Policy Analysis

Ulrich Volz*

On the Potential of Sovereign State-Contingent Debt in Contributing to Better Public Debt Management and Enhancing Sustainability Outcomes

https://doi.org/10.1515/jgd-2021-0071
Received October 28, 2021; accepted December 2, 2022

Abstract: Sovereign state-contingent instruments (SCDIs) have been suggested as complements or alternatives to traditional sovereign debt instruments for a long time, but with little uptake. Markets for SCDIs have suffered from low liquidity and issues around measurement. This article argues that the escalating climate and ecological crises provide a strong rationale to reconsider the use of sovereign SCDIs as the physical and transition impacts of climate change and environmental degradation are increasingly altering the risk profile of sovereigns. The use of risk-linked sovereign instruments such as cat bonds or resilience bonds and embedding disaster risk clauses in sovereign debt contracts would be an important way for governments, especially in highly climate-vulnerable countries, to mitigate climate risks and scale up investment in resilience. Moreover, instruments such as sustainability-linked bonds that incentivise sustainability-oriented policies and investments could help to bring about better sustainability outcomes and contribute to greater debt sustainability. SCDIs can also play an important role in facilitating debt restructurings. The international community, supported by key institutions like the IMF and the major multilateral development banks, should make a concerted

This article was written for a special issue of the Journal of Globalization and Development on Sovereign Debt and Development. I am grateful to Ugo Panizza and Andrea Presbitero for inviting me to contribute to the special issue and for very helpful comments received from Tito Cordella, Anna Gelpern, Ugo Panizza, Andrea Presbitero and Miranda Xafa during a workshop hosted by the Graduate Institute and Johns Hopkins University in May 2021. I am also grateful for feedback received from participants at the Asian Development Bank Institute workshop on 'Effective Public Debt Management and Fiscal Sustainability in the Post-COVID-19 Era' in March 2022 and two anonymous referees.

***Corresponding author: Ulrich Volz**, SOAS, University of London, London, England; London School of Economics and Political Science, London, England; and German Institute of Development and Sustainability, Bonn, Germany, E-mail: uv1@soas.ac.uk

effort to promote the widespread adoption of sovereign SCDIs to support better public debt management, the climate-proofing of public finances, and the achievement of more ambitious sustainability outcomes.

Keywords: sovereign debt, state-contingent debt, GDP-linked bonds, sustainability-linked bonds, debt restructurings

JEL Classification: F34, H63, Q54

1 Introduction

Sovereign debt is not only one of the oldest, but also the world's largest asset class, with around USD 90 trillion of sovereign debt outstanding. Sovereign debt enables governments to invest in crucial areas of development or smoothen fiscal spending during times of crises. The sustainability of public debt is essential for macroeconomic stability. A worsening of sovereign risk does not only increase the cost of sovereign capital but has also effects on the corporate cost of capital through a sovereign ceiling effect (Almeida et al. 2017; Borensztein, Cowan, and Valenzuela 2013). In the worst case, a sovereign debt crisis can trigger financial and economic crises and cause severe harm to a country's growth and development. Sustainable public debt management is therefore of utmost importance.

The macrofinancial risks associated with accelerating global climate change and environmental degradation present a novel risk to public debt sustainability (Buhr et al. 2018; Kraemer and Volz 2022; Volz et al. 2020a). Empirical research indicates that climate vulnerability is already driving up the costs of sovereign debt (Beirne, Renzhi, and Volz 2021a, 2021b; Cevik and Tovar Jalles 2020; Kling et al. 2018) and that the macroeconomic impacts of climate change and nature loss may lead to significant sovereign downgrades by credit rating agencies (Klusak et al. 2021, Agarwala et al. 2022). Moreover, with capital markets becoming increasingly concerned about environmental, social and governance (ESG) risk, mitigating climate and other environmental risks for public finances has become a key challenge for government debt management offices.

Sovereign state-contingent debt instruments (SCDIs) have for long been suggested as complements or alternatives to conventional sovereign bonds (e.g. Blanchard, Mauro, and Acalin 2016; Borensztein and Mauro 2004; Griffith-Jones and Sharma 2006; Lessard 1977, O'Hara 1984; Shiller 1998). The IMF (2017a: 5) defines sovereign SCDIs as "instruments that (i) bear contractual debt service obligations tied to a pre-defined state variable and (ii) are designed to alleviate pressure on

sovereign indebtedness and/or financing needs in a bad state of the world." Buera and Nicolini (2004: 532) describe state-contingent debt as "an instrument to smooth distortions across states of the world" that can enhance welfare.[1] The basic idea behind SCDIs is that they can help to better manage risk for the sovereign or incentivise certain desirable policies. Economic fortunes – and hence also financing conditions – can change quickly, making it difficult for governments to repay old debt or issue new debt.

Krugman (1988), in an attempt to solve the trade-off between debt forgiveness and financing, suggests that linking payments to measures of economic conditions could benefit both debtors and creditors. SCDIs can provide additional creditor compensation in good times and/or some form of debtor relief in bad times. Caballero (2003: 32) even proposed the establishment of a Contingent-Markets Department at the International Monetary Fund (IMF), which would "help identify each country's contractible contingent basis and develop the corresponding contingent bonds; […] help create and regulate Contingent-Emerging-Markets Collateralized-Debt-Obligations funds or their equivalent; [and] help design a macroeconomic policy framework consistent with the insurance mechanism developed for the country, and to monitor its fulfilment."

In 2016, the G20 called on the IMF to conduct "further analysis of the technicalities, opportunities, and challenges of state-contingent debt instruments, including GDP-linked bonds" (G20 2016). In the resultant report, the IMF (2017a: 6) argues that state-contingent debt instruments for sovereigns have the potential to "enhance policy space for sovereigns in bad states of the world, offer diversification opportunities to investors, and generate ancillary benefits for other economic agents and the broader system". More recently, SCDIs such as sustainability-linked bonds have been suggested as instruments that could incentivise sustainability enhancing government policies. SCDIs have recently also played a prominent role in discussions around debt restructuring.

In the context of the Covid-19 crisis and the worsening climate and ecological crises, the time for state-contingent debt to become mainstream may have finally arrived. Sovereign SCDIs are progressively considered as a means of raising new capital for investment in sustainable development and climate resilience, as well as instruments that can be employed to address the looming debt crisis in the Global South.

---

1 Using a calibrated model to explore the properties of the optimal maturity structure of the debt in a dynamic economy, Buera and Nicolini (2004) show that, where SCDIs cannot be issued, governments can in part replicate the welfare enhancing properties of SCDIs by issuing non-contingent debt of different maturities.

Against this backdrop, this article discusses the role that state-contingent debt can play in contributing to better public debt management, climate-proofing public finances, and in enhancing sustainability outcomes in the economy. It develops a taxonomy of SCDIs and reviews the advantages, challenges, and the actual uptake of different SCDIs. It argues that the escalating climate and ecological crises provide a strong rationale for a wider use of sovereign SCDIs as the physical and transition impacts of climate change and environmental degradation are increasingly altering the risk profile of sovereigns. The use of risk-linked sovereign instruments such as cat bonds or resilience bonds and embedding disaster risk clauses in sovereign debt contracts would be an important way for governments, especially in highly climate-vulnerable countries, to mitigate climate risks and scale up investment in resilience. Moreover, instruments such as sustainability-linked bonds that incentivise sustainability-oriented policies and investments could help to bring about better sustainability outcomes and contribute to greater debt sustainability. The international community, supported by key institutions like the IMF and the major multilateral development banks, should make a concerted effort to promote the widespread adoption of sovereign SCDIs to support better public debt management, the climate-proofing of public finances, and the achievement of more ambitious sustainability outcomes.

The article is structured as follows. Section 2 provides a taxonomy of SCDIs and reviews the major types of and experiences with sovereign SCDIs. Section 3 examines the role of SCDIs in sovereign debt restructurings. Section 4 discusses properties and challenges of SCDIs. Section 5 concludes.

2 Types of Instruments

SCDIs can be broadly divided into three categories: (i) debt instruments linked to macroeconomic and price variables, (ii) debt instruments linked to the occurrence of specified events, and (iii) debt instruments linked to sustainability outcomes (Table 1). Furthermore, SCDIs can be distinguished according to the terms of adjustment of debt service payments, i.e. whether these are continuously or discretely adjusted (IMF 2017a). Instruments featuring continuous adjustment of debt service payments are usually linked to macroeconomic or price variables. Instruments involving discrete adjustment are typically triggered by a pre-defined event, such as a natural catastrophe, or the achievement (or not) of specific key performance indicators (KPIs). The different categories will be reviewed in the following.

Table 1: A taxonomy of state-contingent debt instruments.

	Instruments featuring *continuous adjustment* of debt service payments	**Instruments involving *discrete adjustment* of debt service payments**
Debt instruments linked to macroeconomic and price variables	Inflation-linked bonds Commodity-indexed bonds GDP-linked bonds Wage-indexed bonds Revenue-indexed bonds	
Debt instruments linked to the occurrence of specified events		Risk-linked securities Sovereign debt with disaster clauses Sovereign contingent convertible debt Pandemic bonds
Debt instruments linked to the sustainability outcomes		Sustainability-linked bonds Nature performance bonds

Source: Compiled by author.

2.1 Debt Instruments Linked to Macroeconomic and Price Variables

Various debt instruments linked to macroeconomic and price variables have been developed, including inflation-linked bonds, commodity-indexed bonds, GDP-linked bonds, wage-indexed bonds, and revenue indexed bonds.

2.1.1 Inflation-Linked Bonds

Inflation-linked bonds – commonly referred to as linkers – are financial securities devised to protect bond holders from the risk of unexpected inflation or to hedge against long-run inflation risk by linking the principal and coupons to inflation through a price index (Farrugia, Formosa, and Pace 2018; Krämer 2017). Inflation-linked bonds are typically issued with a floor clause that prevents negative returns in the case of deflation.

