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State-Contingent Government Debt: a New Database

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Abstract

State-contingent government debt has been proposed as a way to reduce costly debt crisis. However, markets for this type of debt remain very limited, for reasons that are not yet fully understood. This paper describes a new database covering state-contingent government debt issued between 1863 and 2020. Based on these data, this paper shows stylized facts regarding the main design features, and market performance, of state-contingent government debt. It also provides a brief history of state-contingent government borrowing, which is contextualized with a simple theoretical model of state-contingent debt. The results show that there have been several small, heterogeneous, issuances of state-contingent debt, which resemble pilot runs in this new asset class. The paper concludes with some common challenges associated to state-contingent government debt.

Keywords: State-Contingent Debt, GDP-Linked Bonds, Public Debt

JEL Classification: G1, N2, H63

I. Introduction

International sovereign borrowing has been plagued with costly debt crises (*Tomz/Wright*, 2013). Recent academic and policy work suggests making debt payments indexed to real and nominal variables, that are linked to the overall state of the economy, as a potential improvement on current sovereign debt markets, what is often referred to as state-contingent public debt (*Besley/Powell* 1989, *Shiller* 1993, *Obstfeld/Peri* 1998, *Haldane* 1999, *Council of Economic Advisors* 2004, *Borensztein/Mauro* 2004, *Sandleris/Wright* 2013, *Barr* et al. 2014).

Government borrowing is currently almost exclusively done with non-contingent debt, where payments are fixed, with the exception of very disruptive events like debt default or debt restructuring. By linking payments to the state of the

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economy, state-contingent debt has the potential to make sovereign debt markets more stable and less prone to crises, while borrowing economies could experience more sustainable debt levels, particularly during economic downturns (*Benford* et al. 2016; *Blanchard* et al. 2016, *Cabrillac* et al. 2017, *Cecchetti/Schoenholtz* 2017, *Benford* et al. 2018). In spite of these potential benefits, and the recent policy interest, the use of state-contingent government debt is extremely limited.

The history of state-contingent government debt, however, is not so recent. There have been several examples of government debt where the payments or the maturity depend on economic variables. These include GDP, other measures of production, commodity prices, wages, revenues, and even natural disasters. This history is also not completely well understood. For example, Paul Ramadier, France's Finance Minister in 1956, described France's industrial production linked bond holders as "shareholders whose dividend varies according to national income" (*Le Monde* 1956) almost 40 years before Shiller wrote about the inexistence of "national income markets" (*Shiller* 1993), without referencing France's state contingent bonds.

To fill this lacuna and allow for a holistic view of the phenomena of state-contingent public debt, this paper presents a new database on state-contingent government debt. Some of these instruments reach as far back as the 19th century. This database combines information that is currently scattered in several academic, policy and industry publications, together with primary sources, and codifies it into a database.[1] The information coded includes technical details related to the contracts issued, but also an analysis of their market performance, as well as the factors that crucially determine the success of these types of instruments.

This paper has three main contributions. First it presents the main variables collected in the dataset. Second, it reports stylized facts regarding the main characteristics of state-contingent government debt. Finally, it reviews existing experiences with this type of debt, contextualized by a simple textbook asset pricing model, and draws some lessons for policy makers. The history of state-contingent debt instruments includes a rich variety of experiences, both with respect to design and performance. The results show that there have been several small, heterogeneous, issuances of state-contingent debt, which resemble pilot runs in this new asset class. The analysis also shows some common challenges associated to state-contingent government debt.

Several academic and policy papers have collected information on existing state-contingent debt instruments, and this paper draws from this work. The focus is traditionally on estimating the benefits associated with these debt instru-

[1] All data is available for download at the author's personal website.

ments and understanding their potential limitations. These papers include a few examples of existing debt instruments, but do not systematically review the available data on state-contingent debt.[2]

Until now, the largest collection of examples of state-contingent instruments is the project by the *IMF* (2017). The annexes provide information on several state-contingent debt instruments. Relative to the IMF report, the database presented in this paper increases the coverage both in terms of the number of state-contingent assets and with regard to the information collected. It also tabulates these characteristics into a dataset.

Section II. presents a simple theoretical framework that introduces the concept and potential benefits of state-contingent debt. It also shows conditions under which these markets can exist. Section III. describes the main features included in the database. Section IV. provides an historical overview of experiences with state-contingent debt. Section V. discusses some relevant lessons from these experiences to policy makers and market participants. Section VI. concludes.

