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Financing the costs of disasters: Catastrophe bonds or taxation?

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Abstract

Disasters are becoming more frequent and the economic damages they cause are becoming more severe. The associated costs have grown continuously over the last 60 years, and financing these costs remains a major challenge. Both broadening disaster risk financing options and formulating an effective policy mix of different financial tools have become increasingly important. This paper examines two disaster risk financing tools: catastrophe bonds and taxation, based on a macroeconomic theoretical approach. The results suggest that as far as welfare is concerned, catastrophe bond options are comparatively advantageous. The paper also discusses the importance of utilising catastrophe bonds and taxation appropriately within the context of disaster response policies.

JEL classification: D53, G1, H2, O40, Q54.
Keywords: Disaster risk financing, catastrophe bonds, insurance-linked securities, public finance, disaster risk management.

Foreword

Natural hazards have been increasing around the world in frequency, intensity and damages, giving rise to ever higher disaster-related costs. Consequently, formulating effective disaster policy responses has become more critical than ever.

The international discussion regarding disaster policy response emphasises the importance of preparing an extensive and comprehensive design for disaster risk financing, incorporating not only ex-post but also ex-ante financing. Financing the increasing costs of disasters has yet to be addressed proficiently, as traditional approaches to disaster risk finance are not always sufficient in mitigating or relieving disaster-related damages. Protection gaps remain a major issue and are becoming more challenging to resolve. Broadening financing options by using a mix of different financing tools capable of coping with disasters is becoming increasingly crucial.

With these considerations in mind, this paper analyses two methods for financing disaster costs, namely tax mobilisation and the issuance of catastrophe bonds. It discusses the impact of these financing tools on economic welfare, based on a theoretical macroeconomic model.

Catastrophe bonds (CAT bonds) can play a vital role in disaster risk reduction, acting as a financial mechanism for transferring the economic risks of disasters to the market. They also provide rapid access to funds, thereby allowing for faster responses and recovery. These benefits are widely recognised, and the CAT bond market is growing on a global scale as a result; however, its development is not without challenges. Earlier OECD reports, the *Economic Outlook for Southeast Asia, China and India 2024* and *Fostering Catastrophe Bond Markets in Asia and the Pacific* discussed the importance of CAT bonds as well as policy guidelines to be considered when developing a CAT bond market. Referencing the aforementioned publications, this paper provides a theoretical discussion of policy responses to the challenges surrounding the issuance of CAT bonds.

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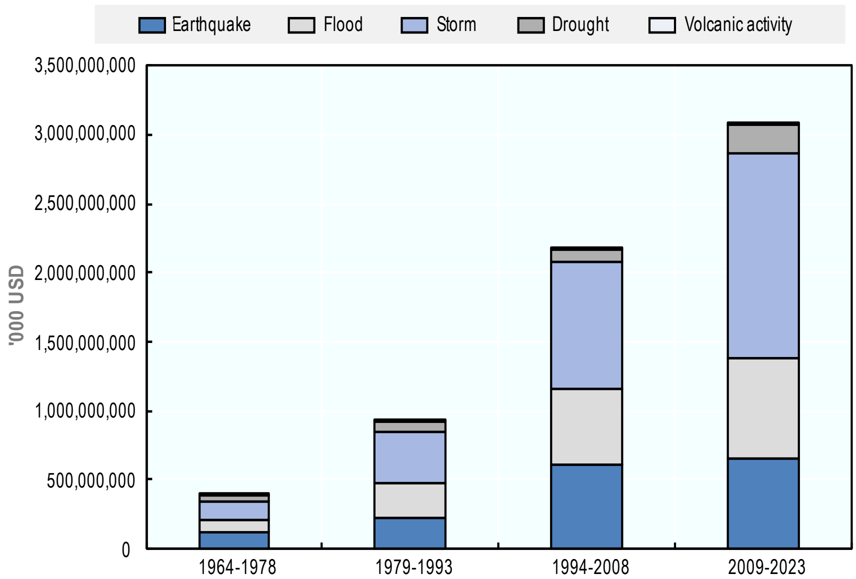
Table of contents

FIGURES

1 Introduction

The risks from natural hazards are increasing and economic damages caused by disasters are becoming more severe around the world. The associated costs have grown continuously over the last 60 years (Figure 1). The discussion on effective policy response to disasters is gaining more attention in recent years. It is crucial to plan comprehensive design for disaster risk financing, including broadening financial options. Moreover, the need to discuss an effective policy mix of different financial tools is becoming increasingly important. Figure 2 shows various financing tools that can be used to cover costs from disasters, though optimal post-disaster responses are determined by types of hazards and magnitude of disruptions to economic activity. And the choice of financial instrument mix will depend on various economic conditions, including the level of economic capital market development and access to debt markets, as well as fiscal space.

Figure 1. Disaster damages worldwide, 1964-2023



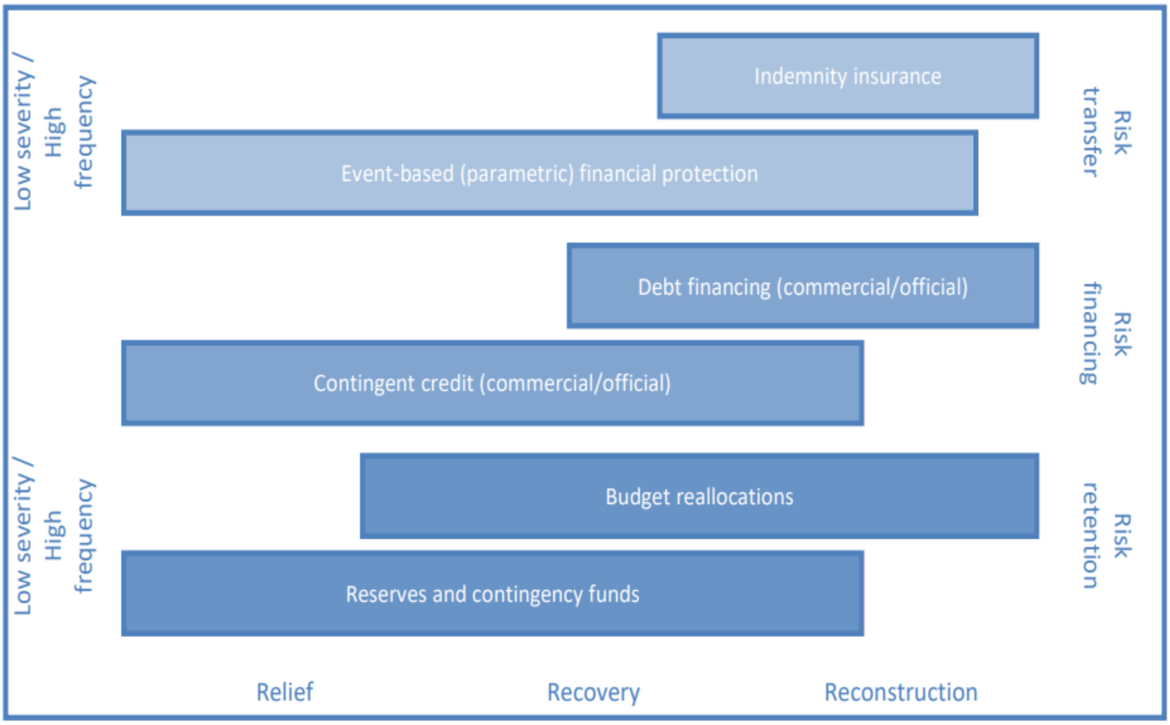
Source: EM-DAT database.

Theoretical discussions of optimal financing options have a long history. This is particularly true in the area of corporate finance, as the topic has been actively discussed since the 1960s due to arguments related to the Modigliani-Miller theorem; however, theoretical discussions within the context of disaster risk financing are fairly recent.

Against this backdrop, this paper examines two disaster financing measures – the issuance of catastrophe bonds (CAT bonds) and tax mobilisation – and compares their impact on economic welfare using a theoretical macroeconomic model. The results suggest that the catastrophe bond option has several advantages from an economic welfare point of view, and it's important to strike a right balance between catastrophe bonds and taxation.

The structure of this paper is as follows. We first review several policy options to finance the costs of disasters. We then present a theoretical model and compare the economic welfare impact of the two measures (i.e. catastrophe bonds and taxation). The paper concludes by discussing the policy challenges linked to the use of catastrophe bonds as a response to disasters, as well as discussing an appropriate balance between catastrophe bonds and taxation.

Figure 2. Funding approaches to cover contingent liabilities from disasters



Source: (OECD, 2022[1]), *Building Financial Resilience to Climate Impacts: A Framework for Governments to Manage the Risks of Losses and Damages*.

2 Policy options to finance the costs of disasters

This section briefly reviews policy options for financing the costs of disasters, including taxes, catastrophe bonds, and other measures, and then discusses the advantages and shortcomings of each as a prelude to the subsequent theoretical discussion.

