure, was NZD 15.1 billion, equivalent to 7.5 percent of GDP at the time of the disaster (New Zealand Treasury 2017). This was spread out over many years, and indeed beyond 2017. The government's financial statements are prepared on an accrual basis, which results in many expenses being recognized before cash is paid out. For example, in the 2011 financial statements, earthquake expenses of NZD 9.1 billion were recognized, but net cash payments were only NZD 1.7 billion (New Zealand Treasury 2011a). Of the NZD 15.1 billion in expenditure, NZD 0.7 billion was absorbed within existing budget baselines.

Just under half the direct fiscal costs were insurance payouts to households by the EQC. This would have been much higher, around NZD11.2 billion, were it not for the NZD 4.5 billion recouped from reinsurance. Other significant costs included support for local government to restore infrastructure, capital expenditure for government-owned assets, compensation for land deemed unsuitable for rebuilding, and welfare support.



Christchurch Earthquake 2011 - New Zealand
Photo by Adwo on Shutterstock

10. The percentage had been below 12 in the eight years prior to the earthquakes.

Christchurch Earthquake 2011 - New Zealand
Photo by Nigel Spiers on Shutterstock



The government established the Canterbury Earthquake Recovery Fund (CERF) in the 2011 Budget, which helped provide transparency around the level of expenses. Nevertheless, the 2017 financial statements (New Zealand Treasury 2017), which was the last year that estimates of expenditure relating to the earthquakes were provided, note that as time elapses, the ability to directly attribute costs to the original events in 2010 and 2011 becomes more difficult.¹¹

In addition to direct fiscal expenditure, the government impaired a total of NZD 375 million against the asset valuation reserve in respect of damage to assets owned by the government. The impact of the earthquakes on the value of Crown assets and liabilities caused by changes to variables such as interest rates and exchange rates was likely to have been negligible. While the currency dipped initially after the February 2011 earthquake, it had fully recovered within a month. The New Zealand equity and bond markets were not impacted.

The New Zealand Treasury has not estimated the full indirect fiscal costs, such as the impact on tax or other revenues as a result of the earthquakes, and this is noted in the financial statements. As the government's tax revenues are driven to a large extent by changes in nominal GDP, it is reasonable

to assume that the short-term impact of the earthquakes was negligible. Over the longer term, the indirect impact on the government's finances could be expected to have been positive, given the boost to activity from the reconstruction. The government's budget statements in the 2012 to 2014 refer to this, and estimates of the boost to the value-added tax ranged up to NZD 1.3 billion, but it was noted that this was partly offset by refunds to insurers, as a large part of the rebuild was funded by insurance claims (New Zealand Treasury 2012b, 2013, 2014).

To summarize, based on information provided in financial statements, the public sector's net worth is NZD 12.1 billion lower and public debt NZD 7.7 billion higher than if the Canterbury earthquakes had not occurred, assuming no second-round effects and other things being equal. To provide a sense of scale, in June 2017, when the majority of the expenses had been recognized and cash paid out, the Crown's net worth was NZD 116.5 billion (around 9.6% lower than otherwise) and gross central government debt was NZD 87.1 billion (around 10% higher than otherwise). At the time, gross central government debt was 32.5 percent of GDP; without the earthquakes it would have been 29.6 percent of GDP.

11. For the purposes of this case study, the 2017 amounts are assumed to reflect the cost of the disaster to the government.

TABLE 1

Item	Accounts	Expenditure (NZ\$ billion)	Assets (NZ\$ billion)	Liabilities (NZ\$ billion)	Net worth (NZ\$ billion)	Net worth percentage of 2017 GDP
Valuation of assets and liabilities	Impairment of Crown assets	-	-0.375	-	-0.375	-0.1
	Valuation impact from market variables	-	Negligible	Negligible	Negligible	-
Direct fiscal cost	Total expenditure	15.1 ^A	-	-	-	-
	Absorbed in existing budget	0.7	-	-	-	-
	Depletion of NDF	-	-6.9	-	-6.9	-2.6
	Funded by debt ^B	-	-	7.5	-7.5	-2.8
	Capital expenditure	-	2.6	-	2.6	1.0
Indirect fiscal cost	Negligible	Negligible	Negligible	Negligible	Negligible	
Total			-4.7	7.5	-12.1	-4.5

Source: World Bank

A. The expenditure figure is net of reinsurance payouts totaling NZ\$ 4.5 billion.

B. In some fiscal years there may be cash surpluses—the NZ\$ 7.5 billion represents the increase in debt compared to a base case without earthquake expenditure and all other expenditure remaining the same.

The increase in public debt levels was not on a scale that would have an impact on the composition of public debt, particularly as the cash impact of the expenses was spread over a number of years.

The ability of the New Zealand Government to comfortably withstand the impact of Canterbury earthquakes on the public sector balance sheet was shaped by two policy actions. The first was building fiscal space during economic expansion prior to the GFC – on the eve of the crisis, central government debt was 17 percent of GDP. The combined shocks of the crisis and the earthquakes raised this to 38 percent of GDP by 2012, with the GFC accounting for a much greater share of the increase.

The second policy action was the establishment of the EQC in

1945 to provide insurance for households against a range of natural hazards. During the next 65 years the Natural Disaster Fund (NDF) grew to over NZD 6 billion, funded by levies on households and investment returns; in addition some of its revenue was used to purchase reinsurance in the international market. The NDF was completely depleted, for the first time in its history, by the Canterbury earthquakes, resulting in a loss of net worth on the public sector balance sheet. Nevertheless, the NDF shielded the government from some additional borrowing after the event. Reinsurance payouts of around NZD4.5 billion provided some protection to net worth. Without the NDF and reinsurance, a further NZD11.4 billion would have been borrowed between 2012 and 2018 to settle the claims by households. This would have increased central government debt by 7.0 percent of GDP, compared to the 2.8 percent that actually occurred.

B. Potential impact of a large earthquake on the balance sheet

The New Zealand Government undertakes stress tests of fiscal resilience. Analysis undertaken in 2018 examined three plausible shocks, including a severe earthquake in Wellington, the capital city (New Zealand Treasury 2018). The scenario assumes significant casualties and injuries, damage to most houses, a closure or relocation of a large number of businesses, and that essential services take months to be restored. Unlike the experience with the Canterbury earthquakes, the scenario assumes that business activity across the country is weak in the near term, with both consumers and business being very cautious, and with a drop in tourist and migrant arrivals. Major reconstruction does not commence until 18 months later and takes over ten years to complete.