As pointed out by Campbell, Shiller, and Viceira (2009: 110), "[t]he basic case for investing in inflation-indexed bonds […] is that these bonds are the safe asset for long-term investors. An inflation-indexed perpetuity delivers a known stream of real spending power to an infinite-lived investor, and a zero-coupon inflation-indexed bond delivers a known real payment in the distant future to an

investor who values wealth at that single horizon."[2] Inflation-linked bonds are particularly attractive in an environment of high and volatile inflation, as they may allow governments to raise long-term funds from capital markets when issuing fixed-rate bonds with long maturities is difficult otherwise (Di Iorio and Fanari 2020). For governments, inflation-linked bonds are also attractive because they are associated with a lower cost of borrowing as investors won't require an inflation risk premium.

Inflation-linked bonds can also help a government to show its commitment to maintaining a low-inflation environment as they reduce the incentive for governments to allow for high inflation to erode the real value of its outstanding obligations. UK Prime Minister Margaret Thatcher reportedly likened inflation-linked bonds to a "sleeping policeman" that would help to keep inflation in check by "by creating a situation in which the government would have to face a large interest expense if it ever allowed inflation to pick up" (Campbell and Shiller 1996: 163).[3]

The first inflation-indexed bonds, so-called "depreciation notes", were issued by the Commonwealth of Massachusetts in 1780 during the Revolutionary War (Shiller 2005). High inflation during and in the aftermath of the Second World War invigorated interest in different forms of value-linking (Aharoni and Ophir 1967). In 1945, the Finnish government was the first to issue an inflation-indexed bond. The principal of this ten-year bond (the Second Indemnity Loan) was linked to the domestic wholesale price index, with compensation for every 10% increase above the price index base (ibid.). Subsequently, inflation-linked bonds were introduced by Sweden in 1952, and by Iceland and Israel in 1955. In the 1960s and 1970s, inflation-linked bonds were primarily issued by emerging market governments of countries with high levels of inflation, including Brazil (1964), Chile (1966), Colombia (1967), and Argentina (1972) (Noyer 2004).

With inflation problems mounting again in advanced economies in the 1970s in the face of the breakdown of the Bretton Woods system of fixed exchange rates and the two oil shocks, interest in inflation-hedging securities grew also beyond emerging markets. In 1975, the UK's National Savings Bank, a state-owned bank, issued Index-linked Savings Certificates – non-marketable inflation-linked bonds knows as "granny bonds" because they were originally only available to savers who were over the retirement age. In the wake of the inflationary 1970s, the UK was the first major developed economy to issue marketable inflation-linked bonds. The first index-linked gilt was issued in 1981 for institutional investors

2 See also Campbell and Shiller (1996).

3 This view is linked to Friedman's (1974) view that "[t]he government (*cum* monetary authority) created inflation in the first place and therefore has the responsibility to provide means by which citizens can protect their wealth."

(Choudhry, Cross, and Harrison 2003). These bonds were indexed to the General Index of Retail Prices, and ownership was initially constrained to pension funds and other institutions in the pension business.

Since the 1980s, inflation-linked bonds have been issued by the governments of more than 30 countries (Table 2). Issuances by advanced country governments account for the bulk of the market for inflation-linked sovereign bonds, which has grown to USD 3.6 trillion by mid-2021. With USD 1.6 trillion of outstanding marketable debt, US Treasury Inflation-Protected Securities (TIPS), account for 44% of all outstanding global inflation-linked sovereign bonds. As noted by Noyer (2004: 1), "it might appear paradoxical that, since 1980, indexed bonds have largely been issued by industrialised countries, characterised both by low inflation rates and price stability-oriented monetary policies". The main motivation for issuing inflation-indexed bonds was to lower the cost of debt and to broaden the investor base (ibid.).

Table 2: Overview of issuances of inflation linked sovereign debt.

Country	Issue date	Index used
Argentina	1972–1991	Non-agricultural wholesale price
	2003	Consumer prices
Australia	1983–1991	Consumer prices
Austria	1953	Electricity prices
	2003	Consumer prices
Brazil	1964–1990	Wholesale prices
	1991	General prices
Belgium	2004	Consumer prices
	2015	Consumer prices
Canada	1991	Consumer prices
Chile	1966	Consumer prices
Colombia	1967	Wholesale prices
	1995	Consumer prices
Czech Republic	1997	Consumer prices
Denmark	1982	Consumer prices
Finland	1945–1968	Wholesale prices
France	1998	Consumer prices
Germany	2006	Consumer prices
Greece	1997	Consumer prices
Hungary	1995	Consumer prices
Iceland	1955	Consumer prices
	1964–80	Cost of building index
Ireland	2017	Consumer prices
Israel	1955	Consumer prices
Italy	1983	Deflator of GDP at factor cost
	2003	Consumer prices

Table 2: (continued)

Country	Issue date	Index used
Japan	2004	Consumer prices
Mexico	1989	Consumer prices
New Zealand	1977–1984	Consumer prices
	1995	Consumer prices
Norway	1982	Consumer prices
Peru	2003	Consumer prices
Poland	1992	Consumer prices
Republic of Korea	2007	Consumer prices
Russia	2015	Consumer prices
Spain	2014	Consumer prices
South Africa	2000	Consumer prices
Sweden	1952	Consumer prices
	1994	Consumer prices
Thailand	2011	Consumer prices
Turkey	1994–1997	Wholesale prices
	1997	Consumer prices
United Kingdom	1981	Retail price index
United States	1997	Consumer prices
Uruguay	2007	Uruguay indexed unit (unidad indexada)

Source: Compiled with data from Aharoni and Ophir (1967), Price (1997), Deacon and Derry (1998), Colchester Global Investors (2017), Farrugia, Formosa, and Pace (2018), and national authorities.

According to a 2016 Survey on Central Government Marketable Debt and Borrowing by the OECD Working Party on Debt Management, the share of inflation-linked debt in central government debt has risen for OECD countries from 5.5% to above 7% between 2007 and 2015 (OECD 2017). For the US, the largest issuer, TIPS accounted for 7% of all public debt in mid-2021. In the UK, the second largest issuer, the share of index-linked gilts has risen to 28% in 2020, up from 23% a decade earlier. The governments that have most actively used inflation linked bonds are Chile and Israel. According to Borensztein and Mauro (2004), the share of inflation-linked public debt was 80% in Israel in 1999. The share of indexed-bonds in total long-term government borrowing reached 79% in Chile in 2008 (but has fallen to 40% by 2017) (OECD 2017).

While the global inflation-linked debt market has grown markedly, it accounted for a mere 4% of total sovereign debt of outstanding in mid-2021. Several explanations have been put forward why the share is so small despite the clear advantages of inflation-linked bonds (i.e. the protection against inflation risk) over fixed-rate bonds. To start with, Westerhout and Ciocyte (2017) highlight that the market for inflation-linked bonds is less liquid than that for fixed-rate bonds; with the liquidity premium larger than the inflation risk premium, inflation risk cannot

neutralise the risk of too little liquidity. Investors may hence be weary to buy inflation-linked bonds, at least in a low-inflation environment. Neither issuers nor investors may be particularly interested in inflation-linked bonds if inflation expectations are low. Westerhout and Ciocyte (2017: 8) also underscore that "perfect price indexation is not possible in practice", which means that inflation-linked bonds may not offer full protection against inflation, either because adjustment to inflation often comes with a lag, or because the inflation index to which the bond is linked does not fully reflect the "true" inflation. The latter could also be the result of manipulation by the government if statistical authorities measuring inflation are not deemed trustworthy. Furthermore, Westerhout and Ciocyte (2017) point out that inflation-linked bonds could lead to a higher volatility of the public deficit ratio, making them less attractive for governments. Last but not least, indexing debt payments to inflation shifts inflation risk from investors to the government, and takes the option away from governments to debase debt through inflation.

2.1.2 Commodity-Linked Bonds

Commodity-linked bonds are financial securities whose payments are linked to the price of one or several underlying commodities. There are two kinds of commodity-linked bonds: those of a forward type and those of an option or warrant type (Priovolos and Duncan 1991). Commodity-linked bonds of the forward type (which are also referred to as convertible or indexed bonds) have their coupon and/-or principle payments linked to a specified quantity of a commodity. The bond can be structured so that if the price of the commodity falls below a predetermined strike price, the coupon and/or principle payment will be lower (Proelss 2008). Commodity-linked bonds of the option type make coupon and principle payments like conventional bonds, but in addition the bond holder gets the option to buy or sell a pre-set quantity of the commodity at a prearranged price when the bond reaches maturity.

Commodity-linked bonds are particularly interesting for countries whose economies are heavily dependent on a small number of primary commodities and whose public revenues are therefore exposed to considerable commodity price risks. By sharing risk between the government and investors, commodity-linked bonds can help to smoothen government revenue streams and facilitate capital budgeting (Lessard 1977).

Commodity bonds date back to the 19th century. In 1863, the Confederate States of America issued bonds "payable in bales of cotton" (O'Hara 1984: 193). The commodity most often used for commodity-linked bonds is gold. In the late 19th century and early 20th century up to the First World War – the period when the

major Western European countries and several peripheral countries adhered to (or tried to) the gold standard –, many loans were made with gold clauses (Bordo and Rockoff 1996). Gold-linked bonds were also prevalent in Europe after the First World War, during which the gold standard had been suspended. In 1952, France issued the Pinay Gold Loan, relating the redemption value of the bond to the market price of gold coins (Rozental 1959). Two decades later, France issued a gold-linked bond in 1973 (the "Giscard") with a 7% nominal coupon rate and a redemption value indexed to the price of a 1-kilogram bar of gold (Atta-Mensah 2004). More recently, gold bonds have been popular in India. The Government of India (through the Reserve Bank of India) started to issue Sovereign Gold Bonds in 2015 to offer investors an alternative to purchasing physical gold. The bonds bear a fixed interest rate of 2.5% p.a., while the principal is linked to the price of gold (RBI 2019).