2.1. Taxation

In the context of disaster response, governments use taxation as a tool to raise funds for recovery programmes. It is also not uncommon for governments to reduce taxes and similar obligations that would otherwise pressure households affected by disasters, either as a bespoke measure or through pre-existing components of the established taxation framework (e.g. temporary tax-relief provisions). Chatterjee (2019[2]) notes that tax policies have been adjusted to raise funding for disaster recovery, particularly with new taxes imposed to raise funds for recovery. These taxes are often national, making it possible to gather funds from all regions. One example is the one-off national flood reconstruction income tax introduced in Australia following the 2011 Queensland floods. Another is Japan's introduction of a temporary 2.1% surtax on income for 25 years after the 2011 earthquake.

In theory, financing through taxation is favourable to a government's fiscal position and therefore warranted in instances when the debt stock is a significant policy consideration. Moreover, as noted by Feldstein (1984[3]), it is shown in a hypothetical set-up that "with plausible parameter values, the excess burden of debt finance is likely to outweigh the advantage of avoiding a large single tax change, [and] financing a temporary increase in government spending by an immediate tax increase is likely to be preferable to debt financing". Choosing between tax finance and debt finance is ultimately argued to be about the timing of taxes, making it an empirical question. The decision rule proposed by Feldstein (1984[3]) is that if the capital stock is initially at an optimal level, financing a temporary rise in spending by government debt is suggested, but if the capital stock is initially below the optimal level, taxes are the better option.

Similar to the golden rule of public finance, which restricts the use of public debt or borrowing solely for investment purposes (Zeyneloglu, 2018[4]), it has been demonstrated theoretically that the social opportunity cost of debt-financed public investments can be greater in the long run than the social opportunity cost of tax-financed public investments (Kellermann, 2007[5]). Hence, a benevolent government that considers the welfare of future generations (i.e. that is less myopic than private households) will use taxes to finance public investment. Citing Minea and Villieu (2009[6]), Nakatani (2019[7]) explains that abiding by the golden rule can improve welfare when the growth-enhancing effect of new resources for productive public spending exceeds the crowding-out effect of the additional debt burden, which can be viewed as deficit on future economic growth. The argument is based on the Ricardian equivalence proposition that an increase in taxes will have the same effect as an incurrence of debt, regardless of whether it occurs now or later, and that governments will thus be unable to spur private consumption in the short run with debt-financed spending because rational consumers will assume that the gains now will be offset by higher taxes in the future (Barro, 1974[8]; Hamada, 2019[9]).

Pursuant to these frameworks, OECD (2021[10]) underscores the importance of utilising tax-policy tools to foster recovery from the COVID-19 pandemic, a large external shock that pushed government debt to its highest levels in decades as a proportion of gross domestic product (GDP). Concerning the type of taxes to impose, Chatterjee (2019[2]) argues that value-added tax (VAT) has the potential to finance disaster resilience more sustainably than income tax because while collection of income tax is vulnerable to widespread evasion, VAT is broad-based and falls uniformly on those of any economic class. When Ecuador was hit by an earthquake in 2016, the government raised the VAT rate from 12% to 14% for one year and imposed one-off taxes of 3% on business profits and of 0.9% on people with wealth exceeding USD 1 million. In India, the state of Maharashtra temporarily raised taxes on tobacco and spirits by 5% to fund programmes helping farmers recover from drought.

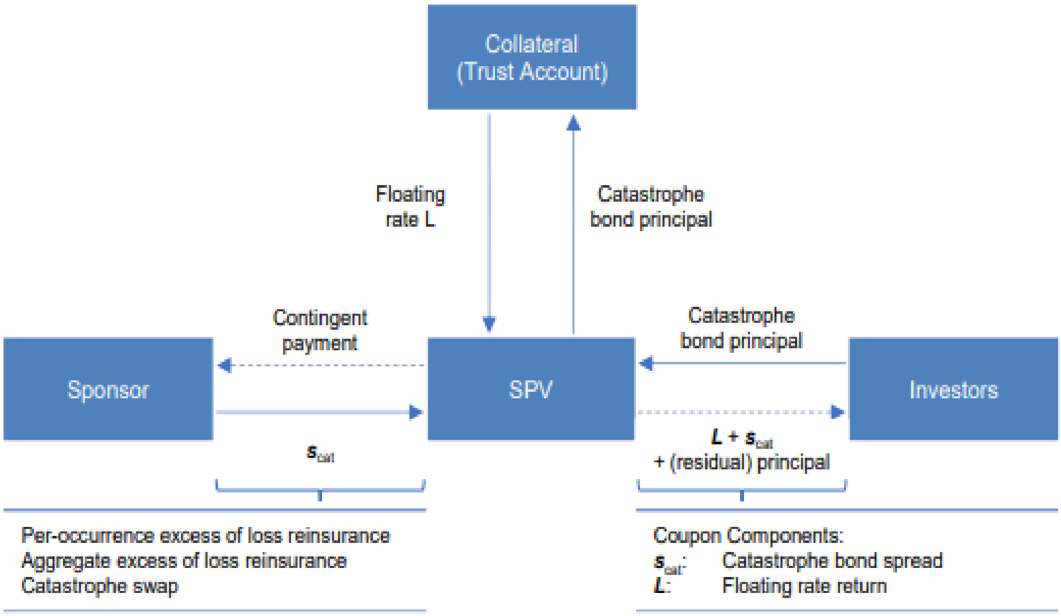
It is important to note the caveats of using taxation. While it can help relief, it may incentivise spending on relief over prevention. Chatterjee (2019[2]) argues that if governments wish to improve preparedness and manage the impact of residual risks, setting up dedicated catastrophe insurance pools to ring-fence additional taxation revenues should be given due consideration (e.g. New Zealand's National Disaster Fund, established in 1945). It is suggested that such pools can help "optimise risk retention by covering less severe but more frequent losses with low return periods and transferring less frequent but more severe losses through reinsurance and alternative risk transfer solutions, which are recognised for making rapid and predictable payouts transparently" (Chatterjee, 2019[2]). In addition, taxation can also induce distortions. Cordes and Sheffrin (1981[11]) note that taxes can encourage the allocation of capital to non-corporate uses and can distort intertemporal consumption patterns. Moreover, corporate tax can influence financing decisions towards debt, because the cost of debt is generally tax deductible, while equity finance is not, thus increasing leverage in the process until the marginal tax advantages of debt equal expected bankruptcy costs. The International Monetary Fund (IMF) adds that the development and use of complex financial instruments is "in part a response to, and shaped by, underlying tax distortions" (International Monetary Fund, 2009[12]). Meanwhile, Hamada (2019[9]) argues that, when disasters occur, "raising taxes to finance disaster recovery is the equivalent of imposing fiscal austerity during a recession". In addition to the direct cost of taxes to taxpayers, using taxation to finance disaster recovery imposes "indirect costs on the economy by distorting the market mechanism, weakening incentives and undermining efficiency at precisely the moment when the country can least afford it" (Hamada, 2019[9]). Adam and Bevan (2020[13]) state that "tax financing can exacerbate the powerful recessionary effects of disasters since taxation is required to increase just as productive capacity is destroyed" which emphasises the point that increasing taxes can be incredibly damaging to the disaster victims this measure intends to support. Miyachi et al. (2025[14]) analysed public approval of the use of taxation by the Japanese government in response to the 2011 Great East Japan Earthquake. Researchers found that the majority of the population supported this tax initially, but opposition grew following tax increases. They pointed out that it is important for governments utilising taxation to be aware of potential for regressive effects and social divisions among income groups.

2.2. Catastrophe bonds

If the market exists and conditions warrant, bonds are a tool that can be utilised by the public sector to raise funds. In the context of disaster recovery financing, they can be used to finance projects such as the reconstruction of roads, bridges and similar infrastructure. The length of the repayment schedule or the bond tenor must be chosen carefully so as not to create a mismatch in revenues and spending.

Beyond traditional bonds, catastrophe bonds have emerged as financial instruments that securitise disaster risk into a tradable format, as in Figure 3. A typical transaction requires the sponsor or cedent to set up a special-purpose vehicle (SPV), which acts as a facilitator to transfer the catastrophe risk from the sponsor to the investors between the two parties. The SPV (also called a special-purpose entity or single-purpose company) is a firm with the solitary purpose of enabling the transaction. The SPV grants reinsurance coverage or catastrophe swap protection to the sponsor and collects the required risk capital by issuing the catastrophe bond to investors (OECD, 2024[15]). In addition to catastrophe bonds, contingent disaster financing facilities, weather- or climate-related risk hedges, tailored agricultural insurance products and natural hazard-oriented microinsurance products are tools that are continuously being developed. Moreover, CAT bonds could be issued in a multi-country framework (OECD, 2024[15]; Molnar-Tanaka and Wu, 2025[16]). An initial attempt of such joint effort is, for instance, the Pacific Alliance CAT bonds, issued simultaneously by Chile, Colombia, Mexico, and Peru in 2018.