II. Theoretical Framework

This section uses a simple textbook model of government borrowing to highlight the potential gains associated with state-contingent debt, as well as the conditions for the existence of a market for state-contingent debt.[3]

1. Government Budget Constraint

Consider the following government budget constraint:

$$B_t = B_{t-1} + IP_t + G_t - T_t + SFA_t \,, \tag{1}$$

where B is the total debt stock, IP are interest payments, G is government expenditure, T represents taxes and SFA represents stock-flow adjustments to public debt. For simplicity, assume there are two types of public debt: contingent (B^c) and uncontingent (B^u), and let interest payments be defined as $r^c B^c$ for contingent debt, and $r^u B^u$ for uncontingent debt. Unlike traditional debt, the interest payments on contingent debt will depend on the state of the economy. Re-

[2] A non-exhaustive list of papers and books with significant descriptions of state-contingent instruments include *Rennhack* et al. (1995), *Atta-Mensah* (2004), *Borensztein/Mauro* (2004), *Tabova* (2005), *Miyajima* (2006), *IMF/World Bank* (2011), *Park/Samples* (2015), *Williamson* (2017), *Bertinatto* et al. (2017).

[3] See *IMF* (2017) for an overview of models of state-contingent debt, including an analysis of fiscal space in a model close to the one presented here.

placing these in equation (1) and letting small caps letters represent variables as a share of GDP, we can rewrite this equation as:

$$(2) \qquad b_t = \frac{1+r^u}{1+\gamma_t+\pi_t} b^u_{t-1} + \frac{1+r^c}{1+\gamma_t+\pi_t} b^c_{t-1} + g_t - \tau_t + sfa_t,$$

where r represents the interest rate on debt, γ is the growth rate of real GDP, π is the inflation rate and τ are taxes as a share of GDP. Let real GDP growth be equal to a steady-state trend γ^* plus an exogenous shock ε. Subtract on both sides by $b_{t-1} = b^u_{t-1} + b^c_{t-1}$ to obtain the following equation describing the evolution of the debt to GDP ratio:

$$(3) \quad b_t - b_{t-1} = \frac{r^u_t - (\gamma^* + \varepsilon_t + \pi_t)}{1+\gamma^* + \varepsilon_t + \pi_t} b^u_{t-1} + \frac{r^c_t - (\gamma^* + \varepsilon_t + \pi_t)}{1+\gamma^* + \varepsilon_t + \pi_t} b^c_{t-1} + g_t - \tau_t + sfa_t.$$

Equation (3) is a standard debt accumulation equation, augmented to include different types of debt and stock-flow adjustments to debt. Assume for simplicity that all debt is denominated in domestic currency, faces no default risk, and has a maturity of one-year. Assuming domestic currency that is non-defaultable allows us to avoid considerations, for now, related to exchange rate or default risk. Longer maturity debt could be replicated with sequences of one-year bonds. Using this budget constraint, it is possible to see how state-contingent debt has the potential to stabilize debt to GDP ratios following shocks to GDP, as I show next.

2. *Stabilizing Role of State-Contingent Debt*

To simplify, assume first that the primary balance plus stock-flow adjustments are equal to zero. Assume further that the real growth trend, the inflation rate, and the risk free rate are all equal to zero. Starting from a situation without any state-contingent debt, under these assumptions, debt dynamics are given by:

$$(4) \qquad b_t - b^u_{t-1} = \frac{-\varepsilon_t}{1+\varepsilon_t} b^u_{t-1},$$

and it is possible to see that the debt to GDP ratio follows a random walk. Shocks to GDP, captured by ε, have a permanent effect on debt to GDP. When the shock to GDP is positive, the debt ratio decreases. When the shock is negative, the debt ratio increases. Large shocks have large impacts on the debt ratio.

Suppose now that debt is fully state-contingent, in particular, that the interest rate on contingent debt r^c is equal to the realization of the exogenous shock to

GDP ε. When the shock is positive, GDP is relatively large, and the interest rate increases. When the shock is negative, the interest rate decreases. Note that in this stylized example with zero risk free interest rate and zero inflation, this would imply negative interest rates following decreases in GDP. In more general versions, the interest rate would be reduced but not necessarily zero. Under these assumptions, it is possible to see that the debt ratio is now fully stabilized:

$$b_t - b_{t-1}^c = \frac{r^c - \varepsilon_t}{1 + \varepsilon_t} b_{t-1}^c = 0. \tag{5}$$

This highly stylized example shows the potential stabilizing role of state-contingent debt, by linking interest rate to innovations in GDP. As the database shows, linking to GDP is a common strategy to implement state-contingent debt. However, there are several potential issues as I show next.