In 1977, Mexico was the first country to issue oil-linked bonds ("petrobonos") through National Financiere S.A., a public development bank (Holt 1981). Each 1000-peso bond was linked to 1.95354 barrels of light crude. Upon maturity, Petrobonos could be redeemed at the maximum of the face value or the market value of the referenced units of oil plus all coupons received during the life of the bond (Rizvi, Bacha, and Mirakhor 2016). The petrobonos were issued after a 45% devaluation of the Mexican peso in the prior year (Fall 1984). Monetary instability and the need to attract capital prompted the Mexican government to develop different type of indexed instruments (Marino 2008). The bonds were designed to appeal to Mexican investors who had invested abroad because they lacked trust in the stability of the peso. Linking the bond payments to oil, whose international prices are set in US dollar, addresses currency risk which also made the bonds attractive to international investors (Fall 1984). In 1981, in the wake of the two oil shocks of the 1970s, the US administration under Ronald Reagan seriously considered issuing oil-linked bonds to finance the country's strategic oil reserve but gave up on this in the end.

2.1.3 GDP-Linked Bonds

Originally proposed by Shiller (1998), GDP-linked bonds have either the coupon or the principal (or both) indexed to the level of nominal GDP.[4] In many ways, they are similar to inflation-linked bonds. The central idea behind GDP-linked bonds is that the government's debt obligations develop in tandem with the country's economic growth. This reduces the government's debt service payments when the economy is weak and fiscal revenues are low, providing it with a cyclical cushion and fiscal space to stimulate the economy. GDP-linked bonds can therefore limit the pro-cyclicality of

4 For a review, see Borensztein and Mauro (2004), Griffith-Jones and Sharma (2006), and Shiller et al. (2018).

fiscal policies while improving risk sharing with international creditors (Borensztein and Mauro 2004; Hatchondo, Martinez, and Sapriza 2007). By allowing debt-service ratios to decline in times of slow or negative growth, they contribute to greater debt sustainability. This, in turn, reduces the likelihood of defaults and debt crises. The resulting lower sovereign risk makes bonds more attractive for investors. Moreover, investors can benefit from GDP-linked bonds by sharing in a country's growth prospects (Griffith-Jones and Sharma 2006).[5]

Using a standard DSGE model with sovereign default risk calibrated to the Argentine economy, Bertinatto et al. (2017) show that GDP-indexed sovereign debt contracts reduce the probability of default, decrease consumption volatility, and increase welfare. Warren-Rodríguez and Conceição (2015) simulate the impact of GDP-linked official lending for development for 124 emerging economies and developing countries for the period 2004–2013. Their simulations suggest that GDP debt indexation would increase the median correlation between debt service payments and government revenue trends by 43%, which would significantly improve countries' ability to repay their debt and to implement counter-cyclical fiscal policies.

Building on the approach developed by Warren-Rodríguez and Conceição (2015), Jensen (2022) conducts a simulation of interest rate payments on public and publicly guaranteed external debt under a GDP-indexed contract versus a non-GDP-indexed contract covering all official creditor debt and 50% of private creditor debt for the period 2010–2020. In this simulation, interest payments over the full period would have been lower by 10% in low-income countries, by 15% in lower-middle-income countries, by 12% in upper-middle-income countries, and by 21% in the 68 countries in the sample that were eligible to take part in the G20's Debt Service Suspension Initiative (DSSI) in 2020–2021. Interest payments for all low-and middle-income countries in the sample would have declined by USD 114 billion or 12% compared to a non-indexed contract. In 2020, when the Covid-19 crisis hit, countries' interest payments would have been USD 69 billion lower than the payments due under conventional contracts; GDP-indexed bonds would have led to a decline in interest payments by 90% in low-income countries, 68% in lower-middle-income countries, 58% in upper-middle-income countries, and 78% in DSSI-countries. Jensen (2022: 16) concludes that "SCDIs hold great potential in improving public debt management."

Despite these favourable characteristics of GDP-linked bonds, the uptake has been limited to date. In 1956, France issued bonds linked to industrial production

5 Farhi and Werning (2017) show that a constrained efficient risk-sharing arrangement could be established within a fiscal union through a contingent transfer rule that resembles a GDP-indexed bond.

("Bons d'équipement industriel et Agricole"), the first output-linked bond. The bond came with an annual interest payment of 5% plus 0.05% for every point by which industrial production exceeded the level of 1955. In 2013 and 2017, Portugal issued small-denomination Treasury certificates to domestic savers with coupon payments linked to GDP. Otherwise, as will be discussed below, several countries issued GDP-linked 'warrants' as part of debt restructuring agreements.

Cecchetti and Schoenholtz (2017) consider the biggest obstacles to the widespread adoption of GDP-linked bonds to be the computation of the GDP index. They emphasise two challenges. The first is that a government could seek to manipulate GDP figures to lower debt payments and urge the national statistical agency to underreport nominal GDP. Countries without strong and independent institutions may find it difficult to find sufficient interest from investors in their GDP-linked issues. The second reason is that even in the absence of a potential manipulation of growth statistics, unavoidable data revisions and changes in methodology will affect the payments and value of the bonds. In principle, this could be addressed by lengthening the lag with which GDP data are used for the calculation of payments. However, as pointed out by Cecchetti and Schoenholtz (2017), "given that most recessions are relatively brief, lasting less than two years, this would reduce the cyclical benefits to the government debt manager."

2.1.4 Wage-Indexed Bonds

In 2014, Uruguay issued a USD 1 billion bond with a maturity of 30 years where principal and coupon payments are indexed to nominal wages. Since then, the government has issued several other wage-indexed bonds. Wage indexation is argued to provide a better hedge against output shocks that affect tax revenues. Important pieces of context are that pension payments in Uruguay have been constitutionally indexed to nominal wages since 1989, and that a pension reform in 1995 created a mixed social security regime that includes an individual capitalisation pillar, in addition to the state-managed pay-as-you-go pillar (Saráchaga 2019). For domestic pension funds, wage-indexed bonds are therefore an attractive asset to invest in.

2.1.5 Revenue-Indexed Bonds

In 2009, Turkey issued Revenue Indexed Bonds in both Turkish lira and US dollar through direct sales. The aim was to increase domestic savings and broaden the investor base. The bonds were structured as Sharia compliant, i.e. non-interest-bearing instruments, that would also help to attract investment from oil-rich Gulf countries. The coupon payments of the bonds were indexed to revenue transfers to

the Treasury from state-owned enterprises including the Turkish Petroleum Corporation, State Airport Authority, State Supply Office and Coastal Safety.

Such revenue-indexed bonds have not been replicated elsewhere. One obvious concern is that governments may manipulate revenue data, which are hard to verify independently. Another factor may be that the market for Islamic bonds ("sukuks") has developed rapidly over the last decade, providing investment opportunities in alternative, Sharia-compliant instruments, including sovereign sukuks.[6]

Table 3 provides an overview of examples of state-contingent debt instruments linked to macroeconomic and price variables other than inflation.

2.2 Debt Instruments Linked to the Occurrence of Specified Events

The second category of SCDIs comprises event-linked bonds, i.e. debt instruments that pay off on the occurrence of specified events. Over the last two decades, several innovative risk-linked securities have been developed, mostly relating to disaster risk. Risk-linked securities are financing instruments that allow insurance risk to be traded in capital markets, enabling insurers and reinsurers – but also governments – to raise funds to pay claims arising from loss events (Cummins 2008). The best-known risk-linked security is the catastrophic risk (cat) bond, "a fully collateralized instrument that pays off on the occurrence of a defined catastrophic event" (Cummins 2008: 23). Cat bonds were originally designed by insurance companies to help finance the insurance claims if a major disaster occurred. But cat bonds can be also used by governments to transfer part of the financial risk arising from natural disasters such as earthquakes or climatic events such as storms and flooding to the capital markets.

Upon issuance of a cat bond, the proceeds go into a secure collateral account or special purpose vehicle (SPV). The SPV will invest the money received from the investors in safe assets, and it will pay the coupons to the investors. In the case that a previously specified disaster occurs, the collateral is released to the issuer, and investors lose all or part of their principal. Cat bond pay-outs are usually linked to an independently verifiable parametric trigger, such as wind speed or earthquake magnitude. In case the disaster does not occur during the lifetime of the cat bond, the SPV will return the full principal to the investors.

While cat bonds provide disaster insurance to issuers, they can be attractive for investors because they offer higher potential returns and show little correlation to

6 The first sovereign sukuk was issued by the government of Malaysia in 2002. On sovereign sukuks, see Wedderburn-Day (2010).

Table 3: Examples of state-contingent debt instruments linked to macroeconomic and price variables other than inflation.

Instrument	Country (period)	Continuous/discrete rate adjustment	Currency	Tenor (years)	State/trigger variable	Payout/deferral type	Tradeable/non-tradeable
Guaranteed equity bond	UK (2002–2009)	Continuous (with principal cap/floor)	LCY	5	Equity index	Payout at redemption linked to FTSE 100 level	Non-tradeable (retail)
Gold bond	India (2015)	Continuous	LCY	8 (redeemable at 5)	Price of gold	Principal linked to price of gold	Non-tradeable (retail)
Nominal wage linked bond	Uruguay (2014)	Continuous (with coupon floor)	LCY	30	Nominal wage index	Principal linked to level of nominal wage index	Tradeable
GDP-linked treasury certificates	Portugal (2013)	Continuous (with coupon floor)	LCY	5	Real GDP growth	Coupon linked to GDP growth (in final 2 years only)	Non-tradeable (retail)
Revenue indexed bond	Turkey (2009–2012)	Continuous (with coupon floor)	USD/LCY	3	Government SoE revenues	Coupon linked to income from SoEs	Tradeable
Oil-linked bond	Mexico (1977–1980)	Continuous (with coupon floor)	LCY	3	Export price of oil in USD	Principal linked to local currency price of oil	Tradeable

Source: Adapted from IMF (2017a).