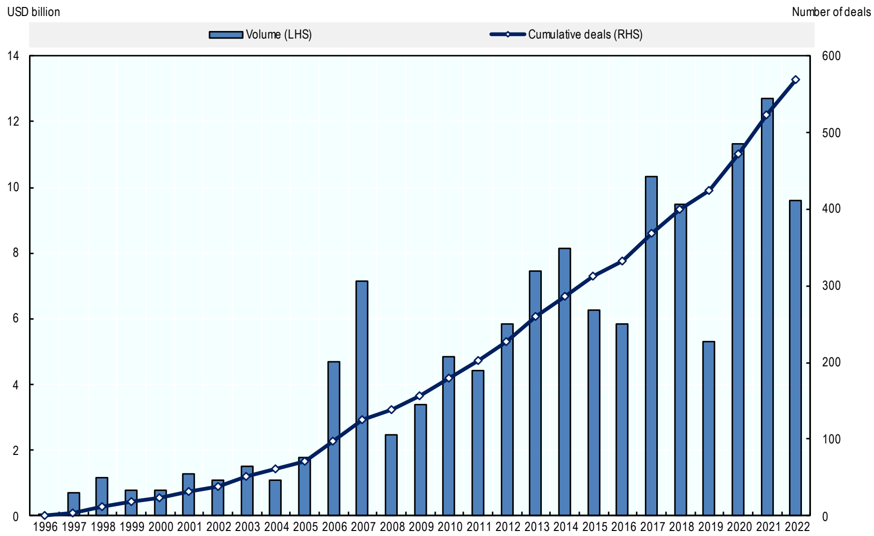
Figure 3 Typical catastrophe bond structure



Source: (OECD, 2024[15]), *Fostering Catastrophe Bond Markets in Asia and the Pacific*, The Development Dimension.

Catastrophe bonds carry notable advantages. A catastrophe bond is an insurance-linked security that: i) allows the transfer of risks to bond investors; ii) provides financial protection to the issuers (e.g. government, insurers, and reinsurers) in the event of a major natural catastrophe; iii) offers high returns to investors that are not correlated with financial market fluctuations; and iv) enables countries to raise funds quickly for disbursement in the event of a catastrophe (Abrigo and Lu, 2018[17]). Indeed, globally, outstanding CAT bonds and related insurance-linked securities (ILS) have grown approximately 40-fold in the last 25 years (Figure 4). Indemnity triggers remain dominant in the current market, accounting for approximately 75% of total catastrophe bond and ILS issuance in 2023 (Figure 5). They remain favoured by sponsors, since they may offer a better way to fit bond coverage within the sponsor's overall reinsurance programme. Issuances in 2020 also featured industry-loss index, parametric and hybrid triggers. According to the Artemis Deal Directory, 2020 was the first year since 2017 when none of the catastrophe bonds issued featured modelled-loss triggers (Artemis, n.d.[18]).

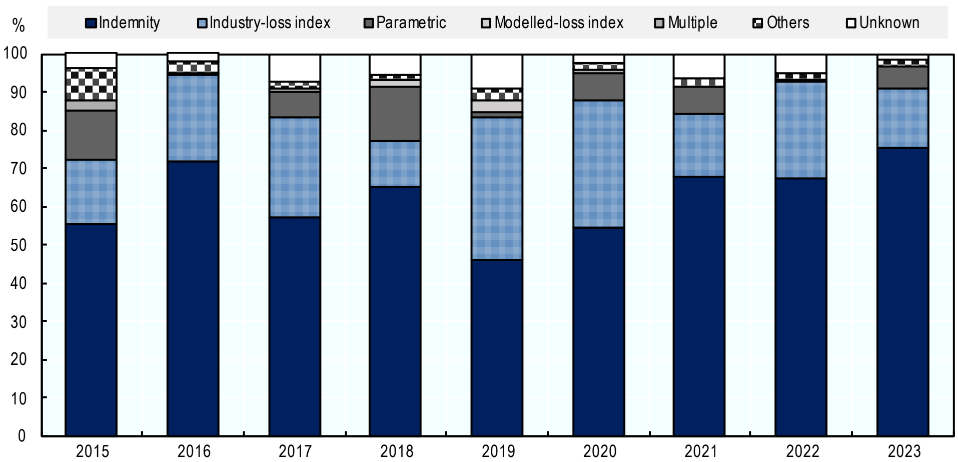
Figure 4. CAT bond issuance and number of deals, 1996-2022



Note: Only 144A CAT bonds or similar are included. 144A CAT bonds are privately placed CAT bonds under Rule 144A of the US Securities Act. LHS = left hand scale. RHS = right hand scale.
Source: (Artemis, n.d.[18]), *Catastrophe Bond & Insurance-linked Securities Deal Directory* (database).

Figure 5. CAT bonds and ILS issuance by trigger type, 2015-23

% of total issuance



Source: (Artemis, n.d.[18]), *Catastrophe Bond & Insurance-linked Securities Deal Directory* (database).

For instance, in the United States, the National Association of Insurance Commissioners adopted regulatory frameworks for protected cells and special-purpose reinsurance vehicles (SPRV) in 1999 and 2001 to incite onshore issuance, but many reinsurers began to circumvent this SRPV legislation by locating the SRPV offshore while the funds of the vehicle were managed onshore (Klein and Wang, 2009[19]). The United Kingdom introduced legislative changes in 2017 to make the country more suitable for ILS issuance. First, corporate and insolvency law were altered by the introduction of a protected cell company regime. Second, financial services law was expanded to include the new regulated activity of "risk transformation". Third, taxation law was changed to allow tax neutrality for insurance special-purpose vehicles (ISPV) domiciled in the United Kingdom (Norton Rose Fulbright, 2017[20]). These changes paved the way for several notable issues, including from Atlas Capital UK (USD 250 million and USD 300 million), Baltic PCC (USD 98 million) and NCM Re (USD 77 million) (CCR Re, 2019[21]). France has a beneficial ILS framework that recognises SPVs. The vehicle that operates as an SPV is the securitisation mutual fund (*fonds commun de titrisation*). The legislation surrounding the vehicle, originally created to securitise debt, has been overhauled (Faure-Dauphin and Marion, 2021[22]), and today it can be used in ILS transactions. The first such instance was in April 2019, when the French reinsurer CCR issued the first ILS (a sidecar) domiciled in France (CCR Re, 2019[21]). In addition, according to CCR, the French market offers favourable tax treatment and, in comparison to offshore tax havens, Paris is a marketplace with a better reputation (CCR Re, 2019[21]). Singapore aspires to be the leading ILS market in Asia and recognises the need to finance climate risk in the region. In an effort to attract issuers from abroad and to expand the ILS market, the Monetary Authority of Singapore (MAS) introduced an ILS grant scheme in February 2018. The scheme funds 100% of the upfront costs of ILS bond issuance up to SGD 2 million, with the aim of removing near-term frictional costs of issuance (Artemis, 2020[23]). Other supportive measures include improving data quality and standardisation in order to develop industry-loss-based indices. These indices track aggregate-level losses to insurers and are often used as benchmarks for industry-loss triggers (Wharton, 2021[24]). In addition, MAS has aimed to establish a sound regulatory and legal infrastructure to support a wide variety of ILS instruments (GuyCarpenter, n.d.[25]; MAS, 2021[26]).

The regulatory framework for ILS in Hong Kong, China is managed by the Insurance Authority (IA). Issuance of CAT bonds in Hong Kong is relatively new, with the first regulatory framework being introduced in 2021. The framework has been refined since then, with efforts to provide favourable tax treatment for domiciling ILS and to develop ILS markets (Insurance Authority, 2021[27]). A Pilot ILS Grant Scheme was also announced at the time of the initial framework release in 2021 as part of the 2021-22 Budget for Hong Kong, China (Insurance Authority, 2021[27]). Since then, the ILS Grant Scheme has remained in place and was recently renewed until 2028 as part of the 2025-26 Budget (Insurance Authority, 2025[28]). The framework and grant scheme have been successful in encouraging ILS issuance in Hong Kong, China, with six CAT bonds having been issued as of 26 February 2025 (Insurance Authority, 2025[28]; 2025[29]), with at least one more being issued as of 30 April 2025, bringing the total issuance to approximately USD 800 million (Insurance Authority, 2025[29]).

2.3. Other funding sources

Other financing tools such as foreign aid, budget reallocations, the use of reserve funds, and donations from philanthropic organisations are also often used to cope with disasters. Debt can play a crucial role in financing national and subnational disaster risk reduction (DRR) investments as well as recovery, and development banks are tasked with providing it. Two routes of engagement are most common: i) (concessional) loan facilities or funds that are exclusively available to dedicated DRR investments; and ii) incentivised (discounted) lending rates for investments that fulfil minimum resilience requirements.

The use of foreign aid is one of the most common disaster financing tools particularly in low- and middle-income countries with high exposure to disasters. Some of the major global initiatives supporting the collection and distribution of foreign aid for this purpose include UN agencies such as UNDP and UNDRR, the World Bank and its GFDRR, the European Civil Protection and Humanitarian Aid Operations (ECHO), and various countries acting as bilateral donors.

National-level budget allocation is another approach that is used for disaster-related financing since it does not rely on external funding. It is indeed an important and a widely used mechanism to fund disaster response, although the pattern of reallocations is not identical across countries (Allan and Bayley, 2023[30]). It can be done by requesting budget allocations through regular budget process, using some of the existing budget lines, or modifying the issued allocations (World Bank, 2023[31]). One example of the use of existing budgets for disaster response is in the Philippines, national government agencies are allowed to either modify the issued allocations or use savings to increase deficient appropriations, in exceptional situations (World Bank, 2023[31]).