One complication deals with lags. Because GDP is a backward looking estimate, the contingent interest rate may reflect last period's innovation in GDP, which may cause fluctuations in debt ratios. Assume that the interest rate responds to GDP lagged one period. Then:

$$b_t - b_{t-1}^c = \frac{\varepsilon_{t-1} - \varepsilon_t}{1 + \varepsilon_t} b_{t-1}^c, \tag{6}$$

which is not necessarily equal to zero. Note that for commodity exporters, linking contingencies to the international price of a commodity may reduce issues related to lags. This price is, however, likely to be only partially correlated with real GDP growth, and again equation (6) is not necessarily equal to zero. Other sources of state-contingency that have been used, for example, natural disasters or industrial production indices, will face different combinations between lags and correlation to GDP. Furthermore, there may be constraints on interest rates, caps and floors, which limit the ability to implement the required contingencies to stabilize debt.

Another issue relates to several premia associated with state-contingent debt. If lenders are risk-averse, they may require higher interest rates to carry state-contingent debt, as this type of debt implies fluctuations in interest payments. Crucially, these fluctuations may correlate with returns on other assets they may hold, which can imply high, time-varying, risk premia. Additionally, given that state-contingent debt is relatively rare, novelty and liquidity premia may be present. Finally, risks related to the manipulation of statistics, or disagreement with methods used in the calculation of contingencies, may increase risk premia. Rewriting equation (5) with fully state-contingent interest rates but risk premia, it is possible to see that

$$b_t - b_{t-1}^c = \frac{premia_t}{1+\varepsilon_t} b_{t-1}^c \neq 0 \,. \tag{7}$$

Under significant premia on contingent debt, not only will the debt to GDP ratio no longer be stable, contingent debt will likely be more expensive than uncontingent debt. Ultimately, this is the price the borrowing country must pay for insurance. This section has assumed away default risk, but state-contingent debt provides protection against unexpected large shocks to GDP. Under a given debt limit, it may the case that uncontingent debt leads a country to default, while state-contingent debt, even with the premia, keeps interest payments low enough following a significant negative shock to GDP, and therefore avoids default.

Inflation and currency denomination will also play a role, both in the choice of variables to index to and in the ability of state-contingent debt to stabilize debt following shocks. Suppose that the government manages to issue state-contingent debt linked to GDP, but has to do so in foreign currency. Then, potential currency movements will limit the ability to stabilize debt ratios. For example, consider that following a negative output shock, the domestic currency depreciates. Debt is state-contingent with respect to output but not with respect to exchange rate movements. Let δ represent exchange rate movements in percentage change, with the exchange rate defined as units of domestic currency per unit of foreign currency. Then, even under $r^c = \varepsilon_t$, if debt is denominated in foreign currency, the debt to GDP ratio will evolve according to:

$$b_t - b_{t-1}^c = \frac{\delta_t}{1+\varepsilon_t} b_{t-1}^c \,. \tag{8}$$

In other words, making debt also state contingent with respect to exchange rate movements would further increase premia demanded by investors that is included in equation (7).

The analysis so far as focused on indexation to GDP growth shocks. The reason for this was the assumption that the only shock to the economy was on GDP growth. However, equation (3) highlights alternatives sources of shocks, and therefore of indexation variables. For example, the source of contingency may be related to tax revenues or government expenditure, or even other interest rates, instead of GDP growth or other proxies to GDP. It may be tied to nominal GDP and include inflation or exchange rate movements. Instead of growth rates, the indexation may be linked to variables in levels; instead of changes in interest payments, stock-flow adjustments to debt may occur when the debt level is made contingent on the state of the economy.

This section showed the potentially stabilizing role of state-contingent debt, but ultimately two parties must agree to trade this debt. The next section investigates conditions under which trade in state-contingent debt may occur.

3. *Market for State-Contingent Debt*

In this section, I derive conditions for the existence of state-contingent debt markets. The goal is to focus on the distribution of debt between contingent and uncontingent bonds rather than the quantity of debt issued. Suppose that the government wishes to maximize the utility of government consumption, given by U(g), with U'(g)>0 and U''(g)<0. Without loss of generality, assume again that the real growth trend, the inflation rate, the risk free rate, and stock-flow adjustments are all equal to zero. Assume also that there is no default risk. Finally, assume that taxes are exogenous, and to simplify notation focus only on two periods, t and t+1. Then, it is possible to rewrite the budget constraint given by equation (2) at t and at t+1 as:

$$g_t = \left(\tau_t + b_t^u + b_t^c - \frac{1}{1+\varepsilon_t} b_{t-1}^u - \frac{1+r_t^c}{1+\varepsilon_t} b_{t-1}^c\right), \tag{9}$$

$$g_{t+1} = \left(\tau_t + b_{t+1}^u + b_{t+1}^c - \frac{1}{1+\varepsilon_{t+1}} b_t^u - \frac{1+r_{t+1}^c}{1+\varepsilon_{t+1}} b_t^c\right). \tag{10}$$