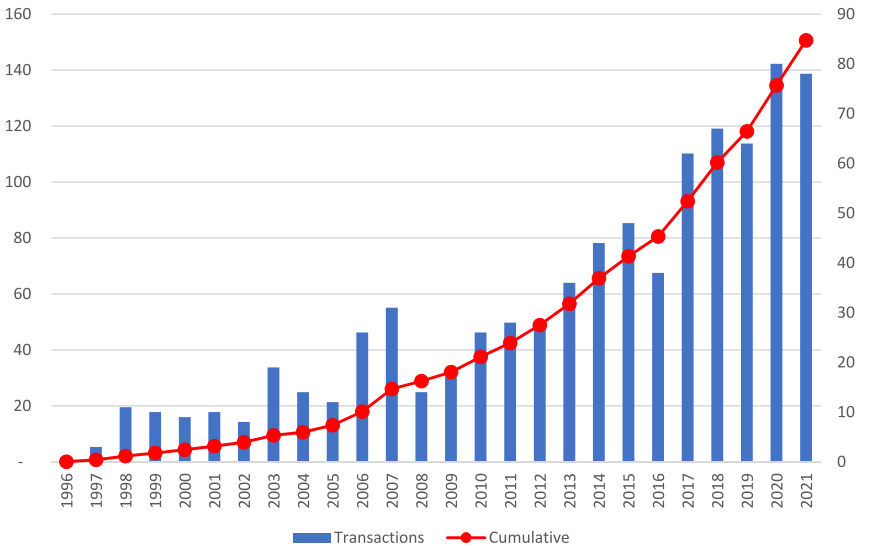

Figure 1: Catastrophe bonds and insurance-linked securities: Cumulative issuance in billion USD (left axis) and number of transactions (right axis) by year, 1996–2021:Q3. Note: Data include property catastrophe bonds; private insurance-linked securities (ILS) deals (cat bond lites); other ILS (specialty, life, mortality); and mortgage ILS deals. Source: Compiled with data from the Artemis catastrophe bond & insurance-linked securities deal directory.

equity and bond markets and thus provide an opportunity to diversify portfolios (Garcia, Singh Paul, and Zelenko 2011). The cat bond market has grown rapidly since the first issuances in the mid-1990s (Figure 1). To date, the majority of issuances have been by insurers or reinsurers. There have been, however, a number of sovereign issuances as well. In 2006, Mexico was the first country to issue a cat bond via its National Disaster Reserve Fund, with several more to follow. Most sovereign cat bonds have been issued through international financial institutions like the World Bank. The latter established the Multicat Program in 2009 to support the access of its member countries to the cat bond market (World Bank 2015).

Somewhat like cat bonds are resilience bonds, which combine the insurance coverage of cat bonds with capital investment in resilience projects that lower the expected losses from disasters. The use of proceeds of resilience bonds are earmarked for projects that increase resilience to climate change, for instance through investment in flood protection. As such, resilience bonds can also qualify as green bonds.[7] If there is no trigger event before the maturity date, investors recuperate the principal as well as the regular coupon payments. However, if a

7 For the resilience bond principles, see CBI (2019).

trigger event occurs, investor will lose both the principal and the coupon payments. The first resilience bond was issued in 2019 by the European Bank for Reconstruction and Development. To date there have been no sovereign issuances yet. In the US, the State of California has been developing plans for the issuance of resilience bonds to invest in strengthening the resilience to wildfires, droughts and floods.

A further way of addressing disaster risk in sovereign bonds are disaster risk clauses. By embedding such clauses in debt contracts, debt issuing countries would be allowed to defer debt service payments for a defined period if a disaster strikes. They would thus benefit from cash flow relief and having greater fiscal space at a time when financing needs are high and new funding may be difficult to obtain. Grenada was the first country to include a disaster risk clause as part of a comprehensive debt restructuring in 2014/2015. The clause, which was endorsed by the Paris Club, allowed for a deferral of debt service payments for up to 12 months in the event of a qualifying hurricane (Cohen et al. 2020).[8] Barbados introduced a hurricane clause in its debt restructuring in 2018/2019.[9] For both countries, parametric-based assessment by the Caribbean Catastrophe Risk Insurance Facility, an independent body, is used to determine if the specified natural disaster event has been triggered.

A different kind of sovereign bond that also has a built-in trigger to allow a standstill of payments is sovereign contingent convertible debt (S-CoCo) (Consiglio and Zenios 2018). Under this proposal, a standstill is triggered when the government's credit worthiness breaches a distress threshold. A trigger could be a market indicator such as the moving average of credit default swap spreads. S-CoCos are similar to contingent convertible debt for banks (where debt is converted to equity), but with S-CoCos the conversion is to debt with a more favourable repayment schedule. Consiglio and Zenios (2018: 1) argue that such instruments could enhance debt sustainability by limiting "*ex ante* the likelihood of debt crises" while also imposing "*ex post* risk sharing between creditors and the debtor".

Another kind of event-linked bonds are pandemic bonds. As the name suggests, these bonds aim to provide insurance for pandemic risk by linking payments to the occurrence of a pandemic. The basic idea is that governments transfer part of the risk of a pandemic to capital markets and thereby reduce risk in their own budget. As with plain vanilla bonds, investors in pandemic bonds receive coupon payments, but the repayment of the principal depends on whether a pandemic occurs during the lifetime of the bond. In case pre-specified trigger conditions

8 In 2018, the International Capital Markets Association (ICMA) published indicative terms and conditions for sovereign hurricane bonds (ICMA 2018).

9 For details, see Asonuma et al. (2017).

relating to a pandemic are met during the lifetime of the bond, investors lose the principal, or part of it, while the government can use the freed-up money to finance the pandemic response. The first – and thus far only – pandemic bond was issued by the World Bank in 2017 and drew heavy criticism for "making the bonds attractive to investors [by] designing them to reduce the probability of payout" (Jonas 2019: 285) while offering generous coupon payments of about 13% interest p.a. The World Bank issued no new pandemic ponds after this first pandemic bond expired in July 2020. Despite the outbreak of the COVID-19 pandemic, there has been little to no interest in new issuances. But proposals for developing this instrument further are being developed (e.g. Huang et al. 2021).

2.3 Debt Instruments Linked to the Sustainability Outcomes

The third category of SCDIs comprises debt instruments linked to sustainability outcomes. Sustainability-linked bonds (SLBs) were developed on the back of the rapid growth in the green bond market. Unlike green bonds (or related instruments such as social bonds or sustainability bonds), where the use of proceeds is earmarked for the financing of green (or social or sustainable) projects, SLBs are linked to outcomes rather than expenditures.[10] They are forward-looking, performance-based instruments. While the use of proceeds from SLBs can be used for any purpose, bond payments are tied to the achievement of predefined KPIs that relate to sustainability performance targets set by the issuer. The International Capital Market Association (ICMA), which published Sustainability-linked bond Principles in 2020, defines SLBs as "any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined Sustainability/ESG objectives. In that sense, issuers are thereby committing explicitly (including in the bond documentation) to future improvements in sustainability outcome(s) within a predefined timeline" (ICMA 2021d: 2).

The first SLB was issued in 2019 by Enel, an Italian utility company operating globally. The USD 1.5 billion five-year SLB was linked to the target of increasing the share of renewable energy as part of Enel's total installed electricity generation capacity from 45.9% at the time of issuance to 55% by 31 December 2021. In case the sustainability-target is not achieved, a ratchet mechanism is activated that raises the coupon payment by 25 bp. Since Enel's initial SLB, market interest in SLBs has grown considerably, as have issuances. From just four issuances of SLBs totalling USD 4.6 billion in 2018, global issuance has already reached USD 78.7 billion in the first ten months of 2021 (Figure 2). In March 2022, Chile became the first country to issue a

10 Principles for green, social and sustainability bonds are set out in ICMA (2021a, 2021b, 2021c).

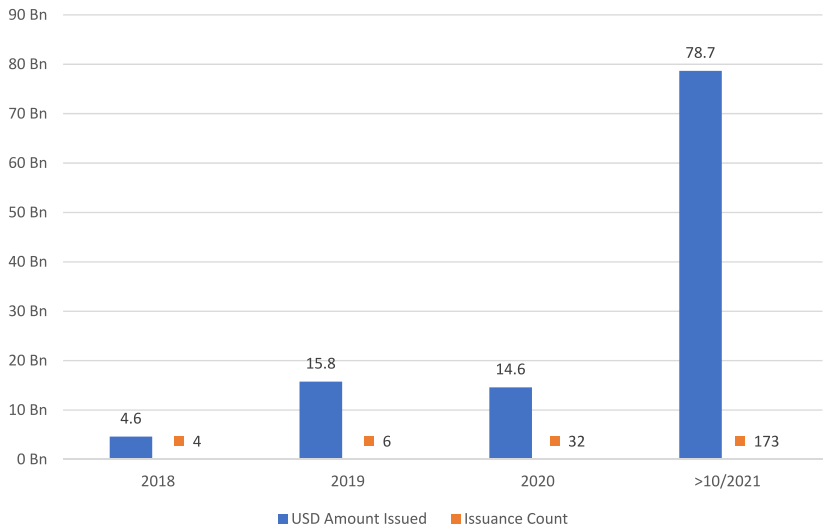

Figure 2: Sustainability-linked bonds market issuance (in billion USD). Source: Compiled with data from the climate bonds initiative green bond Database, October 2021.

sovereign SLBs. The 20-year, US$2 billion bond links payments to the achievements of two KPIs: a target for absolute greenhouse gas emissions to not exceed 95 metric tons of carbon dioxide and equivalent by 2030; and a target for generating half of electric power from non-conventional renewable energy sources by 2028 and increasing this share to 60% by 2032 (Sustainalytics 2022). In a step-up structure, investors will receive a premium of 12.5 bps if a target is not met, and 25 bp if both targets are missed. The Chilean SLB was oversubscribed more than four times.