The use of a designated fund, such as disaster reserve fund, contingency fund, or stabilisation fund is another financing option. Disaster reserve funds are pre-allocated financial resources set aside by governments specifically for disaster-related activities including preparedness, prevention and mitigation, emergency response and recovery. A reserve fund allows rapid response in case of a shock. It is thus suitable for high frequency, low severity hazard type (World Bank, 2022[32]). For example, Peru allocates a portion of the budget to contingency reserve for responding to emergencies following a disaster. The country also has a fiscal stabilisation fund which can be used in case of disasters (World Bank, 2016[33]). India also has dedicated disaster reserve funds at both national and state levels (NDRF and SDRF) to support post-disaster relief measures (Ministry of Home Affairs, 2024[34]). While many countries use these funds mainly for post-disaster response and relief, they are also increasingly being used to finance DRR measures.

Public-private partnerships (PPP) are another potential funding mechanism. PPP mobilises private-sector funds. In the context of disaster recovery, the arrangements usually involve utilities and other infrastructure projects. In Japan, for instance, an attempt to integrate disaster risk management into PPPs involves contractually mandating private operators to shoulder post-disaster responsibilities. This encourages integration of risk reduction measures into a project's design and performance specifications. It requires the inclusion of disaster risk management measures in tender submissions and adjusts the availability payments to compensate or penalise actual performance during a disaster event. Within PPPs, viability gap funding under the auspices of the public sector or international donors can be used to allow private-sector actors to invest in "risk layers of an asset that match their investment horizon and risk-return profile, while the public sector takes on the remaining shares and/or finances the up-front project preparation costs" (ADB, 2020[35]).

The private sector is an important player in global disaster response. Private philanthropic organisations can play a growing role in disaster financing, often filling the gaps that governments or traditional donors cannot address. Between 2016 and 2020, an estimated of USD 1.77 billion in philanthropic funding directed globally towards natural disaster responses, with 37% of this amount originating from companies or company-affiliated foundations (The Conference Board, 2023[36]). It is particularly useful as private funding is often more flexible and can reach on-the-ground responders more quickly (Merrill, n.d[37]). A number of major philanthropic organisations indeed have been contributing to disaster financing through various projects on emergency responses and disaster resilience.

3 Theoretical model analysis

3.1. Model: General setting

In this section, we construct a theoretical model using a macroeconomic approach in order to compare different policy options based on economic welfare. Discussions on policy responses to disasters based on macroeconomic approaches are recently increasing. For instance, Reitz (1988[38]) and (Barro, 2006[39]) discuss economic impacts on disasters and explained how they are related to asset-pricing puzzles. Keen and Pakko (2011[40]) discuss optimal monetary and financial responses to disasters, presenting similar discussions. Molnar-Tanaka, Dutu, Ibrahim (2025[41]) discuss the role of reserve against disasters and Molnar-Tanaka, Choi and Park (2024[42]) examines the importance of capital accumulation in disasters, by using macroeconomic framework. Akao and Sakamoto (2018[43]) develop a unified framework in which various types of catastrophic shocks can be considered simultaneously within a standard model of economic growth using a growth model with disaster risks. More recently, Bakkensen and Barrage (forthcoming[44]) present a framework in which the effect of climate disasters on economic growth can be consistently analysed, both theoretically and empirically.

In this model, we consider a discrete-time, infinite-horizon economy with a continuum of households, indexed by i, each of which owns a stock of physical capital $k_{i,t}$, human capital $h_{i,t}$, and government issued bonds – i.e. sovereign catastrophe bonds $b_{i,t}$ – if any. In this model, we assume that the government can issue bonds only for the purpose of financing disaster risk and other types of bonds are not considered. Denoting the rental rate of physical capital by $r_{k,t}$, the wage rate per unit of human capital by $r_{h,t}$, and the coupon rate of catastrophe bonds by $r_{b,t}$, we write the income of each household as $m_{i,t} := r_{k,t}k_{i,t} + r_{h,t}h_{i,t} + r_{b,t}b_{i,t}$, which can be either consumed or invested. Let $c_{i,t}$ be household i's consumption and let $x_{k,i,t}$ and $x_{h,i,t}$ be its investment in physical and human capital, respectively. Then the budget constraint of household i reads

$$c_{i,t} + x_{k,i,t} + x_{h,i,t} + b_{i,t+1} - b_{i,t} = r_{k,t}k_{i,t} + r_{h,t}h_{i,t} + r_{b,t}b_{i,t} + S_{i,t} \tag{1}$$

where $S_{i,t}$ is the net government subsidy (i.e. subsidies minus tax, if any). $S_{i,t}$ is determined through a combination of taxation and subsidies and this will be specified later in this paper. The stocks of physical and human capital evolve according to

$$k_{i,t+1} = \zeta_{k,i,t}k_{i,t} + x_{h,i,t}, \text{ and } h_{i,t+1} = \zeta_{h,i,t}h_{i,t} + x_{h,i,t}. \tag{2}$$

Here, $\zeta_{i,t} := (\zeta_{k,i,t}, \zeta_{k,i,t})$ represents the stochastic survival rates of physical and human capital, which capture the household-specific (idiosyncratic) risk of disasters. We assume that for a given i, $\zeta_{k,i,t}$ and $\zeta_{h,i,t}$ can be correlated because a single disaster can destroy both types of capital simultaneously. Subject to the constraints $(1)-(2)$ with $(k_{i,0}, h_{i,0}, b_{i,0})$ being given, household i chooses a sequence $(c_{i,t}, x_{k,i,t}, x_{h,i,t}, b_{i,t+1})_{t=0}^{\infty}$ to maximise the expected lifetime welfare

$$\max_{(c_{i,t},x_{k,i,t},x_{h,i,t},b_{i,t+1})_{t=0}^{\infty}} \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_{i,t})\right] \tag{3}$$

where $u(c_i)$ is the period utility function.

The aggregate production technology of this economy is represented by a production function

$$y_t = F(k_t, h_t) \tag{4}$$

where y_t is the output of a final good, k_t is the aggregate stock of physical capital, and h_t is the aggregate stock of human capital. We describe the aggregate-level production process as a profit-maximisation problem of a representative firm, which, at each point in time, employs capital and labour so as to maximise the current profit $y_t - r_{k,t}k_t - r_{h,t}h_t$. It follows that k_t and h_t must satisfy the first-order conditions for each *t* (time).

$$r_{k,t} = F(k_t, h_t), \text{ and } \; r_{h,t} = F(k_t, h_t) \tag{5}$$

We note that the above model is a straightforward generalisation of the tractable growth model originally developed by Krebs (2003[45]; 2003[46]). Unlike Krebs (2003[46]), however, we consider a correlated risk of disasters that can destroy both physical and human capital. Also, our model has a sovereign catastrophe bond as an alternative source of government revenue, whereas (Krebs, 2003[46]) only considers income tax to finance insurance policies. It will be shown that these differences are important and allow us to deliver new insights into disaster risk management policies.

3.2. Equilibrium

At equilibrium, every market must clear. Normalising the mass of population to unity, we can write the market-clearing conditions as

$$y_t = \int_0^1 (c_{i,t} + x_{k,i,t} + x_{h,i,t})\, di \tag{6}$$

And

$$k_t = \int_0^1 k_{i,t} di\,, \qquad h_t = \int_0^1 h_{i,t} di\,, \text{and } \; b_t = \int_0^1 b_{i,t} di, \tag{7}$$

where b_t is the amount of catastrophe bonds issued by the government. The government budget constraint is

$$b_{t+1} - b_t = r_{b,t} b_t + \int_0^1 S_{i,t} di \tag{8}$$

Note that if the government issues no catastrophe bonds, we have $b_t = b_{i,t} = 0$ for all t, in which case (8) becomes

$$0 = \int_0^1 S_{i,t} di, \tag{9}$$

meaning that any policy must be financed through taxation in each period. To characterise the equilibrium, we introduce a few assumptions.

Assumption 1 (isoelastic utility)

The period utility $u(c_{i,t})$ is represented by the following isoelastic function

$$u(c_{i,t}) = \frac{c_{i,t}^{1-\eta} - 1}{1-\eta}, \tag{10}$$

where $\eta > 1$, with the understanding that $u(c_{i,t}) = ln(c_{i,t})$ for $\eta = 1$.

Assumption 2 (linear homogeneity)

The aggregate production function $F(k_t, h_t)$ is linearly homogeneous in (k_t, h_t). Also, the net subsidy $S_{i,t}$ is a time-independent function of $(m_{i,t}, k_{i,t}, h_{i,t}, \zeta_{i,t})$, denoted as $S(m, k, h, \zeta)$, and is linearly homogenous in $(m_{i,t}, k_{i,t}, h_{i,t})$.