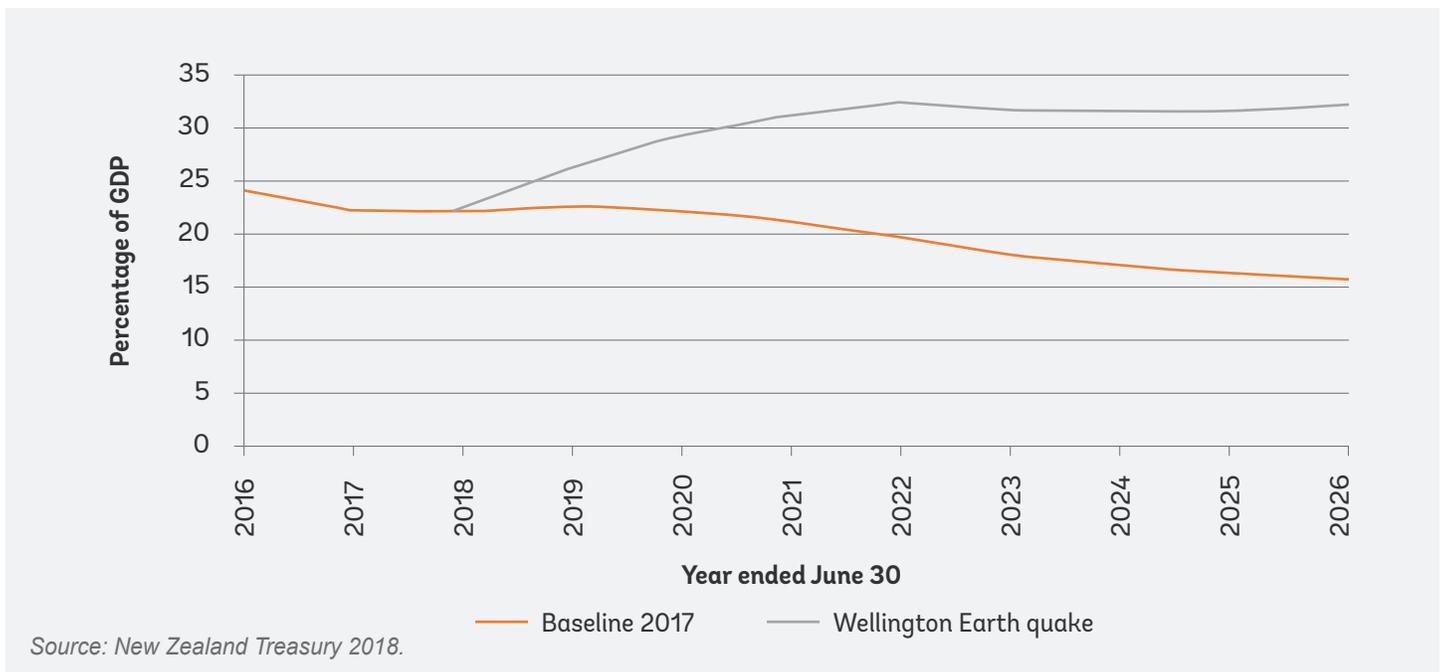
Over the medium term, the economic boost from rebuilding

is not strong enough to lift output to the level in the baseline forecast: as a result, after five years, nominal GDP is projected to be a cumulative NZD 44 billion lower than in the baseline projection. The total impact on the government's finances is projected at NZD68 billion, with indirect fiscal costs comprising the largest share at NZD 38 billion. The government's operating (or budget) balance is projected to be around three percent of GDP worse than the baseline, in each of the five years after the event. The level of central government debt is projected to be 13 percent of GDP higher than the baseline, at the end of the fifth year – see Figure 2.

The stress testing based on scenarios provides an input to fiscal policy, in particular judgments about the level of debt that is sustainable for the New Zealand Government. The scale of the potential impact on debt levels provides a sense of the fiscal space that could be required, in order to respond to shocks without pushing debt levels towards unsustainable levels - or forcing fiscal adjustments that blunt the effectiveness of the response.

> > >

FIGURE 2 - Impact of Wellington earthquake on net central government debt compared to baseline (2016–25)



Serbia: 2014 floods

In May 2014, Serbia suffered flash floods and landslides as a result of heavy rains across the region. During the third week of May, record-breaking levels of rainfall were recorded: more than 200 mm of rain fell in western Serbia within a week, equivalent to three months of rain under normal conditions. Already-high levels of soil saturation before the rains increased the presence of unstable soils in hilly areas and led to landslides in both inhabited and uninhabited areas. The landslides destroyed houses, roads, bridges, and other infrastructure works. The 2014 floods are considered the most severe in 120 years, impacting more than 38 municipalities and affecting more than 1.6 million people, or 23 percent of the total population (Government of Serbia 2014).

Post-disaster needs assessment and response

With the support of the European Union, the United Nations, and the World Bank, the Government of Serbia conducted a post-disaster needs assessment that estimated damages and losses in the affected municipalities at €1.7 billion (US\$1.4 billion), equivalent to 4.8 percent of GDP. Of this amount, €0.9 billion (US\$0.7 billion) represents the value of destroyed physical assets, and €0.8 billion (US\$0.6 billion) refers to losses in production. The hardest hit economic sectors were energy, mining, and agriculture, but significant damages were also inflicted on transport infrastructure (roads, bridges, and railways). The public and private sectors were affected differently by the disaster, although the damages and losses they incurred were similar in size (Government of Serbia 2014).

Financial requirements were estimated for all sectors of social and economic activities, under both public and private domains. Post-disaster needs were valued at €1.3 billion (US\$1.1 billion), of which €403 million (US\$332 million) was for recovery activities (e.g., ensuring the recovery of personal income) and €943 million (US\$777 million) was for reconstruction needs. Financing needs for recovery and reconstruction were estimated to last into at least 2016 (Government of Serbia 2014).

The disaster led Serbia into an economic recession and deteriorated its fiscal position. As a result of the ensuing recession (mostly caused by the floods), the Serbian economy contracted by 1.8 percent in 2014, rather than growing by 0.5 percent as previously projected. After the floods, an estimated 125,000 people fell below the poverty line, an increase of almost 7 percent compared with the level of the previous year.

The Human Development Index also fell to 0.77, pushing Serbia back to 2012 levels (World Bank 2016).