Since the issuance of the first sovereign green bond by Poland in 2016, the sovereign sustainability-labelled bond market has grown rapidly.[11] Sovereign SLBs have been described as "the next frontier in sovereign financing" (Giráldez and Fontana 2021). Given the strong market interest in ESG investments, they have been promoted as instruments that can help governments to raise finance at better terms (Bouzidi and Papaioannou 2021), benefitting from a "greenium" as observed in both corporate and sovereign green bond markets (Löffler, Petreski, and Stephan 2021). Sovereign SLBs are also seen as instruments that can incentivise governments to raise their ambitions regarding climate or other sustainability goals. The hope, as put by Caputo Silva and Stewart (2020) is that "financial markets may 'reward' countries meeting ambitious [sustainability] targets with lower-cost

11 For an overview of the development of the market for sovereign green, social and sustainable bonds, see Giráldez and Fontana (2021).

debt." Favourable financing conditions for sovereign SLBs may also be achieved through credit enhancements provided by international financial organisations (Volz et al. 2020b).

One example of sovereign SLBs are sovereign nature performance bonds (F4B 2021a, 2021b). These are "performance-linked instruments that seek to better align the cost of sovereign debt with success in protecting or enhancing a country's valued, productive natural capital" (F4B 2021b: 2). Nature performance bonds would be issued without restrictions on the use of proceeds, but payments would be tied to the achievement of predefined nature-related KPIs, such as protecting forests or restoring wetlands.

3 The Role of State-Contingent Debt Instruments in Debt Restructurings

Brooke et al. (2013) highlight the deficiencies of conventional practices for sovereign debt crisis resolution and argue that private creditors should play a greater role in risk-sharing ex ante and in helping to resolve sovereign debt crises. They point to the useful properties of SCDIs, and S-CoCos and GDP-linked bonds in particular. They describe S-CoCos as "predictable and transparent means of bailing-in creditors [which] would increase market discipline on sovereigns to prudently manage their debt, ex-ante, thus reducing the incidence of crises" (Brooke et al. 2013: 3). The use of S-CoCos would, in their view, not only help to tackle liquidity crises but also help to "reduce the size of official sector support packages once a crisis has hit, as amortising debt would no longer need to be covered by program financing" (Brooke et al. 2013: 3). GDP-linked bonds would provide a "natural complement" to S-CoCos and lower the likelihood of solvency crises, especially in economies with higher GDP growth volatility (such as emerging market economies) or countries where monetary policy is constrained (such as those in a monetary union) (ibid.).

SCDIs have become a standard feature of sovereign debt restructurings (IMF 2017). As pointed out by Cohen et al. (2021: 6), "[b]y tying the debt service payments of restructured debt contracts to future outcomes, SCDIs may help avoid protracted disputes about current valuations and facilitate quicker agreements between creditors and debtors, thus allowing countries to restore debt sustainability and facilitating their return to market access." SCDIs can be used to "sweeten" the bond exchange offer to private creditors and provide them the opportunity to participate in a recovery that is stronger than anticipated.

SCDIs were first used in the debt restructurings that took place under the Brady Plan in the late 1980s and 1990s (cf. Table 4). Brady bonds were newly issued, partially secured bonds that private creditors swapped for old debt with a haircut. To incentivise participation in debt restructuring, some Brady bonds offered private creditors contingent upside payments through value recovery rights (Cohen et al. 2020). For instance, as oil exporters, Mexico, Nigeria, and Venezuela offered warrants tied to the oil price, which had a direct impact on their public finances and ability to serve foreign currency debt. Bosnia and Herzegovina, Honduras, Costa Rica, Bulgaria, and Côte d'Ivoire included GDP-linked warrants, providing holders with a higher coupon if GDP exceeded some threshold level. Uruguay offered warrants linked to a trade-weighted basket of exports. Most, but not all, sovereign debt restructurings now make use of SCDIs with upside GDP-warrants (Cohen et al. 2020, Table 5).[12]

Against the backdrop of the sovereign debt crisis that has been building in the Global South because of the COVID-19 crisis, various proposals have been put forward linking debt relief with measures to address the climate and nature crises. Several proposals called for conventional debt-for-climate or debt-for-nature swaps (Steele and Patel 2020; Yue and Nedopil Wang 2021). Volz et al. (2020b, 2021) put forward a more aspiring proposal for 'Debt Relief for Green and Inclusive Recovery' that draws on previous experiences with Brady restructurings and makes debt relief contingent on governments' commitments to reforms that align their policies and budgets with the Agenda 2030 and the Paris Agreement. Concretely, debtor governments are expected to develop their own Green and Inclusive Recovery Strategy, in which they map out a set of actions that the country will undertake under this scheme to advance its development and climate goals (Volz et al. 2021). These

Table 4: State-contingent Brady instruments.

Index/ warrant	GDP	Commodity price	Terms of trade
Detachable	Bosnia & Herzegovina (1997)	Venezuela (1990), Nigeria (1992), Mexico (1990)	Uruguay (1991)
Non-detachable	Honduras (1989), Costa Rica (1990), Bulgaria (1993), Côte d'Ivoire (1997)	Bolivia (1992)	

Source: Adapted from IMF (2017b).

12 Notably, the recent restructurings of Argentina and Ecuador in 2020 did not make use of value recovery rights.

Table 5: Issuance of state-contingent instruments in recent sovereign debt restructurings.

Country (year)	Type (upside/ downside)	Haircut[a,b] nominal/NPV	Currency of denomination	Period covered (years)	Main trigger	Formula for payout/ deferral	Caps/exercise limits
Argentina (2005, 2010)	GDP-linked warrant (upside)	29.8%/76.8%	Local and foreign	20	Real GDP level	Pays out 5% of real GDP in excess of reference level	Total payments capped at 48% of notional principal
Greece (2012)	GDP-linked warrant (upside)	53.5%/64.6%	Local currency	27	Real GDP growth	Pays out 1.5 times real GDP growth in excess of reference growth rate	Annual cap at 1%
Ukraine (2015)	GDP-linked warrant (upside)	20%/28%	Foreign currency	20	Real GDP growth, level of GDP in USD	Pays out 15% of real GDP growth between 3 and 4% Pays out 40% of real GDP growth in excess of 4% No payments unless nominal GDP is higher than USD 125.4 bn	Annual cap at 1% of GDP from 2021–25; uncapped from 2026-40
Grenada (2015)	CBI[c] revenue-linked payments in 2030 bond (upside)	50% (of which 25% upfront)/ 54%	Local and foreign currency	15	CBI revenues	Pays out 25% of CBI proceeds between USD 15 mn–50 mn Pays out 35% of CBI revenues in excess of USD 50 mn	Discounted[d] value of total payments capped at 35% of outstanding principal value

Table 5: (continued)

Country (year)	Type (upside/ downside)	Haircut[a,b] nominal/NPV	Currency of denomination	Period covered (years)	Main trigger	Formula for payout/ deferral	Caps/exercise limits
Grenada (2015)	Hurricane clause[e] in 2030 bond (downside)	50% (of which 25% upfront)/ 54%	Local and foreign currency	13	"Modelled" hurricane damage	6-month deferral if modelled loss is greater than USD 15 mn, less than USD 30 mn 12-month deferral if modelled loss is greater than USD 30 mn	Can be triggered a maximum of 3 times
Barbados (2018)	Natural disaster clause[f] in a portfolio of domestic-currency long-term bonds (downside)	0%/43%	Local currency	15–35	"Modelled" natural disaster damage	24-month deferral if modelled loss is greater than USD 5 mn	Can be triggered a maximum of 3 times
Barbados (2018)	Natural disaster clause[g] in 2029 bond (downside)	25%/44%	Foreign currency	8	"Modelled" natural disaster damage	24-month deferral if modelled loss is greater than USD 5 mn 24-month deferral if modelled loss is greater than USD 7.5 mn	Can be triggered a maximum of 3 times

[a]These haircuts calculations do not account for the value of the state-contingent instruments. [b]Sources for haircut estimates are Cruces and Trebesch (2013), Zettelmeyer, Trebesch, and Gulati (2013), IMF (2015, 2017a), and Anthony, Impavido, and van Selm (2020). [c]These refer to revenues from Grenada's 'Citizenship by Investment' programme. [d]Payments to be discounted back to May 2015 using average yield on the 2030 bond in the year in which they occur. [e]Similar clauses were included in restructured debts with the Import-Export Bank of Taiwan and the Paris Club. [f]The natural disaster clause covers earthquake, "flooding", and "hurricane" events. [g]Barbados' natural disaster clause covers earthquake, "flooding", and "hurricane" events. The modelled loss for earthquake and flooding is USD 5 mn and the modelled loss for hurricane is USD 7.5 mn. Source: Adapted from Cohen et al. (2020).

strategies should define clear targets and performance metrics that would become KPIs for debt relief. Private creditors would then swap old debt for new bonds at a significant haircut. Under the proposal, a World Bank sponsored Guarantee Facility would provide a partial guarantee of the principal of the newly issued sovereign bonds, as well as a guarantee on 18 months' worth of interest payments, analogous to the Brady Plan. If a sovereign were to be found in significant violation of their Green and Inclusive Recovery Strategy commitments, the steering committee overseeing the debt restructuring could decide that the government loses some or all of the haircut. In this case, the country would be required to make payments equivalent to the net present value difference of debt service of old and new obligations into an escrow account at the Guarantee Facility. If the debtor country's policies are again in compliance with its commitments within two years, up to two years' worth of excess debt service would be returned to the country. If the government honours its commitments only after a period longer than two years, it also gets two years back but loses the remaining payments for good, which will be moved from the escrow account into the general use of the Guarantee Facility. This process would provide incentives for the debtor government to come back to the commitments quickly. The same authors also suggested that governments that have successfully undergone debt restructuring under this scheme should be eligible for partial guarantees by the proposed Guarantee Facility for newly issued SLBs.