It follows from Assumptions $1-2$ that the equilibrium is characterised by

$$k_{i,t+1} = \frac{\tilde{k}_{i,t+1}}{\tilde{k}_{i,t+1} + 1 + \tilde{b}_{i,t+1}} \left(1 - \tilde{c}_{i,t}\right) R\left(r_{k,t}, r_{h,t}, r_{b,t}, \tilde{k}_{i,t}, \tilde{b}_{i,t}, \zeta_{i,t}\right)\left(k_{i,t} + h_{i,t} + b_{i,t}\right) \tag{11}$$

$$h_{i,t+1} = \frac{1}{\tilde{k}_{i,t+1} + 1 + \tilde{b}_{i,t+1}} \left(1 - \tilde{c}_{i,t}\right) R\left(r_{k,t}, r_{h,t}, r_{b,t}, \tilde{k}_{i,t}, \tilde{b}_{i,t}, \zeta_{i,t}\right)\left(k_{i,t} + h_{i,t} + b_{i,t}\right) \tag{12}$$

$$h_{i,t+1} = \frac{\tilde{b}_{i,t+1}}{\tilde{k}_{i,t+1} + 1 + \tilde{b}_{i,t+1}} \left(1 - \tilde{c}_{i,t}\right) R\left(r_{k,t}, r_{h,t}, r_{b,t}, \tilde{k}_{i,t}, \tilde{b}_{i,t}, \zeta_{i,t}\right)\left(k_{i,t} + h_{i,t} + b_{i,t}\right) \tag{13}$$

where we define the function $R\left(r_k, r_h, r_b, \tilde{k}_i, \tilde{b}_i, \zeta_i\right)$ as

$$R\left(r_k, r_h, r_b, \tilde{k}_i, \tilde{b}_i, \zeta_i\right) := \frac{1}{\tilde{k}_i+1+\tilde{b}_i}\left\{\left(r_k + \zeta_{k,i}\right)\tilde{k}_i + \left(r_h + \zeta_{h,i}\right) + (r_b + 1)\tilde{b}_i + S\left(r_k\tilde{k}_i + r_h + r_b\tilde{b}_i, \tilde{k}_i, 1, \zeta_i\right)\right\} \quad (14)$$

and $(r_{k,t}, r_{h,t}, r_{b,t}, \tilde{c}_{i,t}\tilde{k}_{i,t+1}, \tilde{b}_{i,t+1})i \in [0,1], t \in \mathbb{N}$ is determined as a solution to the following system of equations:[1]

$$c_{i,t} = 1 - \left(\beta\mathbb{E}\left[R(r_{k,t+1}, r_{h,t+1}, r_{b,t+1}, \tilde{k}_{i,t+1,}\tilde{b}_{i,t+1,}, \zeta_{i,t+1}\right]^{1-\eta}\right)^{\frac{1}{\eta}} \quad (15)$$

$$\mathbb{E}\left[\frac{r_{k,t+1} + \zeta_{k,i,t+1} + S_{m,i,t+1}r_{k,t+1} + S_{k,i,t+1} - R(r_{k,t+1}, r_{h,t+1}, r_{b,t+1}, \tilde{k}_{i,t+1,}\tilde{b}_{i,t+1,}\zeta_{i,t+1})}{(R(r_{k,t+1}, r_{h,t+1}, r_{b,t+1}, \tilde{k}_{i,t+1,}\tilde{b}_{i,t+1,}, \zeta_{i,t+1}))^{\eta}}\right] = 0 \quad (16)$$

$$\mathbb{E}\left[\frac{r_{b,t+1} + 1 + S_{m,i,t+1}r_{b,t+1} + S_{b,i,t+1} - R(r_{k,t+1}, r_{h,t+1}, r_{b,t+1}, \tilde{k}_{i,t+1,}\tilde{b}_{i,t+1,}\zeta_{i,t+1})}{(R(r_{k,t+1}, r_{h,t+1}, r_{b,t+1}, \tilde{k}_{i,t+1,}\tilde{b}_{i,t+1,}, \zeta_{i,t+1}))^{\eta}}\right] = 0 \quad (17)$$

$$r_{k,t} = F_k\left(\tilde{k}_t, 1\right), \ \ r_{h,t} = F_h\left(\tilde{k}_t, 1\right) \quad (18)$$

$$\tilde{b}_{t+1}\frac{h_{t+1}}{h_t} - \tilde{b}_t = r_{b,t}\tilde{b}_t + \int_0^1 \frac{h_{i,t}}{h_t} S\left(r_{k,t}\tilde{k}_{i,t} + r_{h,t} + r_{b,t}\tilde{b}_{i,t}, \tilde{k}_{i,t}, 1\zeta_{i,t}\right) di \quad (19)$$

At symmetric stationary equilibrium, where $\tilde{k}_{i,t} = \tilde{k}$ and $\tilde{b}_{i,t} = \tilde{b}$ for all i and t, the equilibrium value of $(r_k, r_h, r_b, \tilde{c}, \tilde{k}, \tilde{b})$ is pinned down by

$$\tilde{c} = 1 - \left(\beta\mathbb{E}\left[(R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta))^{1-\eta}\right]\right)^{\frac{1}{n}} \quad (20)$$

$$\mathbb{E}\left[\frac{r_k + \zeta_k + S_m r_k + S_m r_k + S_k - R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta)}{(R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta))^{\eta}}\right] = 0 \quad (21)$$

$$\mathbb{E}\left[\frac{r_b + 1 + S_m r_b + S_b - R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta)}{(R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta))^\eta}\right] = 0 \tag{22}$$

$$r_k = F_k(\tilde{k}, 1), \;\; r_h = F_h(\tilde{k}, 1) \tag{23}$$

$$\tilde{b}(1-\tilde{c})\mathbb{E}\left[R(r_k, r_h, r_b, \tilde{k}, \tilde{b}, \zeta\right] - \tilde{b} = r_b\tilde{b} + \mathbb{E}\left[S(r_k\tilde{k} + r_h +, r_b\tilde{b}, \tilde{k}, 1, \zeta)\right] \tag{24}$$

In what follows, we calibrate the model and quantitatively investigate how the stationary equilibrium is affected by different policies.

3.3. Calibration

To calibrate the model, we closely follow Krebs (2003[46]). We first specify the production function as $F(k,h) = Ak^\alpha h^{1-\alpha}$, where we set $A = 0.28$ and $\alpha = 0.36$ to roughly replicate the observed capital share of income (36%) and savings rate (24%); see Feenstra, Inklaar and Timmer (2015[47]) for more details. As in Krebs (2003[46]), the households are assumed to discount future-period utility at the annual rate of 5.35%, which means that $\beta = 0.9465$. The consumption elasticity of marginal utility, η, is set to 2, the value commonly used in the literature.[2] We also assume that $\zeta_i = (\zeta_{k,i}, \zeta_{h,i})$ follows the bivariate normal distribution $N(\mu, \Sigma)$, where

$$\mu := \begin{bmatrix}\mu_k \\ \mu_h\end{bmatrix}, \text{and } \Sigma := \begin{bmatrix}\sigma_k^2 & \rho\sigma_k\sigma_h \\ \rho\sigma_k\sigma_h & \sigma_h^2\end{bmatrix} \tag{25}$$

On average, both types of capital are assumed to depreciate at the annual rate of 6%, which means $\mu_k = 0.94$ and $\mu_h = 0.94$. As mentioned above, we assume that the two types of risks are highly correlated, and here we set $\rho = 0.99$ to quantify the risk of disasters, and we choose $\sigma_k = 0.145$ and $\sigma_h = 0.200$, with which the equilibrium rates of return are in line with the observed values. At equilibrium with no policy intervention, the model predicts that the return on physical capital investment is 7.3%, the return on human capital investment is 9.3% and the coupon rate is 2%.[3] In order to solve for the equilibrium numerically, we use the multivariate Gauss-Hermite quadrature to approximate the bivariate normal distribution.

3.4. Comparison of taxation and catastrophe bonds as policy options

In the ideal economy where disaster risk is fully insured through a market system, no governmental intervention can deliver a welfare benefit. In reality, however, people are still facing uninsured risk of disasters. This leaves room for governmental risk management policies to play an important role. To investigate the effects of disaster risk management policies, we consider an insurance scheme where those households that have been affected by a disaster receive subsidies to compensate for the capital destruction they experience. More precisely, we specify the net-subsidy function $S(m, k, h, \zeta)$ as

$$S(m_i, k_i, h_i, \zeta_i) = v_k(\mu_k - \zeta_{k,i})k_i\mathbb{1}_{\{\mu_k > \zeta_{k,i}\}} + v_h(\mu_h - \zeta_{h,i})h_i\mathbb{1}_{\{\mu_h > \zeta_{h,i}\}} - \tau m_i \qquad (26)$$

where $\mathbb{1}$ is an indicator function. Note that $(\mu_k - \zeta_{k,i})k_i$ and $(\mu_h - \zeta_{h,i})h_i$ represent the damage caused by disasters. Here, v_k and v_h represent the intensities of disaster risk management policies[4]. If $v_k = \mu_h = 0$, no insurance is provided against disaster risks. For positive values of these parameters, households receive compensation for the capital destruction whenever the survival rate ζ_i is lower than its average μ. Our baseline scenario assumes $v_k = v_h$, meaning that the insurance is uniformly targeted to both types of disaster risk.[5]

We consider two policy options for financing disaster risk: taxation and catastrophe bonds. As for taxation, we assume that the government collects a constant fraction, τ , of households' income to pay for the cost of disaster risk management policies. Such an income tax has distortionary effects and disincentivises investment by households, which can be seen as a cost of mitigating disaster risks.