Following the floods, the government of Serbia launched a significant response and reconstruction operation with extraordinary support from the international community. Various sources were used to finance the emergency response, reconstruction, and recovery: a combination of government funds, private sector resources (including personal and enterprise contributions, family remittances from abroad, and limited insurance proceeds), cash grants and donations from the international community, and new and rescheduled loans from international financial institutions. The total funding raised to implement recovery and reconstruction activities over the period May 2014–October 2015 was €514 million (US\$423 million), of which €227 million (US\$187 million) was from international borrowing, €193 million (US\$159 million) was European Union funds, €42 million (US\$35 million) was from individual donations, and €40 million (US\$33 million) was from bilateral international donations. According to the National Bank of Serbia, only €16.9 million (US\$14 million) had been paid out by private insurance companies by the end of 2014, and total post-flood insurance claims amounted to only €38.8 million (US\$32 million)—less than 2.5 percent of the total damages and losses and less than 2.9 percent of the recovery needs (World Bank 2016). The size of this contribution highlights the fact that the overall insurance market in Serbia is underdeveloped and dominated by a state-owned company which may deter other market entrants. This suggests that there is an opportunity for the government to incentivize the insurance sector to improve product offering on flood insurance to reduce future government liabilities. However, the affordability and attractiveness of any new products would need to be carefully assessed.

Sovereign asset and liability and disaster shock

Like many developing countries, Serbia does not prepare comprehensive balance sheets, does not have a complete data set on nonfinancial assets, and does not consolidate SOEs. Financial statements are prepared by the Treasury's Budget Accounting and Reporting Department. Quarterly and year-end aggregated financial statements are based on the balance sheet and on budget execution information submitted both electronically and manually by direct and indirect budget beneficiaries. Accounting and financial reporting in Serbia are currently maintained on a modified cash basis. The main difference between cash - and accrual - based accounting lies in the timing for recording revenues and expenditures. Cash-based budgeting systems record receipts and outlays when cash is received or paid, without regard to when the activity generating the revenue, consuming the resources, or increasing the liability occurs.

This form of accounting has traditionally been recognized for its emphasis on compliance with the annual budget law. Several measures have been introduced into Serbian public sector accounting to supplement cash-based data with noncash information. Some issues with the accuracy of nonfinancial asset valuation have been identified. According to the Republic Property Directorate, it is solely the responsibility of the budget user to enter accurate data on nonfinancial assets, such as their value, changes in value, and information related to the disposal of assets. The directorate does not assume responsibility for data quality; does not validate or verify information in the asset registry; and does not demand it when missing (World Bank 2017).

The three channels affecting the balance sheet—valuation of assets and liabilities, direct fiscal cost, and indirect fiscal cost—

are described below for the case of the Serbian floods.

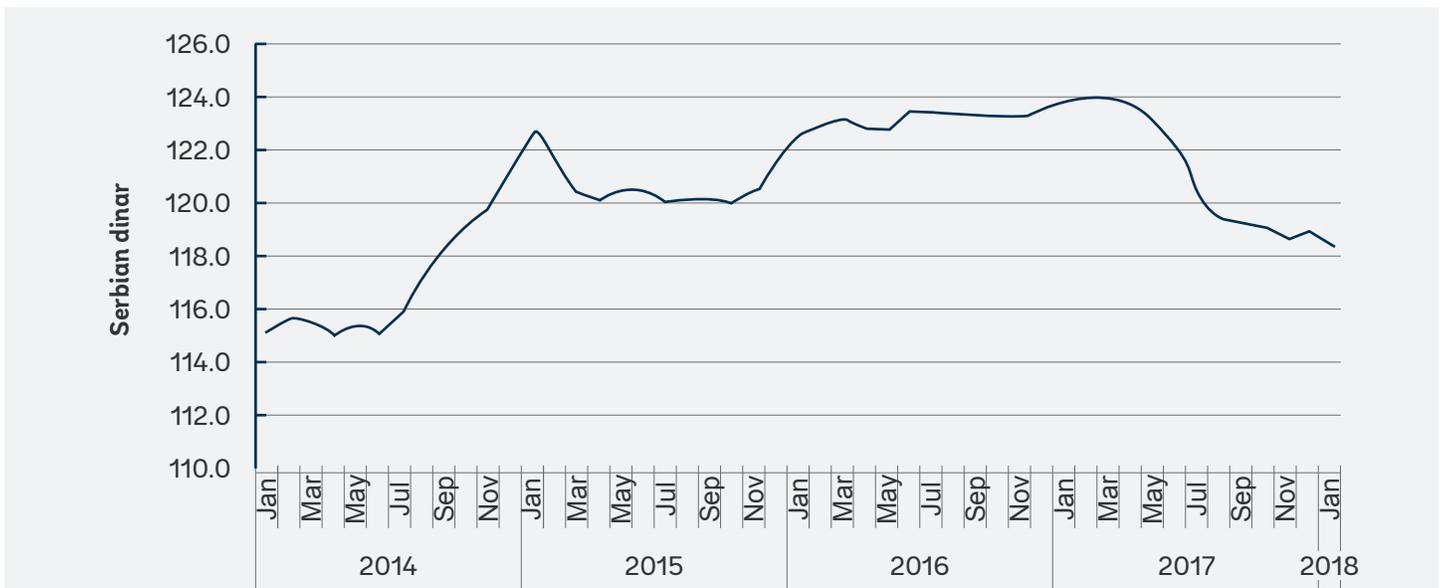
Valuation of assets and liabilities

Since no accurate asset valuation is available, as a proxy, the analysis assumes that €450 million (US\$371 million), or half of the total damages, falls within the public sector.

Over 2014, the Serbian dinar depreciated around 2.8 percent (see figure 3), influenced by developments in the international financial markets, reduced foreign exchange inflow from investments, and deterioration in the foreign trade deficit in the second half of the year. In November 2014, the National Bank of Serbia lowered its key policy rate by 0.5 percentage points to the level of 8 percent (see figure 4). This decision was due mainly to low inflationary pressure.