The problem of the government is then given by:

$$\max_{b_t^u, b_t^c} U(g_t) + \beta E U(g_{t+1}), \tag{11}$$

subject to equations (10) and (11), where β is the subjective discount factor and E is the expectations operator. Taking first-order conditions and rearranging, it is possible to obtain the standard asset pricing equation:

$$E\left[U'(g_{t+1})\frac{1}{1+\varepsilon_{t+1}}\right] = E\left[U'(g_{t+1})\frac{1+r_{t+1}^c}{1+\varepsilon_{t+1}}\right]. \tag{12}$$

This equation can be rewritten as the difference between expected interest rates for the two types of debt, scaled by the GDP shock. This difference represents the maximum premium that the government is willing to pay for issuing state-contingent debt:

$$(13)\quad E\left[\frac{1+r_{t+1}^{c}}{1+\varepsilon_{t+1}}\right]-E\left[\frac{1}{1+\varepsilon_{t+1}}\right]=\frac{Cov\left[U'(g_{t+1}),\frac{1}{1+\varepsilon_{t+1}}\right]-Cov\left[U'(g_{t+1}),\frac{1+r_{t+1}^{c}}{1+\varepsilon_{t+1}}\right]}{E\left[U'(g_{t+1})\right]},$$

and given that $E\left[\frac{1+r_{t+1}^{c}}{1+\varepsilon_{t+1}}\right]-E\left[\frac{1}{1+\varepsilon_{t+1}}\right]\approx E\left[r_{t+1}^{c}\right]$, it is possible to see that this premium depends crucially on the covariance (defined in the equations as Cov) between marginal utility of government expenditure and the interest rate payments, scaled by the shock. The covariance terms are positive or zero. When the GDP shock is positive, the marginal utility of government expenditure is likely low. Therefore, as long as the covariance between the marginal utility of government expenditure and uncontingent interest payments is larger than the covariance between the marginal utility of government expenditure and contingent interest payments, the government is willing to pay a premium for the contingent bond. As shown before, state-contingent interest rates imply less variation in interest payments scaled by GDP growth, and the premium is positive.

What determines the size of the interest rate premium that the government is willing to pay? Marginal utility is decreasing in government expenditure. Government expenditure in turn depends positively on tax revenues and negatively on interest payments on other bonds. Therefore, the government is willing to pay more for issuing state-contingent debt when state-contingent payments are not very correlated with other bond payments, but very correlated with tax revenues. Furthermore, the more correlated state-contingent payments are with real GDP growth, the higher the premium the government is willing to pay for these bonds. Increasing risk aversion from the government would further increase this premium.

For a market for state contingent debt to exist, it is necessary that the minimum premium required by investors is smaller than the term defined in equation (13). Define this premium r^{min}. Under the simplifying assumptions made above, as long as $E\left[r_{t+1}^{c}\right]\geq \mathrm{r}^{min}$, it is possible for trading in state-contingent debt to occur. More complicated models would deliver similar necessary conditions for the existence of a state-contingent debt market. One crucial thing to note is that this condition may be satisfied for relatively small amounts of state-contingent debt, but not as investors get more exposed to country risk.

If lenders were risk-neutral and deep-pocketed, $\mathrm{r}^{min}=0$, and they would be willing to lend to the government using state-contingent debt. However, if lenders are risk averse, r^{min} may be larger than zero. It would be possible to write an investment problem for the investors in government debt that mirrors the problem of the government. Let V represent the utility of lenders, with similar properties to U. Let c be investor consumption, and assume that the investor can purchase contingent bonds and other assets, which include uncontingent government bonds but also stocks and other bonds. For any asset i, with return r^i, the following standard asset pricing equation will hold:

$$(14) \qquad E\left[r_{t+1}^{c}\right]-E\left[r_{t+1}^{i}\right]=\frac{Cov\left[V'\left(c_{t+1}\right),r_{t+1}^{i}\right]-Cov\left[V'\left(c_{t+1}\right),r_{t+1}^{c}\right]}{E\left[V'\left(c_{t+1}\right)\right]}.$$

Equation (14) defines the minimum return required by investors to hold state-contingent debt. This minimum return is lower when there is relatively small variance in state-contingent payments, investor risk aversion is low, the covariance between the return on state-contingent bonds with other sources of returns for investors is lower, the covariance with investor liabilities is relatively high, liquidity of state-contingent instruments is high, exchange rate risk is low, novelty premia is low, and the risk of statistical manipulation is relatively low.

This section described the theoretical determinants for the existence and success of markets for state-contingent debt. The next section turns to the data and presents the database.