The other option is sovereign (government-issued) catastrophe bonds. In our model, as discussed, the sovereign bonds are issued for the sole purpose of financing the disaster risks. With the scale of policy intervention given by v, the government adjusts the amount of bonds it sells, which, together with households' demand for the bond, determines the equilibrium coupon rate r_b in the bond market. Similar to the case of taxation, issuing a sovereign catastrophe bond hinders capital accumulation by diverting resources from investments in physical and human capital. As we will see shortly, however, financing the policy differently can produce different effects on household welfare and economic growth. We assume that the two financing options are mutually exclusive, meaning that the government either uses taxation ($\tau > 0$ and $b = 0$) or catastrophe bond issuance ($\tau = 0$ and $b > 0$) to finance the disaster risk management policy, but not both. This way we can better illustrate the different roles played by different financing instruments.

Note that the disaster risk financing policy described above not only retroactively helps households financially, but also proactively changes the behaviour of households prior to a disaster. Once the policy is implemented, it allows people to invest in physical and human capital with reduced concern about the risk of disasters, which in turn could potentially spur economic growth. The overall impact is not trivial, though, because the policy intervention induces a distortion and at least partially offsets the benefit of disaster risk management, no matter how it is financed.

3.5. Results

Figures 6-11 summarise the main findings of our analysis. First and foremost, we find that government intervention to insure against disaster risk unambiguously improves equilibrium welfare, regardless of how the policy is financed. As shown in Figure 6, spending just 0.1% of GDP on disaster risk management yields a welfare gain equivalent to a permanent 0.16% increase in consumption if financed by taxes, or a 0.25% increase if financed by catastrophe bonds, relative to the baseline with no intervention. This demonstrates that the benefits of mitigating disaster risk exceed the costs of the policy.

However, the channels through which these welfare gains materialise – and the corresponding effects on economic growth – differ dramatically between the two financing options. Our analysis reveals a stark trade-off: catastrophe bond financing provides superior welfare gains by offering better insurance, while tax financing leads to higher long-run economic growth. Understanding the transmission mechanisms behind this counterintuitive result is crucial to effective policy design.

When the government issues sovereign catastrophe bonds, it introduces a new risk-free asset into the economy. As Figures 8-10 illustrate, households divert a portion of their savings from productive but risky physical and human capital into these government bonds, seeking to shield their wealth from disaster shocks. This portfolio reallocation is a form of "crowding-out," not through direct government spending, but through competition for private savings. This shift reduces the economy's total stock of productive capital because the bonds themselves are not productive assets, leading to a lower long-run growth rate (Figure 7). Despite this negative impact on growth, sovereign catastrophe bond financing yields a much larger welfare gain. The primary reason is that the catastrophe bond market, once established, provides a powerful insurance mechanism that is otherwise unavailable. By holding a risk-free asset, households can significantly smooth their consumption and income in the face of disaster shocks. As Figure 11 clearly shows, the introduction of sovereign catastrophe bonds dramatically reduces the variance of equilibrium income. For risk-averse households, the welfare benefit of this enhanced insurance is substantial and outweighs the cost of lower long-term growth.

The tax-financed policy, in contrast, generates two opposing effects on investment. On one hand, the income tax is distortionary, reducing the after-tax return on all assets and creating a drag on investment. On the other hand, the insurance payments are targeted to reduce the risk associated with human capital, which carries a higher expected return in equilibrium to compensate for its greater risk exposure. This targeted risk reduction makes human capital more attractive than physical capital on a risk-adjusted basis. This can induce households to rebalance their portfolios toward the higher-return human capital asset. As our results in Figure 7 indicate, this portfolio rebalancing effect is strong enough to slightly outweigh the general tax distortion, leading to a small net increase in the long-run growth rate. However, because this policy does not introduce a new safe asset, it offers far less income smoothing than the sovereign catastrophe bond option (Figure 11), resulting in a smaller overall welfare gain.

In summary, while both financing instruments improve welfare by providing insurance, their economic impacts are fundamentally different. Taxation maintains a higher growth rate, yet is less effective than catastrophe bonds at reducing income uncertainty. Catastrophe bonds lead to lower growth than a tax-financed policy does due to crowding out of productive investment, but they offer superior risk-sharing that households value highly by creating a more complete asset market.

Our analysis, while comprehensive in its treatment of disaster financing mechanisms, necessarily abstracts from several real-world complexities that merit discussion. First, our framework does not feature an endogenous labour supply. Incorporating a labour-leisure choice would likely strengthen the case for catastrophe bonds, as distortionary income taxes would create a second channel of inefficiency by discouraging work, in addition to their effect on capital accumulation. Second, the analysis centres on ex-post financing for disaster relief. In practice, this is complemented by ex-ante adaptation investments, such as building resilient infrastructure. Such measures would reduce the magnitude of disaster losses in our model, thereby lowering the demand for insurance and altering the optimal policy mix. Exploring the interaction between ex-ante investment incentives and ex-post financing mechanisms remains a key area for future research.

Finally, our model abstracts from real-world fiscal and distributional constraints. The viability of bond financing depends heavily on a country’s sovereign risk profile, as nations with high initial debt may face prohibitive risk premia. Conversely, the feasibility of raising revenue through taxation may be limited in countries with a large share of the population at subsistence consumption levels. Incorporating these constraints would allow for more targeted policy guidance tailored to specific country contexts. It is also important to note that while we focus on a public insurance scheme, the welfare gains we identify stem from the provision of risk-sharing itself; these benefits could, in principle, be delivered by private markets, provided they could overcome issues of correlated risk and ensure solvency.

Figure 6. Impact of disaster policy: Welfare

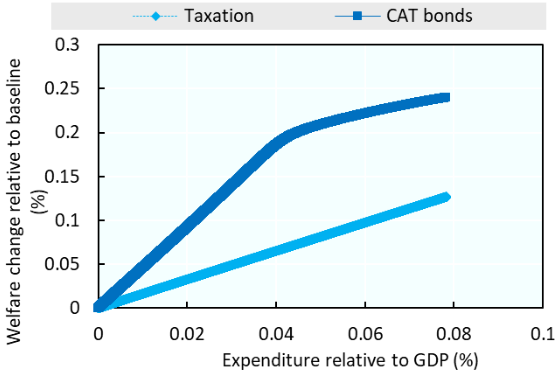
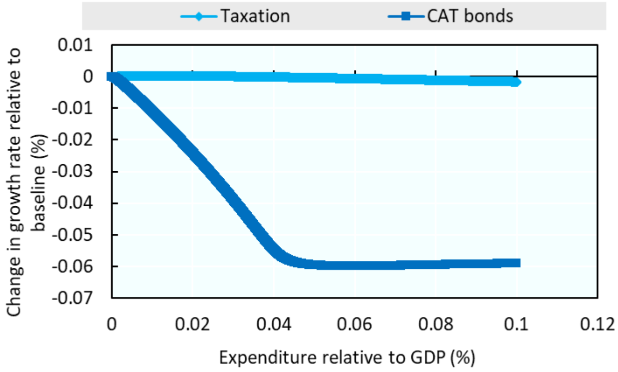


Figure 7. Impact of disaster policy: Economic growth



Source: Authors.

Figure 8. Impact of disaster policy: Physical capital

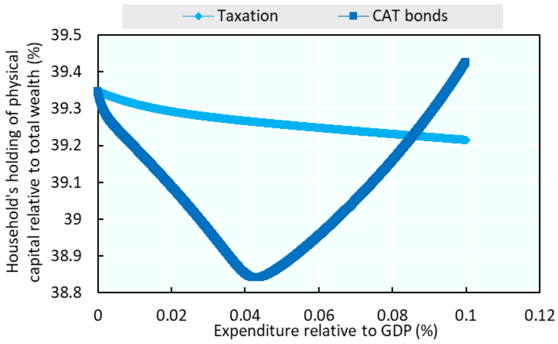
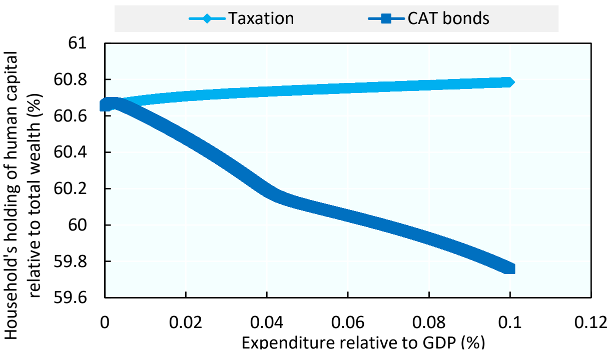


Figure 9. Impact of disaster policy: Human capital



Source: Authors.