> > >

FIGURE 3 - Exchange rate: Euro/Serbian dinar(2014–January 2018)

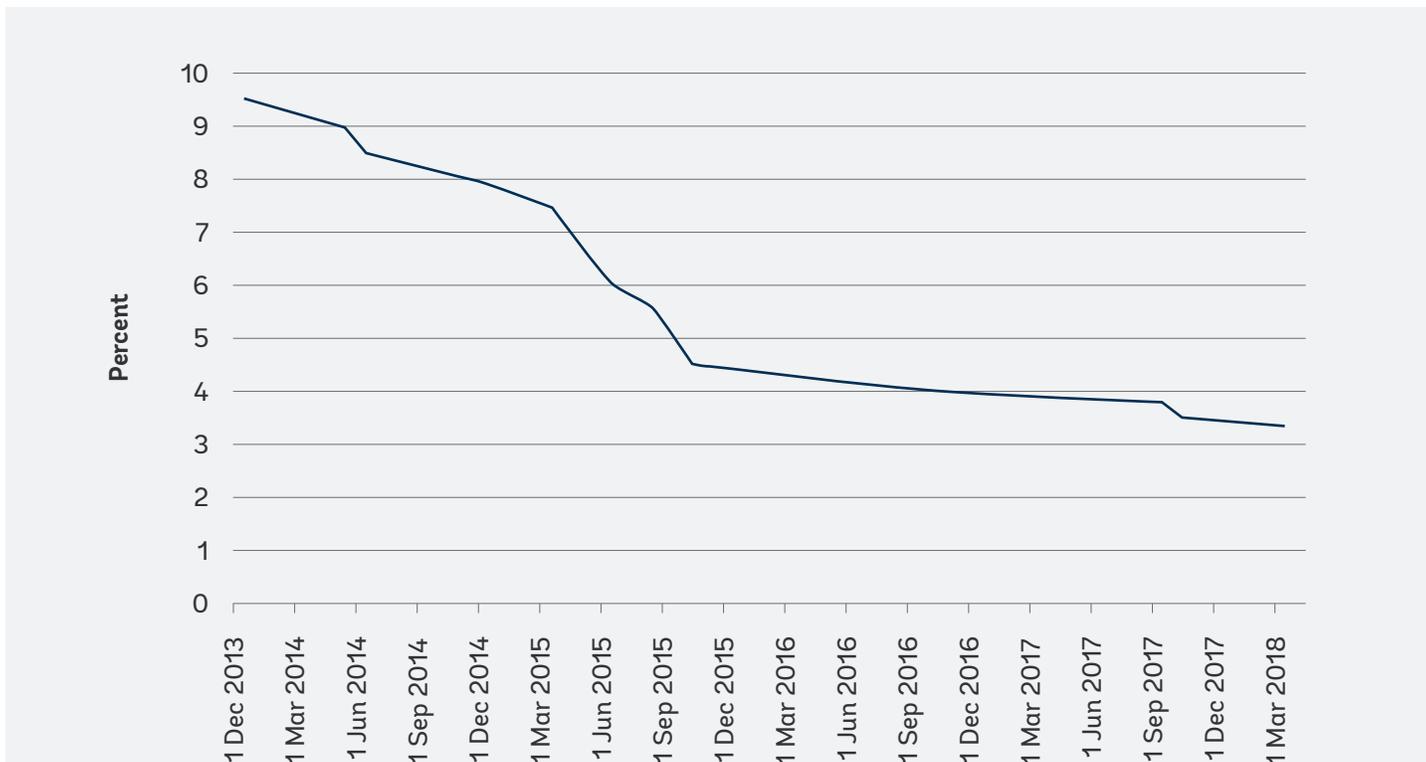


Source: National Bank of Serbia.



House and street in Obrenovac under water
Photo by Nesa Cera on Shutterstock

FIGURE 4 - Serbian monetary policy rate (December 2013–March 2018)



Source: National Bank of Serbia.

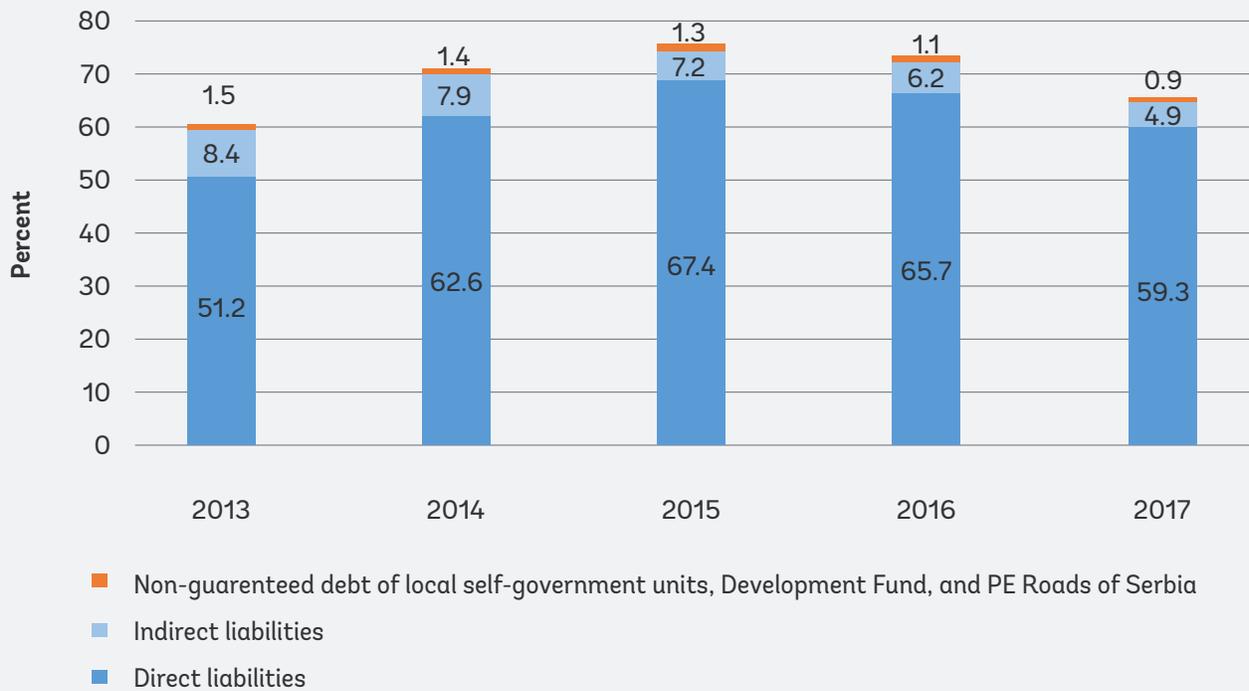
Direct fiscal cost

Direct costs are those incurred as a result of the damage, including emergency support and recovery. The availability and quality of data are key determinants in adopting a SALM framework, and in Serbia, data on post-disaster expenditures are limited and fragmented. Much of the spending on disasters remains embedded in other budget lines like operations and maintenance budgets. The primary financial sources in 2014 were government revenues, debt (US\$300 million), and grants (US\$182 million) (World Bank 2016). In addition, public utility companies financed reconstruction from their own funds and loans backed with state guarantee. Based on a review of balance sheets, other current expenditures were RSD 14 billion (around US\$95 million) higher than initially planned as a result of floods and early elections.