III. Database

The database presented in this paper is divided into three main categories: (i) basic features, (ii) design and (iii) performance. There are currently 36 entries. The unit of observation is the first issuance of a state-contingent government debt instrument. Some observations will therefore include multiple issuances by the same country, for example, in different years or within the same year but with slightly different structures. Others will include multiple issuances of the same instrument by different countries, for example, through official lenders. This approach regarding the unit of observation is done in order to avoid double counting of what is essentially the same state-contingent instrument. Disaggregated information on these dimensions is included in the database when available.

This section also presents figures with summary statistics for selected variables available in the database. These summary statistics, which are not weighted by volume of debt issued, provide an overview of existing state-contingent government debt instruments.

1. Basic Features

The first contribution of the database is to provide researchers and policy makers with an overview of the history of state-contingent government debt, which is captured by the following basic features: Sovereign, Name of debt instrument, Year first issued, Type of instrument, Indexation, Indexation detail, and Years used.

Table 1 collects the database entries including the sovereign, the name of the debt instrument and the type of asset. For simplicity, the focus is limited to first issues. In other words, when an instrument is withdrawn or matures, and is replaced by a similar one, the data reported is only of the first issue. For example, Uruguay updated its nominal wage-linked 2014 bond with a new bond in 2017. Portugal's GDP-linked certificates of treasury issued in 2013, called "Tesouro Poupança Mais – CTPM", were withdrawn and replaced in 2017 with the slightly different "Certificados de Tesouro Poupança Crescimento – CTPC". In both cases, the database entry corresponds to the first debt issue, although details on all of them are recorded. Issuance of the same instrument by multiple countries is also counted once. For example, the 2007 AFD countercyclical loans were issued to Burkina Faso, Mali, Mozambique, Senegal, and Tanzania; while the 2018 IBRD Cat Bonds were issued to Chile, Colombia, Mexico and Peru. Again, each of these is treated as one observation in the dataset, although details on any updates are recorded as well.

Figure 1 shows the frequency of issuance of state-contingent government debt between 1850 and 2020. These data show two main developments, namely the Brady restructurings of the 1990s, which included state-contingent warrants and the renewed interest in these instruments in the 2000s.

There are three main types of instruments issued by sovereigns with state-contingent features: bonds, warrants and loans. Bonds and warrants are traditionally issued to the public, while loans are issued to official or private lenders, usually banks. Warrants have been traditionally attached to a traditional "plain vanilla bond" but in some cases have been detachable. The main difference between a bond and a warrant is that warrants are designed in a way that they may lead to an increase in payments to investors, and never a decrease. In other words, the contingency is only on the upside. Unsurprisingly, warrants are traditionally issued as sweeteners in debt restructuring deals.

Figure 2 plots the distribution of debt instruments and shows that bonds and warrants account for most of the issuances in this dataset. However, it should be noted that this is likely to underestimate the number of public loans linked to commodities, as several state-owned companies have issued loans where either the repayment or the maturity are linked to the price of an exported commodity. These loans are often guaranteed by the government, either implicitly or ex-

Table 1

Database Entries as of June 2021

Sovereign	*Debt instrument and linkage*	*Type*
Algeria	Oil-linked loan	Loan
Argentina	Real GDP growth linked warrants	Warrant
Bolivia	Bond linked to price of tin	Bond
Bosnia and Herzegovina	GDP Performance Bonds	Warrant
Bulgaria	Additional Interest Paid (AIP) linked to GDP	Warrant
Burkina Faso, Mali, Mozambique, Senegal, Tanzania	AFD countercyclical loans linked to Exports	Loan
Confederate States of America	Cotton Bonds	Bond
Costa Rica	Value Recovery Rights linked to GDP	Warrant
France	Pinay Bond linked to Gold	Bond
France	Bons d'équipement industriel et agricole linked to Industrial Production	Bond
France	Emprunt national linked to Index of securities prices	Bond
France	Bons Indexés linked to index of French varia-ble-income securities	Bond
France	Rentes Giscard Bond linked to Gold	Bond
Greece	GDP-warrant linked to real GDP	Warrant
Grenada	Bond hurricane clause	Bond
Grenada	Citizenship by investment revenues linked bond	Bond
Various countries*	Petrocaribe loans linked to oil	Loan
Honduras	GDP-linked bond	Warrant
India	Gold Bond	Bond
Italy	BTP Futura GDP-linked bond	Bond
Ivory Coast	GDP-linked bond	Warrant
Malaysia	Citibank Loan	Loan
Mexico	Petrobonos linked to oil	Bond
Mexico	Value Recovery Rights linked to oil	Warrant