Figure 10. Impact of disaster policy: CAT bond holding

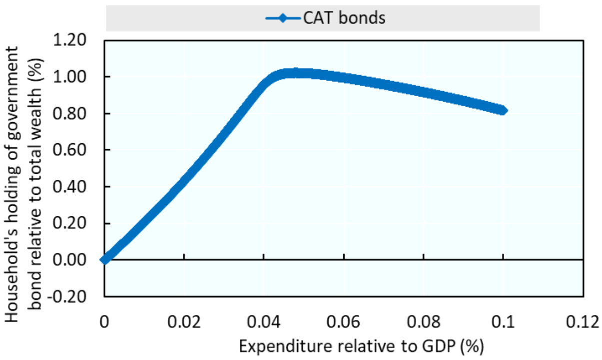
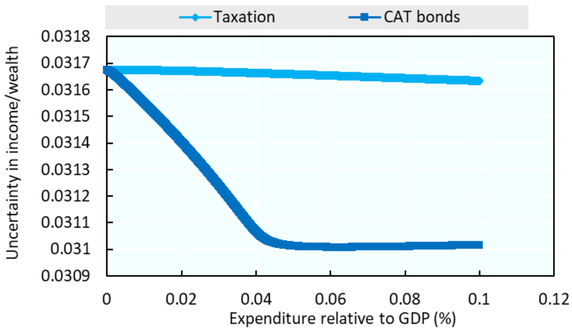


Figure 11. Impact of disaster policy: Uncertainty in income



Source: Authors.

3.6. Extension of the model

As a robustness check, we extend the baseline model and introduce an aggregate risk of capital destruction. The baseline model considers idiosyncratic disaster risks; each individual household faces uncertainty, but there is no uncertainty from the perspective of aggregate economy. Although this modelling approach is reasonable, one could argue that some disasters are actually unpredictable even at the aggregate level and therefore the results we obtained above may only capture part of the story. To incorporate an aggregate-level risk in the simplest possible way, we assume that the occurrence of unpredictable disasters follows a Bernoulli process with probability $\lambda > 0$. Once a disaster strikes, all types of capital are destroyed and only a fraction $\Delta \in (0, 1)$ of them survive. This aggregate risk is introduced on top of the idiosyncratic risks that already exist in the model. Formally, the law of motion for physical and human capital is now changed to

$$k_{i,t+1} = D_t \zeta_{k,i,t} k_{i,t} + x_{k,i,t} \text{ and } h_{i,t+1} = D_t \zeta_{h,i,t} h_{i,t} + x_{h,i,t}, \qquad (27)$$

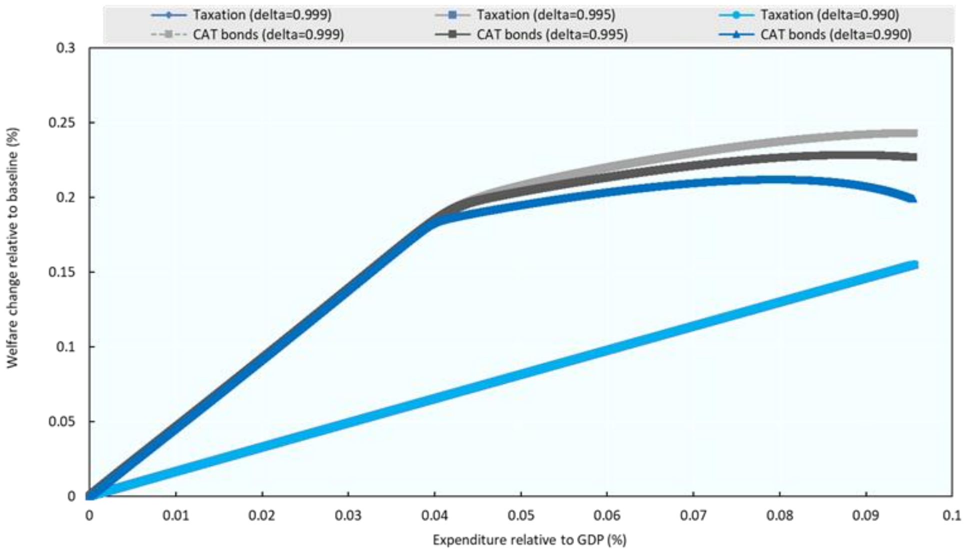
respectively, where D_t is a stochastic process defined by

$$D_t = \begin{cases} \Delta \text{ with probability } \lambda, \\ 1 \text{ with probability } 1 - \lambda \end{cases} \qquad (28)$$

The other model components are all kept unchanged. Given the fact that a large-scale, economy-wide disaster is rather rare, we assume that the annual hazard rate is 1% $(\lambda = 0.01)$. Varying magnitudes of capital destruction (with $\Delta \in [0.990, 0.999]$) are considered.

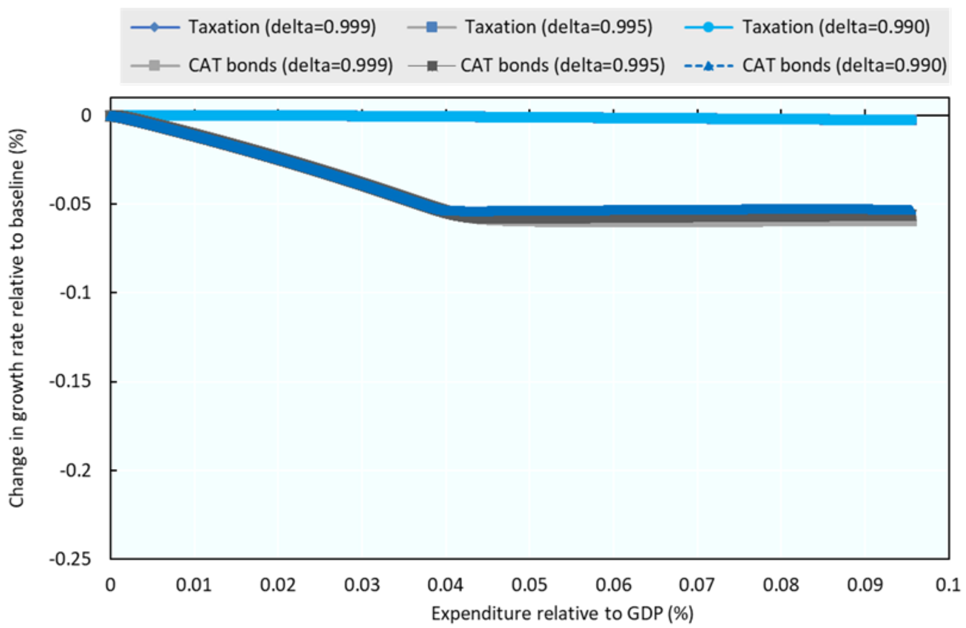
The results are summarised in Figures 12-15. From those figures, one can easily see that the introduction of aggregate risk does not change the overall picture. The welfare consequences of disaster risk management policies are unambiguously positive, just as we found in the baseline model. Importantly, Figure 12 shows that catastrophe bond issues remain a preferable financing option compared to taxation, even if the impact of aggregate uncertainty is taken into account. The presence of aggregate risk slightly scales down the welfare benefits of catastrophe bond option, though especially when the cost of policy exceeds 0.4% of GDP. The negative impact of catastrophe bond issues on the long-term economic growth seems somewhat mitigated in return (Figure 13). When the policy is financed through taxation, the aggregate risk forces the economy to reallocate the existing resources from human to physical capital, relative to the baseline case (Figure 14). Such a reallocation is not predicted when the same policy is financed through catastrophe bond issues as long as the total expenditure is smaller than the 0.4% threshold (Figure 15). Overall, we can conclude that the findings of the baseline model are in large part robust against this modification.

Figure 12. Impact of disaster policy: Welfare and growth



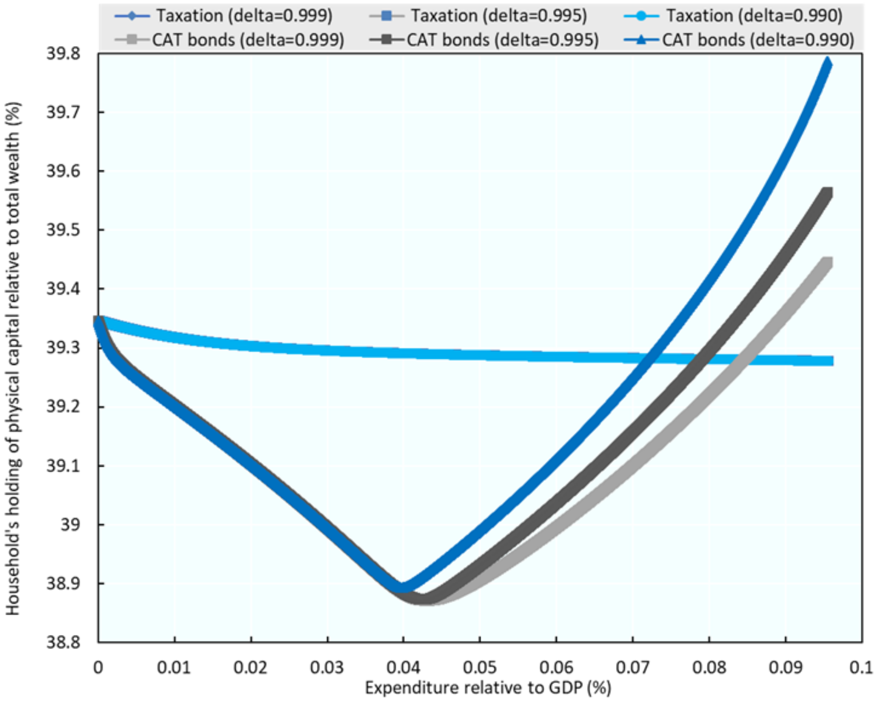
Source: Authors.