Compared to 2013, the total debt stock in 2014 increased from 61.1 percent of GDP to 71.9 percent of GDP (around US\$4.3 billion) (see figure 5). Public debt levels increased due to the 6.2 percent increase in the budget deficit, lower real GDP growth rate, and depreciation of local currency (dinar) against foreign currencies. In October 2014, the World Bank approved the Floods Emergency Recovery Loan to Serbia in the amount of US\$300 million, and Serbia issued 10-year dinar-denominated bonds for the first time. The issue amount was RSD 10 billion (US\$0.1billion) with an effective yield rate of 12.99 percent and 10 percent coupon (see figure 6). The issuance of the bond was planned before the floods with a strategic goal of a maturity extension, but it likely also covered the financial requirements from the flood.

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FIGURE 5 - General government public debt in Serbia as a share of GDP (2013–17)

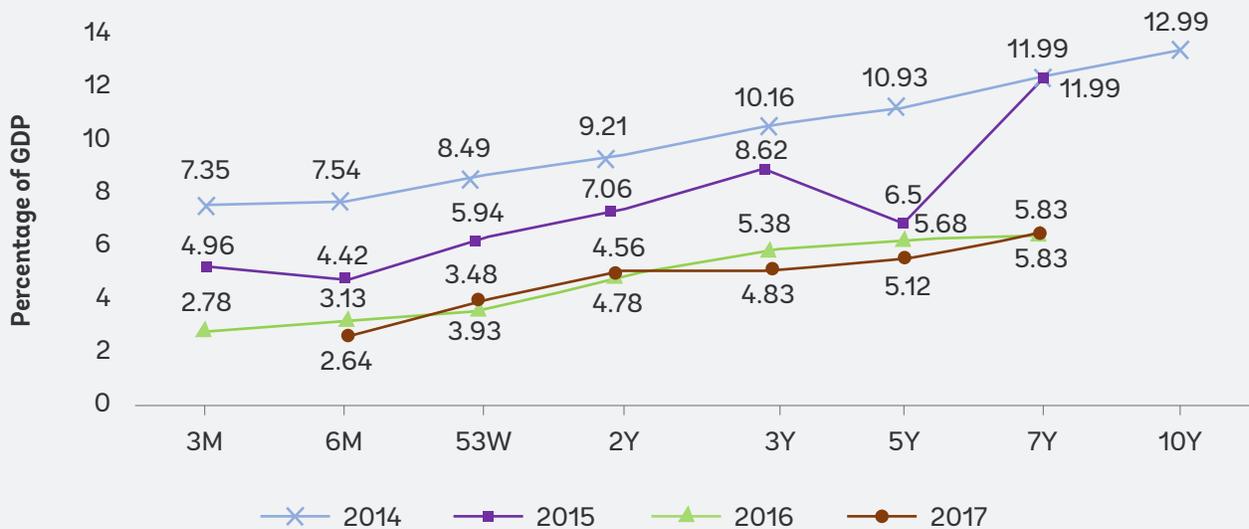


Source: Ministry of Finance of Serbia.

Note: PE = Public Enterprise. Indirect liabilities include guarantees issued by Serbia for other legal entities.

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FIGURE 6 - Dinar weighted average accepted rate on primary auctions (2014–17)



Source: Serbian Public Debt Department.

Indirect fiscal cost

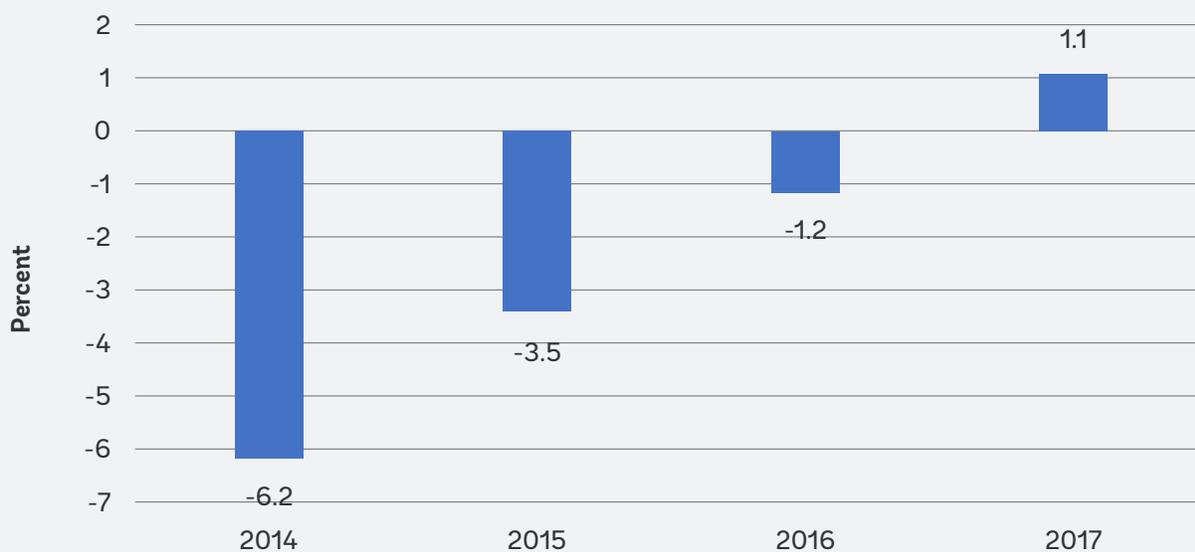
Disaster shocks are expected to decrease the revenue base. The Serbia damage and loss assessment estimated a reduction in revenues of €130 million (US\$107 million). Based on the 2014 balance sheet, the collection of total revenues was RSD 35 billion (US\$247 million) lower than expected, while tax revenues were RSD 53 billion (US\$358 million) lower than expected. The exact impact of floods here cannot be determined, as lower collection of revenues was greatly influenced by other factors, such as slower nominal growth of private consumption (partially caused by lower inflation) and growth of activity in the gray market, especially in the market for tobacco products. It is impossible to determine the disaster impact over the following years, given that Serbia concluded a Precautionary Arrangement with the IMF and started implementing fiscal consolidation measures and structural reforms at the end of 2014. All the budget positions—like current expenditures, capital expenditures, and deficit—were agreed with the IMF in the budget preparation process. The approved numbers were treated as limits, which means

that no reallocation between specific budget positions was allowed. In the first year of the program's implementation, a strong turnaround occurred in fiscal policy, with results higher than expected. The improved fiscal position of the country has reduced the need for borrowing and the costs of servicing liabilities.