4 Properties and Challenges of SCDIs

Even though many SCDIs have appealing features, they have thus far remained rather fringe. The issuance of SCDIs has been limited both in quantity and frequency, and governments have not been able to issue SCDIs at a reasonable premium (Moretti 2020; Roch and Roldán 2021). Several potential problems have limited the widespread use of SCDIs. IMF (2017a, 2017b) identify various "complications" related to SCDIs, including high novelty and liquidity premia demanded by investors during transition due to the smaller size of their market, political economy difficulties and/or myopia on the part of issuers, moral hazard and adverse selection, incentives for data manipulation and constraints on servicing SCDIs in good times, excessive risk migration to the private sector, pro-cyclical investor demand, a decline in the supply of 'safer' conventional assets, and adverse pricing effects on conventional debt.

Igan, Kim, and Levy (2022) document three empirical properties of GDP-linked bonds. First, they find the premium associated with SCDIs to be high and persistent. They hence dismiss the notion of a novelty premium for that disappears as market participants become familiar with SCDIs. Second, the premium appears to be

pro-cyclical (i.e. lower during a recession). And third, the liquidity premium for GDP-linked bonds is higher and more volatile than that for plain-vanilla bonds issued by the same sovereign.

Incorporating search frictions into a standard model with incomplete markets, limited commitment, and exogenous costs of default, and assuming that the liquidity of GDP-linked debt is related to the size of its secondary market, Moretti (2020) shows that the liquidity premium demanded by bond holders reduces the welfare gains from issuing SCDIs by more than 50%. Using a standard sovereign default model, Roch and Roldán (2021) show how international lenders' concerns for model misspecification reduce their demand for SCDIs with a commonly used threshold state-contingent bond structure (such as the GDP-linked bonds issued by Argentina in 2005). In their setting, ambiguity averse lenders guard themselves against possible misspecification errors in their approximating model, which leads to an "ambiguity" premium in bond spreads associated with the contingency of the bond, a severe underpricing of SCDIs, and lower issuance than would be optimal. Roch and Roldán (2021) highlight that the optimal bond indexation depends on the degree of lenders' preferences for robustness: The stronger lenders' preference for robustness, the less contingency elements should feature in the optimal debt structure. Roch and Roldán (2021: 35) conclude that "a state-contingent structure with linear indexation and potentially a threshold to cover against the extreme left tail of shocks to income" may be most appropriate.[13]

Table 6 provides an overview of potential benefits and challenges of SCDIs. While there are clear upsides to SCDIs, the challenges need to be taken seriously. What appears clear is that a wider adoption of sovereign SCDIs is unlikely to happen by itself. However, the universal adoption of collective action clauses (CACs) in sovereign debt contracts in the 2000s – after a period of persistent resistance to their inclusion by markets since they had been initially recommended by the Rey Report in 1996 in the wake of the Mexican tequila crisis (Boorman 2002; Häseler 2009) – suggests that market practice can indeed change where the official sector is determined, and governments are willing to take a concerted approach internationally. As highlighted by Brooke et al. (2013: 3): "The promotion of [CACs] by the G10 and the major emerging market economies in the mid-2000s provides evidence that it is possible for the international community to reach agreement on, and implement, changes to the contractual terms of sovereign debt."

Especially against the backdrop of a widespread adoption of ESG practices in international capital markets, a wider uptake of sovereign debt instruments linked to sustainability outcomes appears realistic. Indeed, it would be eminently

13 This finding is corroborated by Igan, Kim, and Levy (2022), who extend Roch and Roldán's (2021) model to study the time-varying properties of SCDIs.

Table 6: Challenges and benefits of state-contingent debt instruments.

Benefits	Challenges
Help governments to better manage public debt (including "climate-proofing" of public finances) and reduce the probability of default.	High and potentially persistent premium associated with SCDIs.
Can incentivise certain desirable government policies, including those that benefit macroeconomic stability or enhanced sustainability outcomes (e.g. climate action, SDGs).	Small size of primary and secondary markets due to limited issuance (both in quantity and frequency) reduces attractiveness of SCDIs and results in high liquidity premia demanded by investors.
Can benefit both debtors and creditors by providing additional creditor compensation in good times and/or some form of debtor relief in bad times.	Problems of moral hazard and adverse selection, including incentives for data manipulation by governments.
Can facilitate debt restructuring by helping to avoid protracted disputes about current valuations and facilitate quicker agreements between creditors and debtors.	Challenges in the computation of payments related to data revisions and changes in methodology.
	Decline in the supply of 'safer' conventional assets and adverse pricing effects on conventional debt.
Can be used to "sweeten" the bond exchange offer to private creditors in debt restructurings and provide them the opportunity to participate in a recovery that is stronger than anticipated.	Could lead to an excessive shift of risk from public debtors to private investors.
	Could suffer from pro-cyclical investor demand.

Source: Compiled by author.

sensible, given that sustainability risk is linked to sovereign risk. However, designing outcome-linked sustainability bonds poses some challenges of its own. In particular, the selection of the "right" KPIs is a challenge, as is performance assessment. Issuing sustainability-linked SCDIs requires the development of relevant nature and climate metrics and associated monitoring, reporting and verification (MRV) assessment tools to oversee robust performance outcomes. To address this challenge, case-by-case solutions should be avoided. These would be both costly and time-consuming, and they would also make it cumbersome to compare instruments and lead to fragmented and illiquid markets.

An internationally coordinated approach to develop standards for sustainability KPIs and MRV assessment approaches and tools could help to overcome these challenges while allowing for sufficient context-specific flexibility. A proposal for a "Nature and Climate Sovereign Bond Facility" that seeks to do exactly this was recently put forward by F4B (2021). The proposed Facility is meant to build "on recent experience in establishing collaborative platforms to support green and sustainability bonds [which] have provided services to creditors and debtors in advancing nature-and climate-linked debt agreements, including technical assistance,

performance assessment, credit enhancement and other financial services" (F4B 2021c: 2). Following this proposal, the World Bank published a report on KPIs for SLBs as part of a joint World Bank Group/IMF project exploring the need for a Global Platform to Scale Finance for Climate and Nature Action (Flugge, Mok, and Stewart 2021). The report puts forward a framework for selecting KPIs and setting the associated sustainable performance targets for sovereign SLBs. In September 2022, a Sustainability-linked Sovereign Debt Hub was launched under involvement of several multilateral development banks, the ICMA, Climate Bonds Initiative, the Nature Conservancy, and the Institute of International Finance. This Hub seeks to connect stakeholders and support the creation of standards and tools that incorporate nature and climate considerations into the sovereign bond ecosystem.

Furthermore, digital solutions, such as the use of blockchain in bond certification processes and automating the proof of impact of the use of proceeds, could further help to make MRV not only cheaper but also more transparent and reliant (Chen and Volz 2021). Moreover, issuances of sustainability-linked SCDIs by major countries could help to develop and mainstream this asset class.

5 Conclusions

For decades, sovereign SCDIs have been suggested as complements or alternatives to traditional sovereign debt instruments. Inflation-linked sovereign bonds have gained a certain popularity, with issuances by more than 30 countries, and inflation-linked treasuries accounting for 7% of all public debt issued by the US, the largest issuer. However, the global inflation-linked debt market accounts for less than 5% of total sovereign debt of outstanding. The uptake of other SCDIs, such as GDP-or commodity-linked bonds has been even smaller, despite often appealing features that could improve public debt management while providing interesting opportunities for investors. To date, markets for SCDIs have suffered from low liquidity and issues around measurement.

The escalating climate and ecological crises provide a strong rationale to reconsider the use SCDIs. The physical and transition impacts of climate change and environmental degradation are increasingly recognised to alter the risk profile of sovereigns. The use of risk-linked sovereign instruments such as cat bonds or resilience bonds and embedding disaster risk clauses in sovereign debt contracts would be an important way for governments, especially in highly climate-vulnerable countries, to mitigate climate risks and scale up disaster risk financing. Moreover, SCDIs such as SLBs that incentivise sustainability-oriented policies or investments could not only help to bring about better sustainability outcomes. They could also contribute to greater debt sustainability, given that climate change and a depletion of

natural capital are likely to worsen sovereign credit ratings and undermine debt sustainability (Agawala et al. 2022; Klusak et al. 2021; Kraemer and Volz 2022). SCDIs can also play an important role in facilitating debt restructurings.

Although the uptake of SCDIs has been slow to date, the experience with CACs has shown that market practice can change when governments take a concerted approach internationally. The international community, supported by key institutions like the IMF and the major multilateral development banks, should make a concerted effort to promote the widespread adoption of sovereign SCDIs to support better public debt management, the climate-proofing of public finances, and the achievement of more ambitious sustainability outcomes.

References

Aharoni, Y., and T. Ophir. 1967. "Accounting for Linked Loans." *Journal of Accounting Research* 5 (1): 1–26.