(continue next page)

(Table 1 continued)

Sovereign	*Debt instrument and linkage*	*Type*
Mexico	CatMex linked to earthquakes	Bond
Mexico	Multicat linked to earthquakes and hurricanes	Bond
Nigeria	Payment Adjustment Warrant linked to oil	Warrant
Papua New Guinea	Metallgesellschaft Loan linked to copper	Loan
Peru, Colombia, Chile, Mexico	IBRD Cat Bonds CAR 116-120 linked to earthquakes	Bond
Portugal	Treasury certificates linked to real GDP growth	Bond
Singapore	New Singapore Shares, Economic Restructuring Shares linked to GDP growth	Share
Turkey	Revenue indexed bond	Bond
Ukraine	Warrants linked to real GDP	Warrant
Uruguay	Value Recovery Rights linked to terms of trade	Warrant
Uruguay	Nominal wage linked bond	Bond
Venezuela	Oil-indexed payment obligations	Warrant

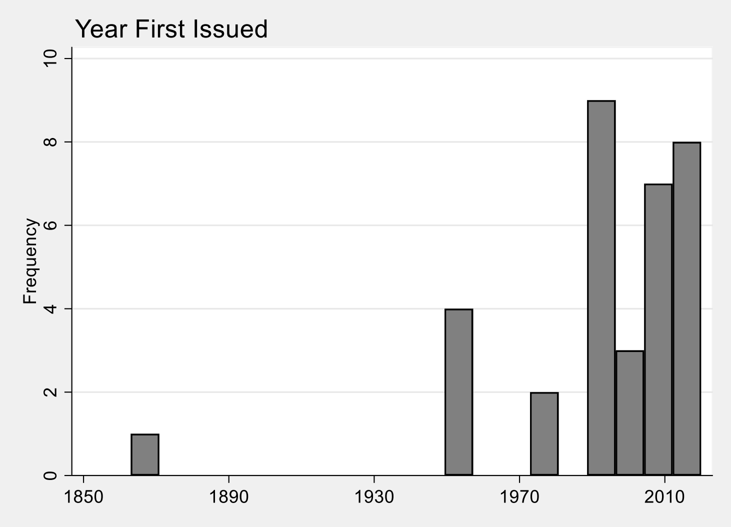
Notes: Entries in the State-contingent government debt database as of June 2021. * Guyana, Nicaragua, Haiti, Belize, Jamaica, Antigua, Dominica, Grenada, St. Kitts & Nevis, St. Vincent & the Grenadines, and the Dominican Republic.

Source(s): Author's calculations collected in the State-contingent debt database that accompanies this paper.

plicitly, and therefore are effectively state-contingent government debt. Unfortunately, data regarding the details of these contracts is currently limited.[4]

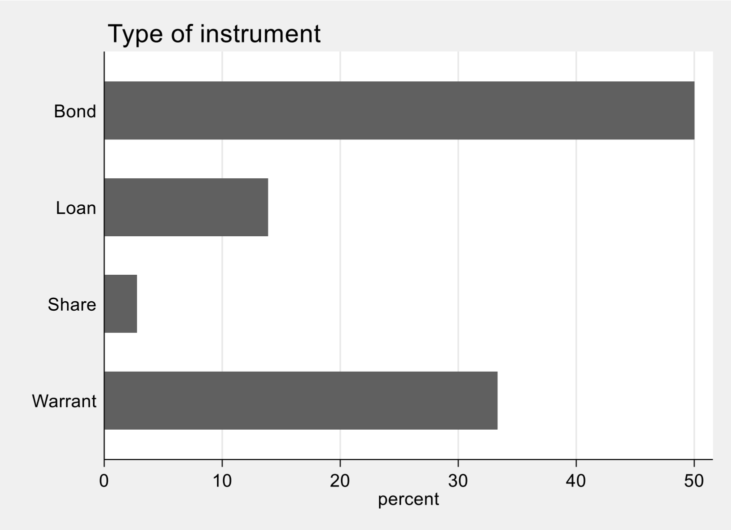
State-contingent debt instruments may be indexed to many different variables. These can be related to production and income (level and/or growth), terms of trade, commodity prices, government revenues or natural disasters. This database collects indexations to all these different variables as they are related to the state of the economy, in particular, to GDP. For example, exogenous increases in commodity prices increase the value of production in a commodity exporter, while natural disasters will likely reduce it. Figure 3 shows the distribution between these types of indexation. It shows that commodity prices and GDP are the most common variables to link state-contingent debt to.

[4] Two important exceptions are the China Africa Research Initiative (http://www.sais-cari.org/) and the China-Latin America Finance Database (https://www.thedialogue.org/map_list/). Adam et al. (forthcoming) reviews resource-backed lending by sovereigns and state-owned companies.