Since there is no comprehensive balance sheet, list, or valuation of nonfinancial assets, it is very difficult to determine in what way the 2014 floods affected the government's balance sheet. According to the available data, it can be assumed that €450 million (US\$371 million), half of the total damage for physical assets, falls within the public sector. As a direct result of floods, public debt increased by US\$300 million. Considering that the deficit in 2014 was 6.2 percent (see figure 7), mainly caused by the floods, it is fair to assume that the direct effect on public debt was significantly higher. Total reduction of revenues in 2014 was around €300 million (US\$247 million), and it was estimated that €130 million (US\$107 million) was caused by the floods.

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FIGURE 7 - Consolidated fiscal balance in Serbia as percentage of GDP (2014–17)



Source: Serbian Ministry of Finance.

Peru: 2017 coastal El Niño flooding

Disaster event

In the first half of 2017, an El Niño costero (coastal) event, one of the strongest El Niño events documented in Peru, caused major impacts in the country. A sudden and unexpected increase in the temperature of the Pacific Ocean created heavy storms and rainfall, which triggered floods and landslides that continued for nearly four months. The impacts were unevenly distributed in the country, affecting mainly the coast, with half of the geographic regions declaring a state of emergency. These events ultimately triggered the overpopulation of mosquitos that spread dengue and chikungunya virus. An El Niño event with such a localized impact had not been documented since 1925 and is comparable to the strongest ones in the 20th century (Government of Peru, 2017a).

Governmental assessments documented the damage experienced by the population in terms of loss of lives and physical assets across the country. The event affected 1.7 million people (around 5 percent of the population), caused 132 deaths, and damaged 413,000 houses and 132,000 ha of crops. Buildings and infrastructure were severely damaged, including 2,600 km of national roads, 192 bridges, 7,000 km of regional roads, about 1,500 school buildings, and 726 health facilities (Government of Peru 2017a). There are no official records about the cost of these impacts. However, Macro-consult, a local consulting firm, estimated such physical damages at US\$3 billion (equivalent to 1.6 percent of the 2017 GDP); roads and bridges alone accounted for 48 percent of the total (Macro-consult 2017). This amount is to be interpreted as a lower bound, as it does not include total physical damages in infrastructure (e.g., the collapse of sewage systems).

The coastal El Niño had severe impacts on production, mainly in non-primary sectors; effects were widespread in manufacturing, construction, and transport services. Impacts in primary industry were narrower, affecting some agricultural products and the production chain of some mines. Economic activity was affected by the closing of roads, the damage to physical capital, and lower demand. According to a preliminary analysis performed by the Ministry of Economy and Finance (MEF), the shock was expected to shrink GDP growth by 1.2 percentage points (Government of Peru 2017d). The impact was difficult to isolate, however, given the Lava Jato corruption case in 2017, which compounded the shock by decreasing investors' confidence and paralyzing public-private partnership investment projects.

The recovery process started with the establishment of an agency, the Authority for the Reconstruction with Changes (ARCC), to lead implementation of the 2017–21 reconstruction plan. The entire plan's allocation is S/. 26.7 billion (US\$7.8 billion, 3 percent of 2017 GDP), which is programmed into four components: (i) public infrastructure (73 percent of the total amount), (ii) mitigation projects (21 percent), (iii) houses (3 percent), and (iv) capacities of recipient entities (3 percent). The reconstruction of public infrastructure focuses mainly on transport (US\$2.5 billion), education (US\$1 billion), and drainage and sewerage systems (US\$1 billion). In the case of houses, ARCC is financing 100 percent of the cost for rebuilding or replacing around 41,000 dwellings among the most vulnerable families affected by the event (Government of Peru 2017c).

The Government of Peru has a combination of instruments to finance disaster recovery, aligned with its fiscal policy and financial strategies.



Fishing village residents work to clean their town of mud after flooding brought on by El Niño rains in Cabo Blanco, Peru
Photo by CLJ Giordano on Shutterstock

The Multi-annual Macroeconomic Framework 2020–2023 emphasizes that the current fiscal policy, which encompasses two decades of effort, has been vital to mitigate the effects of adverse shocks. As part of this effort, the Stabilization Fund (FEF) was established in 1999 with the aim of creating fiscal savings to respond in adverse scenarios (Government of Peru 2019). Peru officially launched its national Disaster Risk Financing and Insurance (DRFI) strategy in 2016, after several years of work. The strategy builds on extensive analytical support, and includes the following financial instruments for recovery: (i) the FEF, (ii) contingent credit lines, and (iii) debt (Government of Peru 2016). In 2016, a pass-through disaster fund was established (FONDES). In addition, in 2017 the country joined a three-year catastrophe bond that provides US\$200 million in seismic coverage (World Bank, 2018b). The management of these financial instruments is governed by the Global Asset and Debt Strategy (Government of Peru 2017b).

The financial needs raised by the coastal El Niño are expected to be covered mainly by assets. According to the MEF, 80 percent of total financial needs due to the event will be covered by assets—including FEF, Treasury, and non-Treasury resources¹² as well as donations—with a mild impact on the debt stock. Indeed, a total of US\$2.8 billion was mobilized from the FEF to FONDES over the 2017–19 period.¹³ These resources were authorized by law on an annual need basis, with US\$1.8 billion in 2017 followed by lower amounts thereafter. It is important to highlight that FEF had accumulated US\$5.4 billion by the end of 2019.

Sovereign asset and liability and disaster shock

Financial statements are published annually by the MEF, covering the entire public sector. Before discussing the impacts of the El Niño event on sovereign assets and liabilities, it is

necessary to understand how Peru defines the public sector balance sheet and what the basis is for its financial reporting. Financial statements in Peru are a consolidation at the public sector level. The Accounting Department of the MEF (DGCP) is responsible for annually compiling and publishing the financial statements, which covered the following units by 2017:

- 2,505 public sector entities, of which 2,345 were general government units and 160 were public corporations, including the reserve bank
- 272 central government units (including the health insurance system, the military pension scheme, and three housing funds), 27 regional government units, and 2,046 local government units

In Peru, public financial accounts are based on a combination of accrual and cash-based methods, with accounts still pending to move into full accrual. In 2015, an IMF mission identified valuation methods for pension, infrastructure, building, and land as areas for strengthening (IMF 2015). According to the IMF report, infrastructure and equipment are recorded at the historical value and often fully depreciated. This approach mainly affects the valuation of buildings and structures, many of which have residual value in the balance sheet of only S/. 1. The government has been working to strengthen the valuation of public financial accounts. For example, an IT module was created for registering the updated value of buildings and structures at the general government level.