Agarwala, M., M. Burke, P. Klusak, M. Kraemer, and U. Volz. 2022. *Nature Loss and Sovereign Credit Ratings*. London: Finance for Biodiversity.

Almeida, H., I. Cunha, M. A. Ferreira, and F. Restrepo. 2017. "The Real Effects of Credit Ratings: The Sovereign Ceiling Channel." *The Journal of Finance* 72: 249–90.

Anthony, M., G. Impavido, and B. van Selm. 2020. "Barbados' 2018-19 Sovereign Debt Restructuring—A Sea Change?" In *IMF Working Paper No. 20/34*. Washington: International Monetary Fund.

Asonuma, T., M. X. Li, M. G. Papaioannou, S. Thomas, and E. Togo. 2017. "Sovereign Debt Restructurings in Grenada: Causes, Processes, Outcomes, and Lessons Learned." In *IMF Working Paper No. 17/171*. Washington: International Monetary Fund.

Atta-Mensah, J. 2004. "Commodity-Linked Bonds: A Potential Means for Less-Developed Countries to Raise Foreign Capital." Staff Working Paper No. 04-20, Ottawa, ON: Bank of Canada.

Beirne, J., N. Renzhi, and U. Volz. 2021a. "Feeling the Heat: Climate Risks and the Cost of Sovereign Borrowing." *International Review of Economics & Finance* 76: 920–36.

Beirne, J., N. Renzhi, and U. Volz. 2021b. "Bracing for the Typhoon: Climate Change and Sovereign Risk in Southeast Asia." *Sustainable Development* 29 (3): 537–51.

Bertinatto, L., D. Gomtsyan, G. Sandleris, H. Sapriza, and F. Taddei. 2017. *Indexed Sovereign Debt: An Applied Framework, Carlo Alberto Notebooks No. 104*. Torino: Collegio Carlo Alberto.

Blanchard, O., P. Mauro, and J. Acalin. 2016. "The Case for Growth Indexed Bonds in Advanced Economies" In *PIIE Policy Brief No. 16-2*. Washington: Peterson Institute for International Economics.

Boorman, J. 2002. "Sovereign Debt Restructuring: Where Stands the Debate?" In *Speech by Jack Boorman, Special Advisor to the Managing Director of the IMF, at Conference Cosponsored by the CATO Institute and the Economist New York, 17 October*. Also available at https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp101702.

Bordo, M. D., and H. Rockoff. 1996. "The Gold Standard as a "Good Housekeeping Seal of Approval"." *The Journal of Economic History* 56 (2): 389–428. Papers Presented at the Fifty-Fifth Annual Meeting of the Economic History Association.

Borensztein, E., K. Cowan, and P. Valenzuela. 2013. "Sovereign Ceiling Lite? the Impact of Sovereign Ratings on Corporate Ratings in Emerging Market Economies." *Journal of Banking & Finance* 37: 4014–24.

Borensztein, E., and P. Mauro. 2004. "The Case for GDP Indexed Bonds." *Economic Policy* 19 (38): 165–216.
Bouzidi, D., and D. Papaioannou. 2021. *Sovereign Sustainability-Linked Bonds. Opportunities, Challenges and Pricing Considerations*. Available at SSRN: https://doi.org/10.2139/ssrn.3919159.
Brooke, M., R. Mendes, A. Pienkowski, and E. Santor. 2013. "Sovereign Default and State-Contingent Debt." In *BoE Financial Stability Paper No. 27*. London: Bank of England.
Buera, F., and J. P. Nicolini. 2004. "Optimal Maturity of Government Debt without State Contingent Bonds." *Journal of Monetary Economics* 51: 531–54.
Buhr, B., U. Volz, C. Donovan, G. Kling, Y. Lo, V. Murinde, and N. Pullin. 2018. *Climate Change and the Cost of Capital in Developing Countries*. London: Imperial College London, SOAS University of London, and UN Environment.
Caballero, R. J. 2003. "The Future of the IMF." *The American Economic Review* 93 (2): 31–8. Papers and Proceedings of the One Hundred Fifteenth Annual Meeting of the American Economic Association.
Caputo Silva, A., and F. Stewart. 2020. "My Word Is My Bond: Linking Sovereign Debt with National Sustainability Commitments." In *Development and a Changing Climate*: World Bank Blogs. Also available at https://blogs.worldbank.org/climatechange/my-word-my-bond-linking-sovereign-debt-national-sustainability-commitments.
Campbell, J. Y., and R. J. Shiller. 1996. "A Scorecard for Indexed Government Debt." In *NBER Macroeconomics Annual*, Vol. 11, 155–97. Chicago: The University of Chicago Press.
Campbell, J. Y., R. J. Shiller, and L. M. Viceira. 2009. "Understanding Inflation-Indexed Bond Markets." *Brookings Papers on Economic Activity* 40 (Spring): 79–138.
Cecchetti, S., and K. Schoenholtz. 2017. "GDP-Linked Bonds: A Primer." In *VoxEU*. Also available at https://voxeu.org/article/gdp-linked-bonds-primer.
CBI. 2019. *Climate Resilience Principles. A Framework for Assessing Climate Resilience Investments*. London: Climate Bonds Initiative. Also available at https://www.climatebonds.net/files/page/files/climate-resilience-principles-climate-bonds-initiative-20190917-.pdf.
Chen, Y., and U. Volz. 2021. "Scaling up Sustainable Investment through Blockchain-Based Project Bonds." *Development Policy Review* 40 (3): e12582.
Choudhry, M., G. Cross, and J. Harrison. 2003. *The Gilt-Edged Market*. Oxford: Butterworth-Heinemann.
Cevik, S., and J. Tovar Jalles. 2020. "This Changes Everything: Climate Shocks and Sovereign Bonds." In *IMF Working Paper No. 20/79*. Washington: International Monetary Fund.
Cohen, C., S. A. Abbas, M. Anthony, T. Best, P. Breuer, H. Miao, A. Myrvoda, and E. Togo. 2020. "The Role of State-Contingent Debt Instruments in Sovereign Debt Restructurings." In *IMF Staff Discussion Note No. 20/06*. Washington: International Monetary Fund.
Colchester Global Investors. 2017. "Global and Emerging Market Inflation-Linked Bonds." In *Commentary*. London: Colchester Global Investors.
Consiglio, A., and S. A. Zenios. 2018. "Contingent Convertible Bonds for Sovereign Debt Risk Management." *Journal of Globalization and Development* 9 (1): 20170011.
Cruces, J. J., and C. Trebesch. 2013. "Sovereign Defaults: The Price of Haircuts." *American Economic Journal: Macroeconomics* 5 (3): 85–117.
Cummins, J. D. 2008. "CAT Bonds and Other Risk-Llinked Securities: State of the Market and Recent Developments." *Risk Management and Insurance Review* 11 (1): 23–47.
Deacon, M., and A. Derry. 1998. *Inflation-Indexed Securities*. New York: Prentice-Hall.
Di Iorio, A., and M. Fanari. 2020. "Break-even Inflation Rates: The Italian Case." In *Banca D'Italia Occasional Paper No. 578*. Rome: Banca D'Italia.
F4B. 2021a. *Recapitalising Sovereign Debt*. London: Finance for Biodiversity.
F4B. 2021b. *Nature Performance Bonds. Frequently Asked Questions*. London: Finance for Biodiversity.

F4B. 2021c. *Greening Sovereign Debt. Building a Nature and Climate Sovereign Bond Facility*. London: Finance for Biodiversity.

Fall, M. A. 1984. *Commodity Bonds: A Financing Alternative*. Master's thesis. Cambridge: Massachusetts Institute of Technology.

Farhi, E., and I. Werning. 2017. "Fiscal Unions." *The American Economic Review* 107 (12): 3788–834.

Farrugia, M., G. Formosa, and J. J. Pace. 2018. "Inflation-linked Bonds: An Introduction." In *CBM Working Paper No. 05/2018*. Valletta: Central Bank of Malta.

Flugge, M. L., R. C. K. Mok, and F. E. Stewart. 2021. *Striking the Right Note: Key Performance Indicators for Sovereign Sustainability-Linked Bonds*. Washington: World Bank Group.

Friedman, M. 1974. "Monetary Correction." In *Essays on Inflation and Indexation*. Washington: American Enterprise Institute.

G20. 2016. *Hangzhou Action Plan*. Also available at www.g20chn.org/English/Documents/Current/201609/t20160908_3410.html.

Garcia, A., N. Singh Paul, and I. Zelenko. 2011. "The World Bank's MultiCat Program: Using Catastrophe Bonds to Insure against Natural Disaster Risks." In *The Euromoney International Debt Capital Markets Handbook 2011*, 41–8. London: Euromoney Institutional Investor.

Giráldez, J., and S. Fontana. 2021. *Sustainability-linked Bonds: The Next Frontier in Sovereign Financing*. Available at SSRN: https://doi.org/10.2139/ssrn.3829946.

Griffith-Jones, S., and K. Sharma. 2006. "GDP-Indexed Bonds: Making it Happen." In *DESA Working Paper No. 21*. New York: United Nations Department of Economic and Social Affairs.

Hatchondo, J. C., L. Martinez, and H. Sapriza. 2007. "Quantitative Models of Sovereign Default and the Threat of Financial Exclusion." *Federal Reserve Bank of Richmond Economic Quarterly* 93 (3): 251–86.

Häseler, S. 2009. "Collective Action Clauses in International Sovereign Bond Contracts – Whence the Opposition?" *Journal of Economic Surveys* 23 (5): 882–923.

Holt, B. J. 1981. *Financing Options for the Strategic Petroleum Reserve*. Washington: Congressional Budget Office.