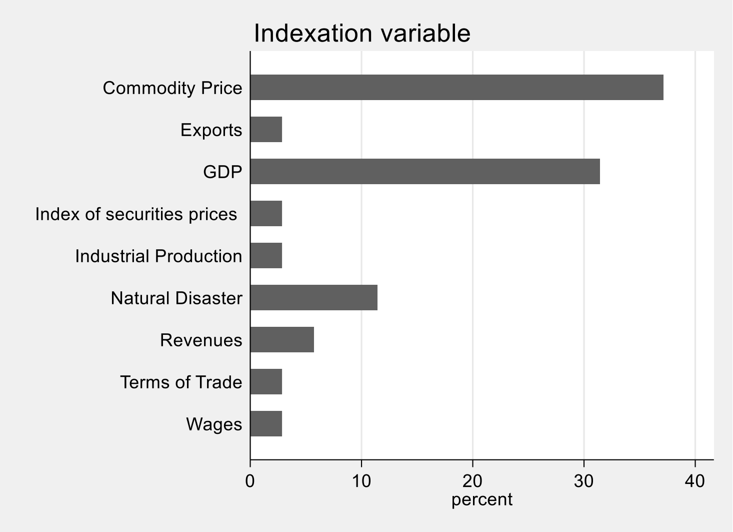
Note(s): Frequency of entries in the database by year when they were first issued.
Source(s): Author’s calculations based on the State-contingent debt database that accompanies this paper.

Figure 1: Year of First Issuance



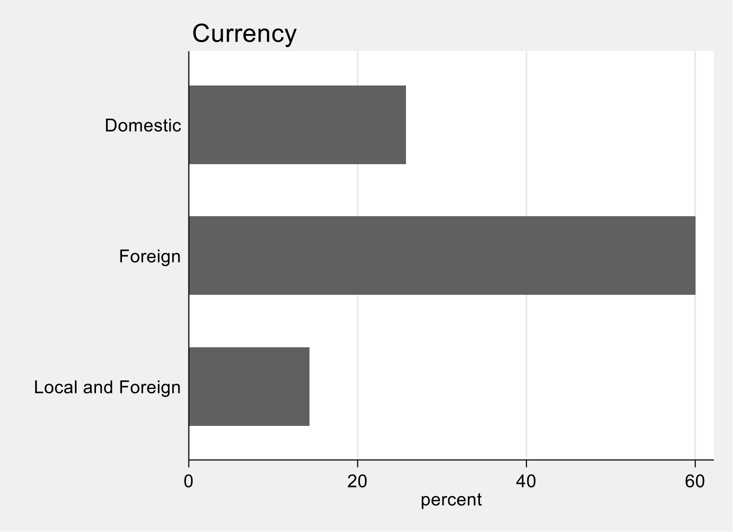
Note(s): Type of debt instrument in percent of total.
Source(s): Author’s calculations based on the State-contingent debt database that accompanies this paper.

Figure 2: Distribution of Type of Instrument Issued



Note(s): Variable to which payments are indexed to in percent of total.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 3: Distribution of Type of Instrument Issued



Note(s): Currency of debt issue in percent of total.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 4: Currency of Issuance

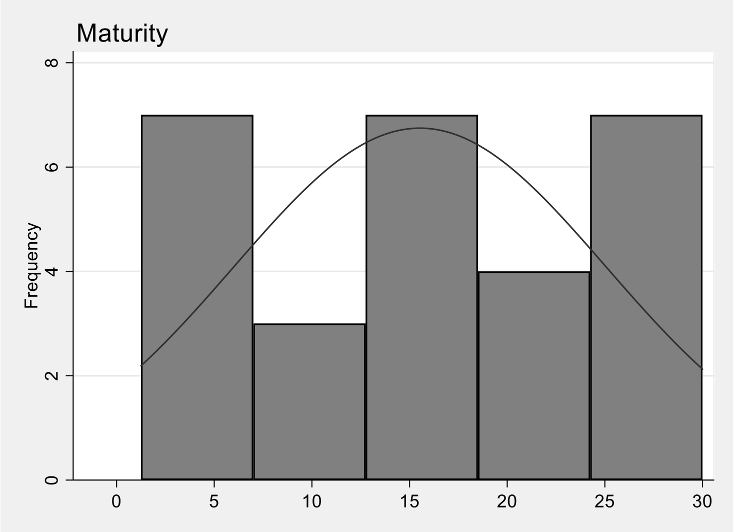
2. Design

A crucial issue for policy makers is the design of state-contingent debt, which is very heterogeneous and, with a few exceptions, not yet standardized. The database collects information on the following design features: Currency, Jurisdiction, Maturity (average for multiple issues), Maturity (detail), Linked to Plain Vanilla Bonds or Loan (yes/no), Linked to Plain Vanilla Bonds or Loan (detail), Tradability (yes/no), Tradability (detail), Contingency type, Payout/Deferral Mechanism, Payout/Deferral Details, Callable, Redeemable, Sinking fund, Grade period, Coupon rate, Coupon ceiling/floor, Payout date, and Payout lag relative to linking data.