Table 2 summarizes the impacts of the El Niño event, including the valuation of assets and liabilities and direct and indirect fiscal costs. Net worth is estimated to decline by S/. 13.2 billion, with an increase in debt by S/. 2.5 billion over the 2017–19 period. The estimations are limited, given the data and assumptions, and should be interpreted to illustrate trends rather than as offering precision.



12. Non-Treasury resources include non-tax revenues collected and accumulated from national institutions and subnational governments, such as fees, property levies, and supply of goods and services, among others.

13. Stabilization Fund Report. Reports from 2017, 2018 and 2019.

TABLE 2 - Estimated impacts of 2017 El Niño event, 2017–19 (S/. billion)

Item	Accounts	Asset	Liability	Net Worth
Valuation of assets and liabilities	Building and properties	-10.3	-	-10.3
Direct fiscal cost	Fixed assets	+3.5	-	+3.5
	Financial assets, debt and operative results	-3.9	2.5	-6.4
Indirect fiscal cost	-	-	-	-
Total	-	-10.7	2.5	-13.2

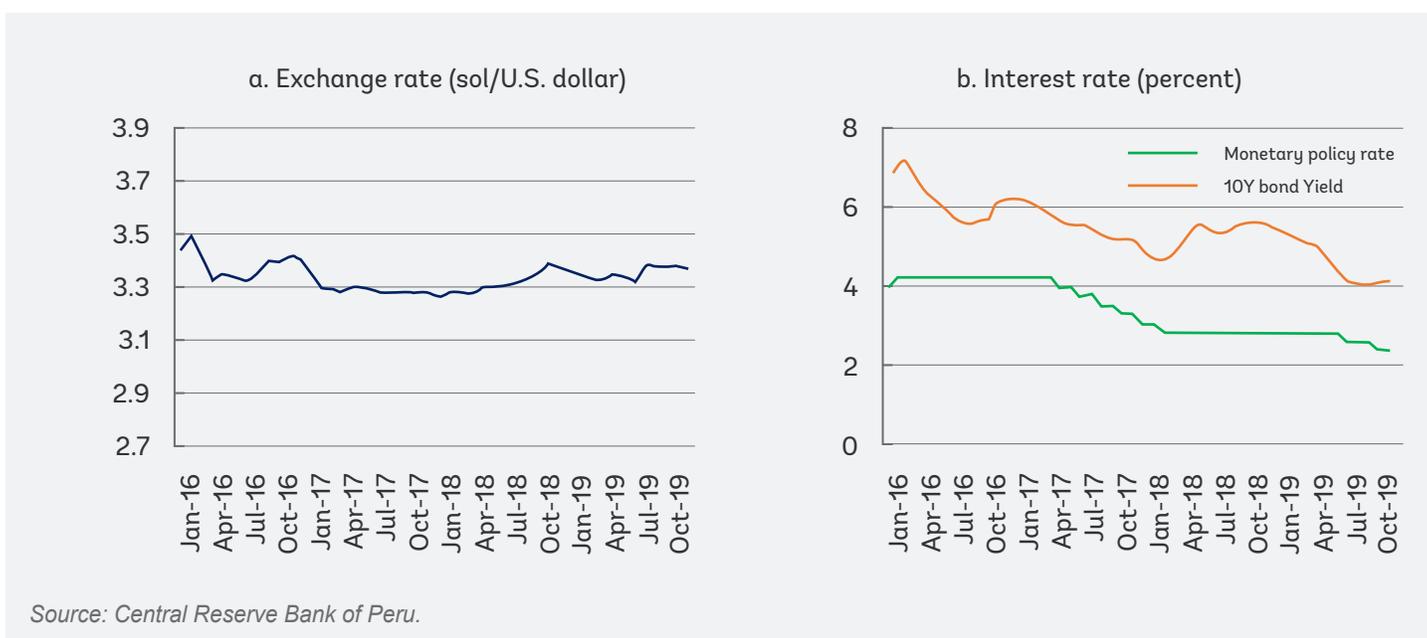
Valuation of assets and liabilities

The 2017 financial statement did not specify a decrease in the valuation of properties due to the shock (Government of Peru 2018a). This is probably related to difficulties in the valuation of fixed assets mentioned above. As a proxy, damage of US\$3 billion (S/. 10.3 billion) can be considered a lower bound. In the balance sheet analysis, the damages due to the disaster (destruction) lead to a reduction in the fixed assets, thus reducing the assets and net worth by S/.10.3 billion.

Changes in the exchange rate and interest rate may affect the valuation of financial assets and debt. However, Peru’s financial statements did not report any impact attributed

to the disaster shock. See figure 8 for more details on the evolution of variables. Over the first half of 2017, the Peruvian sol appreciated about 3.4 percent, influenced by the recovery of commodity prices and global depreciation of the dollar.¹⁴ In May 2017, the monetary policy rate was cut by 25 basis points to 4 percent, and then further reduced to 3 percent over the same year. On the debt side, the 10-year bond interest rates declined 84 basis points in the first half of 2017, implying a reduction in the cost of new debt. At the same time, the overnight interest rate was cut in line with the monetary rate, decreasing the rentability of Treasury’s deposits in the reserve bank and overall rentability of the public sector’s deposits in commercial banks (Government of Peru 2018a).

FIGURE 8 - Peru’s exchange rate, interest rate, and 10-year bond yield (January 2016–October 2019)



14. Debt variation was registered at S/. 1.4 billion due to the sol appreciation, but there is no evidence on a relation with the disaster shock.

Direct fiscal cost

This section covers the actual cost incurred as a result of the damage, including emergency support and recovery. Table 3 summarizes the executed expenditures through FONDES over the 2017–19 period. The amount recognized for operating and capital expenditures is S/. 6.3 billion. The primary financial sources were central government revenues and debt, in the amounts of S/. 3.3 billion and S/. 2.5 billion, respectively.