Huang, S., K. S. Tan, J. Zhang, and W. Zhu. 2021. "Epidemic Financing Facilities: Pandemic Bonds and Endemic Swaps." In *Nanyang Business School Research Paper No. 21-37*. Singapore: Nanyang Technological University.

ICMA. 2018. *Indicative Terms and Conditions for Sovereign Hurricane Bonds and Loans*. Zurich: International Capital Markets Association. Also available at https://www.icmagroup.org/resources/Sovereign-Debt-Information/.

ICMA. 2021a. *Green Bond Principles. Voluntary Process Guidelines for Issuing Green Bonds*. Zurich: International Capital Markets Association. Also available at https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Green-Bond-Principles-June-2021-140621.pdf.

ICMA. 2021b. *Social Bond Principles. Voluntary Process Guidelines for Issuing Social Bonds*. Zurich: International Capital Markets Association. Also available at https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Social-Bond-Principles-June-2021-140621.pdf.

ICMA. 2021c. *Sustainability Bond Guidelines*. Zurich: International Capital Markets Association. Also available at https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Sustainability-Bond-Guidelines-June-2021-140621.pdf.

ICMA. 2021d. *Sustainability-Linked Bond Principles. Voluntary Process Guidelines*. Zurich: International Capital Markets Association.

Igan, D., T. Kim, and A. Levy. 2022. "The Premia on State-Contingent Sovereign Debt Instruments." In *BIS Working Paper No. 988*. Basel: Bank for International Settlements.

IMF. 2015. *The Fund's Lending Framework and Sovereign Debt— Further Considerations"*. Washington: International Monetary Fund.

IMF. 2017a. “State-contingent Debt Instruments for Sovereigns.” In *IMF Policy Paper*. Washington: International Monetary Fund.

IMF. 2017b. *Staff Note for the G20: State-Contingent Debt Instruments for Sovereigns*. Washington: International Monetary Fund.

Jensen, L. 2022. “Avoiding ‘Too Little Too Late’ on International Debt Relief.” In *Development Futures Series Working Paper*. New York: United Nations Development Programme.

Jonas, O. 2019. “Pandemic Bonds: Designed to Fail in Ebola.” *Nature* 572: 285.

Kling, G., Y. Lo, V. Murinde, and U. Volz. 2018. “Climate Vulnerability and the Cost of Debt.” In *Centre for Global Finance Working Paper No. 12/2018*. London: SOAS University of London.

Kraemer, M., and U. Volz. 2022. *Integrating Nature into Debt Sustainability Analysis*. London: Finance for Biodiversity and SOAS, University of London.

Klusak, P., M. Agarwala, M. Burke, M. Kraemer, and K. Mohaddes. 2021. “Rising Temperatures, Falling Ratings: The Effect of Climate Change on Sovereign Creditworthiness,” Cambridge Working Paper in Economics No. 2127, Cambridge: Faculty of Economics, University of Cambridge.

Krämer, W. 2017. “An Introduction to Inflation-Linked Bonds.” In *Investment Research*. Frankfurt: Lazard Asset Management.

Krugman, P. 1988. “Financing vs. Forgiving a Debt Overhang.” *Journal of Development Economics* 29: 253–68.

Lessard, D. 1977. “Commodity-linked Bonds from Less-Developed Countries: An Investment Opportunity?” In *Proceedings, Seminar on the Analysis of Security Prices*. Chicago: University of Chicago.

Löffler, K. U., A. Petreski, and A. Stephan. 2021. “Drivers of Green Bond Issuance and New Evidence on the “Greenium”.” *Eurasian Economic Review* 11: 1–24.

Marino, R. 2008. “Developments and Trends in Mexico’s Bond Market.” In *Financial Innovation and Emerging Markets. Opportunities for Growth vs. Risks for Financial Stability*, edited by U. Volz, 81–103. Bonn: German Development Institute and Inwent.

Moretti, M. 2020. *Financial Innovation and Liquidity Premia in Sovereign Markets: The Case of GDP-Linked Bonds*: Mimeo. Also available at https://mmorettifiles.github.io/Paper_2020_GDPBonds.pdf.

Noyer, C. 2004. “The Role of Inflation-Indexed Bonds in the Process of Setting Monetary Policy: A Central Banker’s Perspective.” In *Speech by Mr Christian Noyer, Governor of the Bank of France, at the Morgan Stanley Seminar on Indexed Bonds*. Paris. Also available at https://www.bis.org/review/r040618a.pdf.

O’Hara, M. 1984. “Commodity Bonds and Consumption Risks.” *The Journal of Finance* 39 (1): 193–206.

OECD. 2017. *OECD Sovereign Borrowing Outlook 2017*. Paris: Organisation for Economic Cooperation and Development.

Priovolos, T., and R. C. Duncan. 1991. “Introduction.” In *Commodity Risk Management and Finance*, edited by T. Priovolos and R. C. Duncan, 1–7. Oxford: Oxford University Press.

Proelss, J. 2008. “Commodity-linked Bond.” In *Encyclopedia of Alternative Investments*, edited by G. N. Gregoriou, 87–8. Boca Raton: CRC Press.

RBI. 2019. “Sovereign Gold Bond Scheme.” In *Frequently Asked Questions*. Mumbai: Reserve Bank of India. Also available at https://m.rbi.org.in/scripts/FAQView.aspx?Id=109.

Rizvi, S. A. R., O. I. Bacha, and A. Mirakhor. 2016. *Public Finance and Islamic Capital Markets: Theory and Application*. New York: Springer.

Roch, F., and F. Roldán. 2021. *Uncertainty Premia, Sovereign Default Risk, and State-Contingent Debt*. Forthcoming: Journal of Political Economy Macroeconomics.

Rozental, A. A. 1959. “Variable-Return Bonds – the French Experience.” *The Journal of Finance* 14 (4): 520–30.

Saráchaga, R. 2019. *Long-term Bonds: Different Ways to Support (And Benefit from) Pension Needs. Uruguay: The Case of Wage-Linked Sovereign Bonds*: World Bank Webinar. Also available at https://thedocs.

worldbank.org/en/doc/745511554741389877-0340022019/original/LongtermsbondsThecaseofUruguay30420191.pdf.

Shiller, R. J. 1998. *Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks*. Oxford: Oxford University Press.

Shiller, R. J. 2005. "The Invention of Inflation-Indexed Bonds in Early America." In *The Origins of Value: The Financial Innovations that Created Modern Capital Markets*, edited by W. N. Goetzmann and G. K. Rouwenhorst, 239–48. Oxford: Oxford University Press.

Shiller, R. J., J. D. Ostry, J. Benford, and A. VoxE. U. org Book. 2018. *Sovereign GDP-Linked Bonds: Rationale and Design*. London: CEPR Press.

Steele, P., and S. Patel. 2020. "Tackling the Triple Crisis. Using Debt Swaps to Address Debt, Climate and Nature Loss Post-COVID-19." In *IIED Issue Paper*. London: International Institute for Environment and Development.

Sustainalytics. 2022. *Government of Chile Sustainability-Linked Bond Framework Second Party Opinion*. Amsterdam: Sustainalytics. Also available at https://www.sustainalytics.com/corporate-solutions/sustainable-finance-and-lending/published-projects/project/government-of-chile/government-of-chile-sustainability-linked-bond-framework-second-party-opinion-(2022)/government-of-chile-sustainability-linked-bond-framework-second-party-opinion-(2022).

Volz, U., J. Beirne, N. Ambrosio Preudhomme, A. Fenton, E. Mazzacurati, N. Renzhi, and J. Stampe. 2020a. *Climate Change and Sovereign Risk*. London, Tokyo, Singapore, Berkeley: SOAS University of London, Asian Development Bank Institute, World Wide Fund for Nature Singapore, and Four Twenty Seven.

Volz, U., S. Akhtar, K. P. Gallagher, S. Griffith-Jones, J. Haas, and M. Kraemer. 2020b. *Debt Relief for a Green and Inclusive Recovery: A Proposal*. Berlin, London, and Boston: Heinrich-Boll-Stiftung; SOAS, University of London; and Boston University.

Volz, U., S. Akhtar, K. P. Gallagher, S. Griffith-Jones, J. Haas, and M. Kraemer. 2021. *Debt Relief for a Green and Inclusive Recovery: Securing Private-Sector Participation and Creating Policy Space for Sustainable Development*. Berlin, London, and Boston: Heinrich-Boll-Stiftung; SOAS, University of London; and Boston University.

Warren-Rodríguez, A., and P. Conceição. 2015. *Risk-Informed Finance for Development. Can GDP-Linked Official Lending to Emerging Economies and Developing Countries Enhance Risk Management and Resilience?* New York: United Nations Development Programme.

Wedderburn-Day, A. R. 2010. "Sovereign "Sukuk": Adaptation and Innovation." *Law and Contemporary Problems* 73 (4): 325–33.

Westerhout, E., and O. Ciocyte. 2017. "The Role of Inflation-Linked Bonds. Increasing, But Still Modest." In *CPB Discussion Paper No. 344*. The Hague: CPB Netherlands Bureau for Economic Policy Analysis.

World Bank. 2015. "MultiCat Program." In *Product Note*. Washington: World Bank. Also available at https://thedocs.worldbank.org/en/doc/438301507314977367-0340022017/original/productnotemulticatprogramcatbond2015.pdf.

Yue, M., and C. Nedopil Wang. 2021. "Debt-for-nature Swaps: A Triple-Win Solution for Debt Sustainability and Biodiversity Finance in the Belt and Road Initiative (BRI)?" In *IIGF Green BRI Center Paper*. Beijing: International Institute of Green Finance.

Zettelmeyer, J., C. Trebesch, and M. Gulati. 2013. "The Greek Debt Restructuring: An Autopsy." *Economic Policy* 28 (75): 513–63.