Figure 13. Impact of disaster policy: Economic growth



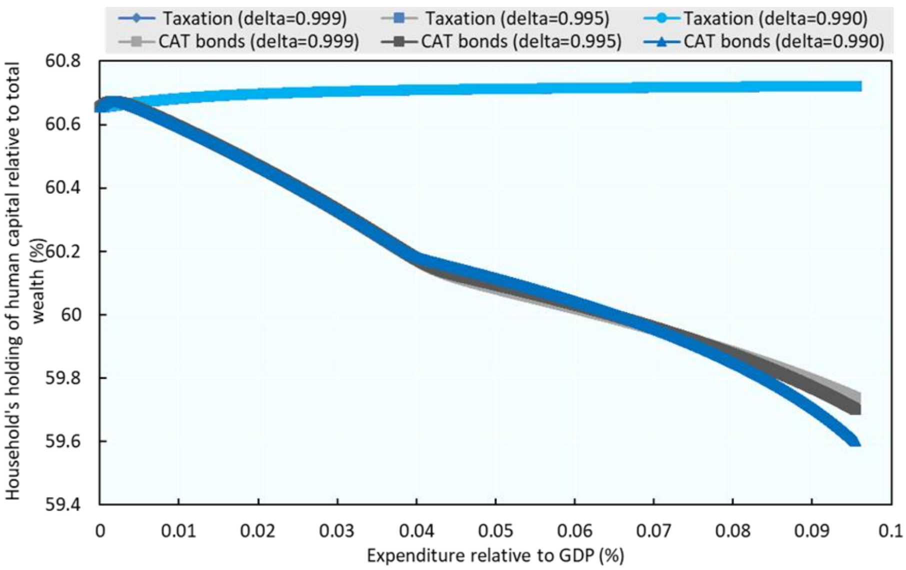
Source: Authors.

Figure 14. Impact of disaster policy: Physical capital



Source: Authors.

Figure 15. Impact of disaster policy: Human capital



Source: Authors.

4 Policy discussion: Challenges of issuing catastrophe bonds

As the theoretical model in the previous section suggests, the catastrophe bond financing option of the costs of disasters has certain advantages from an economic welfare point of view. When it comes to policy implementation, the development of catastrophe bond markets is a long and complex process. This section focuses on broader policy discussions related to challenges regarding the use of catastrophe bond instruments from both public and private perspectives.

4.1. Broadening the investor base

Although catastrophe bonds are complicated instruments and meant for sophisticated investors, efforts should be made to build up the currently limited investor base, thereby facilitating this market's development. The investor base of catastrophe bonds is comprised mostly of specialised ILS funds, reinsurance companies and institutional investors (Wharton, 2021[24]). ILS funds are financed by large institutional investors such as pension funds, which still allocate a proportion of their portfolio to them, although this is a vanishing practice (DiFiore, Drui and Ware, 2021[48]). In comparison to the increasing costs associated with disaster recovery, the amounts allocated to catastrophe bonds are still minimal. Efforts to expand the base could include highlighting the benefits of catastrophe bonds. Indeed, one benefit of catastrophe bonds is that they are mostly independent of financial markets as an asset class, offering enhanced portfolio diversity (PartnerRe, 2017[49]). This would make catastrophe bond bidding more competitive, enhance secondary market liquidity, and reduce the costs of risk management for sovereigns and other catastrophe bond issuers.

Introducing public-private partnerships in catastrophe bond issuance is also important. In addition, how to spur corporate catastrophe bond issuance is key. Corporate entities are traditionally reluctant to issue catastrophe bonds because hedging catastrophe risk with bonds in capital markets is usually more costly than doing so with traditional insurance.

Training is key to broadening investor bases. It is also important that potential investors receive advice from trustworthy and knowledgeable sources (van Rooij, Lusardi and Alessie, 2011[50]), so that both institutional and retail investor authorities can foster trust in credentialed experts as superior sources of financial advice.

4.2. Investing in measurement infrastructure

Investing in measurement infrastructure is important for data collection. National government agencies should be created to be responsible for collecting and analysing data on different types of disasters important (OECD, 2024[15]). Governments also need to stress test their existing data measurement, data transmission, and data storage infrastructure. They must maintain reliable maintenance plans to ensure their functionality in the long run. If capital market investors doubt the accuracy and reliability of the measurement infrastructure, they will demand substantial spread markups or avoid purchasing sovereign catastrophe bonds altogether.

Advanced monitoring technologies, such as AI-based approaches, remote sensing, satellite imagery, and permanent drone surveillance can deliver real-time data on disasters and offer superior measurements compared to classical methods for certain perils (e.g. floods and drought). A recent report from the World Bank discusses how technologies making use of AI will allow more countries to add catastrophe bonds to their disaster risk financing menus by improving reliability of modelling, overcoming current limitations and accelerating model and instrument development as a result (Wells, 2024[51]). Models using these tools will be able to provide more precise estimates of losses more rapidly, trends that should continue as technology improves. Even so, it will be just as important to establish trustworthy data providers to deliver accurate, reliable, and up-to-date information that can be used with confidence for decision-making purposes both by investors and policy makers (OECD, 2024[15]).

4.3. Minimising basis risk

Basis risk is the possibility that the payout of a catastrophe bond will not perfectly match the value of the actual losses suffered by the cedent. This is an especially significant challenge if the CAT bond does not rely upon indemnity triggers. When parametric triggers are chosen, the key characteristics of the CAT bond (e.g. the geography and layer) can be modified to maximise the stochastic dependence of the physical trigger parameter (e.g. wind speed) with the disaster losses that are expected under any given catastrophe scenario. In doing so, sponsors can minimise the expected shortfall of the payout across all trigger scenarios (OECD, 2024[15]). In addition, the choice of parameters should be aligned with exposure in the best possible way. This can be achieved by switching from pure parametric to parametric index triggers. The latter allow cedents to apply a weighting to the readings from different measurement stations that best mirror their actual exposure (ADB, 2009[52]). To build a parametric index that is most correlated with losses, accurate historical data and advanced modelling capabilities are imperative. In early 2025, a major digitally based catastrophe and parametric risk exchange company launched a set of AI tools to enhance its operations. The tools assist initial risk exploration and final instrument structure while providing clients with a detailed overview of the risks they face. The tools are suitable for analysing a variety of perils and trigger types, while integrating data from reputable sources (e.g. state meteorological agencies) to provide a single platform for this work. Furthermore, the tools can also connect potential clients to institutional investors, allowing them to gauge interest in their offerings and tailor them to suit the desires of investors. The tool also provides investors with a range of potential offerings that are available based on their preferences and risk appetites (Willard, 2025[53]).

4.4. Developing the local-currency bond market

Local-currency government bond markets provide the necessary platform and institutional framework for the issuance of catastrophe bonds (OECD, 2024[15]). The trust both local and international investors have in local-currency-denominated government bonds fosters confidence in catastrophe bonds. Ebeke and Lu (2015[54]) show that higher ratios of foreign holdings in local currency denominated bonds from emerging markets lowers those bonds. Large proportions of foreign holdings within local currency bond markets could also increase yield volatility. Molnar-Tanaka and Imisiker (2023[55]) pointed out that depth of financial markets and institutions, and access to them, have significantly positive relationships with LCBM development.

5 Conclusion

In the face of increasing exposure to natural catastrophes, the costs associated with disasters have grown continuously. Refining innovative tools for financing those costs is an important challenge. Traditional approaches in disaster risk finance will not necessarily be sufficient, so there is an increasing need to broaden financial options for coping with that risk.

This paper compares two disaster risk financing measures – the issuance of catastrophe bonds and taxation – and discusses their impact on economic welfare based on a theoretical model, by using a macroeconomic approach. The results from the theoretical model showed that as far as welfare is concerned, catastrophe bond issues have some advantages. However, developing a catastrophe bond market presents several challenges, including, broadening investor bases, investment in infrastructure, minimising basis risk, and developing local-currency bond markets.

The discussion on effective policy response to disasters is gaining more attention and the need to determine an effective policy mix of different financial tools has become increasingly important in recent years. This paper contributes to the discussion on the importance of striking the right balance between catastrophe bonds and taxation.

Notes

[1] Here, to simplify the expressions, we use the notation

$$S_{z,i,t} \coloneqq \frac{\partial}{\partial z_{i,t}} S(m_{i,t}, k_{i,t}, h_{i,t}, \zeta_i) \,|m_{i,t} = r_{k,t}\widetilde{k}_{i,t} + r_{h,t} + r_{b,t}\widetilde{b}_{i,t}, k_{i,t} = \widetilde{k}_{i,t}, h_{i,t} = 1,$$
$$z \in \{m, k\}.$$

[2] See Groom and Maddison Pr. (2018[57]) for more recent estimates of the elasticity of marginal utility.

[3] The rate of return on human capital investment is discussed in Krueger and Lindahl (2001[56]). For the observed values of interest rates, see Federal Financial Institutions Examination Council and Federal Reserve Bank of St. Louis (2022[58]).

[4] We note that providing this type of insurance may induce moral hazard, discouraging households from undertaking their own risk mitigation efforts, though our model does not account for this channel, so the results should be interpreted with caution.

[5] We also considered the cases where either $v_k > 0 = v_h$ or $v_h > 0 = v_k$ and found that such a modification makes little difference.

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