Smaller shares were contributed by non-treasury commodity resources and donations.¹⁵ By type of expenditure, capital investment amounted to S/. 3.5 billion. Thus, the government fixed assets and net worth increased S/. 3.5 billion. At the same time, financial assets decreased by S/. 3.9 billion, debt increased by S/. 2.5 billion, and net worth decreased by S/. 6.4 billion (total expenditures in the operating results). The result is a total decrease of S/. 2.9 billion in net worth.

> > >

TABLE 3 - Peru's emergency and reconstruction expenditure following 2017El Niño event (S/. million)

Item	2017	2018	2019	Total
Total expenditure	896	1,906	3,551	6,353
By financing source				
Revenues and buffers*	830	1,541	1,479	3,850
Debt	66	365	2,072	2,503
By financing source				
Operating	846	1,103	939	2,888
Capital	50	804	2,612	3,465

Expenditure in table 3 is less than a quarter of that programmed in the reconstruction plan due to significant delays. According to the Audit Office, delays arose in the first years of the plan's implementation because the central government was in charge of executing around 84 percent of the total budget, with minimum participation of local governments. Then, in

2018, a more decentralized approach was implemented, and subnational governments are now in charge of executing 50 percent of the total budget. This new approach has raised the levels of budget execution from 15 percent in 2017 to 35 percent in 2018 and 2019 (Government of Peru 2018b).

15. Government of Peru, Ministry of Economy and Finance, data tracking expenditure from FONDES, http://apps5.mineco.gob.pe/seguimiento_fondes/Navegador/default.aspx.



7. Conclusions

The preceding discussion emphasizes the importance of accounting for disaster impacts across public sector balance sheets, and the case for the implementation of SALM to help build understanding of the impacts of disaster risk. This can then be used to provide key practical recommendations for understanding risk in its multiple dimensions (economic, fiscal, and financial). The case studies demonstrate nicely that viable mechanisms to assist timely post disaster response and reconstruction can have very high payoffs, especially when assisted by an appropriate SALM framework, moreover, that the lack of these may be very costly. These conclusions provide a summary of the lessons learned and the implications for applying the SALM framework to help manage disaster risk.

Public sector balance sheet

Accrual accounting and cash based accounting both recognize reconstruction as an investment, however, one identified advantage of accrual accounting over cash based accounting is that it allows better identification of when and how reconstruction occurs, and hence of the associated costs and benefits, which can be used to inform measures to build financial resilience against disasters. Recognizing reconstruction as an investment; the value of public assets increases as old assets are replaced with new—even if funded by debt, this is neutral in terms of net worth. The loss of net worth arises from the impairment or write-off of the old assets. However, accrual accounting with a public sector balance sheet provides higher-quality information about the value of government assets that are susceptible to disaster risk and as such can be used to develop and implement disaster risk finance policies.

Countries that are only starting to consider SALM should start with simple analysis (e.g., debt analysis). Countries like Serbia, with cash accounting and no complete data set on government assets, face challenges in adopting and implementing the SALM approach. However, as highlighted in the discussion not all aspects need to be included at once, and having some basic level of understanding on how disaster risk can impact the structure of your debt portfolio would benefit many countries, perhaps now more than ever in the wake of the COVID-19 pandemic.

In practice, it can be difficult to identify the total direct cost of a disaster with any precision. The Peru, Serbia, and New Zealand cases demonstrated that reconstruction can last for many years; there might be reallocation within existing budget baselines that is difficult to track, and replacement assets might be of a higher standard. Still, the establishment of specific institutions to oversee the response in Peru and New Zealand made it easier to track expenditure than otherwise would have been the case.

The impact of disasters on the national economy, and therefore the indirect fiscal costs, are specific to each case depending on factors such as the relative size of the local economy that is impacted, damage to critical infrastructure, nature of supply chains, sector interdependencies, substitution, and other resilience measures. In the New Zealand case, the lack of national economic impact surprised most observers, but was at least partly attributed to minimal damage to agriculture, manufacturing, and transport.

Given these complexities, it is a significant challenge to estimate the potential impact of disasters on the national economy and the sovereign balance sheet, as it requires modeling many variables and relationships. Nevertheless, broad-brush scenario analysis, such as that undertaken in the New Zealand case, provides useful input to the development of long-term fiscal policy, in particular the degree of fiscal space that may be required to accommodate the realization of large, credible fiscal risks.

The application of SALM can increase countries' resilience to financial shocks posed by disaster risk through improved understanding of the impacts of disaster risk on both sides of the sovereign balance sheet. Going forward it could even be used to define a country's risk tolerance to disaster risk, monitor changes in this position and help to inform policy design on disaster risk and where needed support the introduction of financial instruments to manage disaster risk.

Managing Disaster Risk: lessons learned from the case studies.

Reserve funds can mitigate the need to borrow after the event, as demonstrated by both the Peru and New Zealand cases. In the case of New Zealand, the Natural Disaster Fund, in essence the capital of a government-run insurance scheme for households, covers the first tier of losses for most natural disasters. In Peru, the Stabilization Fund may be accessed to finance severe economic and disaster shocks. The long reconstruction period also resulted in a phased requirement for cash, allowing additional borrowing to be spread over time. Establishing an off-budget fund, specially designated for natural disasters, allows governments to keep and accumulate resources over the years, thus mitigating the need to borrow after the disaster event.

Disasters create an opportunity to embark upon a more systematic approach to disaster risk management. Following the floods in Serbia the government developed a more systematic approach to disaster risk management, with technical assistance from the World Bank. The government developed a disaster risk financing strategy and established a dedicated fiscal risk management unit. Embedded within the strategy was the inclusion of a contingent credit, a World Bank Catastrophe Deferred Draw Down Option (CAT-DDO) to strengthen the financial response capacity to natural disasters by having a pre-agreed line of credit that can be used following an event.

Reinsurance can play a major role in reducing the economic impact of disaster. The New Zealand case study included the use of the global reinsurance market, both by the government scheme and private sector insurers; it showed that claims on foreign reinsurers improved the net international investment position of New Zealand by around eight percentage points of GDP. Without this, the government would have been required to borrow more, as the NDF was exhausted (for the first time in 70 years).

The creation of fiscal space in addition to specific financing measures for natural disasters reduces the risk of a parsimonious response to a disaster, as shown in New Zealand's response to the Christ church earthquakes. The creation of fiscal space in the form of lower central government debt (as a percentage of GDP) during periods of reasonable to strong growth can provide additional financial resources to finance response to disasters.



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