Figure 4 plots the distribution of issuances across domestic, foreign and both domestic and foreign currencies. It shows that most of these assets are issued in foreign currency. Some assets are payable in commodities, for example, cotton or oil, and are therefore recorded as foreign currencies. Note that Eurozone countries are coded as issuing their debt in local currency when issuing in euros. However, there is an element of foreign currency in them, as they do not have direct control over monetary policy. A related issue, jurisdiction, is only covered for some entries.

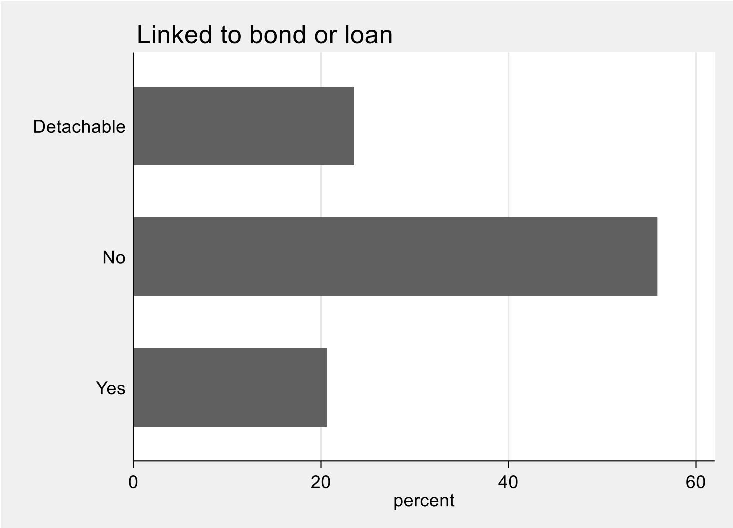
Figure 5 shows the distribution of the maturity of state-contingent debt instruments. When there are multiple structures or multiple debt issues with different maturities in one database entry, the data presented here refers to their unweighted average maturity. Details on the maturity for each of these debt issues are recorded under a different variable in the database. The data show that there is substantial variability in the maturity of state-contingent government debt.

Many debt instruments are linked to plain vanilla bonds or regular loans, that is, to other debt instruments with no indexation. Figure 6 describes whether these assets are linked, detachable (initially linked but potentially not linked), or never linked. It captures the proportion of state-contingent instruments that are connected to other assets in the sense that it is not possible to own one without the other. A related issue is whether these assets are tradable in secondary markets. Figure 7 summarizes the data and shows that a large percentage, about 40 %, cannot be traded. Contingent assets linked to tradeable bonds are recorded as tradeable in the database. Some contingent assets are issued to individuals or corporations under retail agreements or to official creditors, and are therefore non-tradeable.



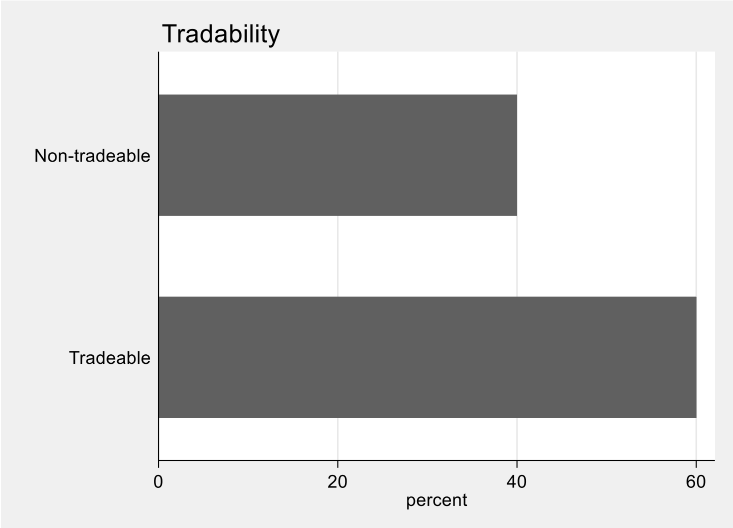
Note(s): Frequency of average maturity by debt instrument, measured in years.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 5: Maturity at Issuance



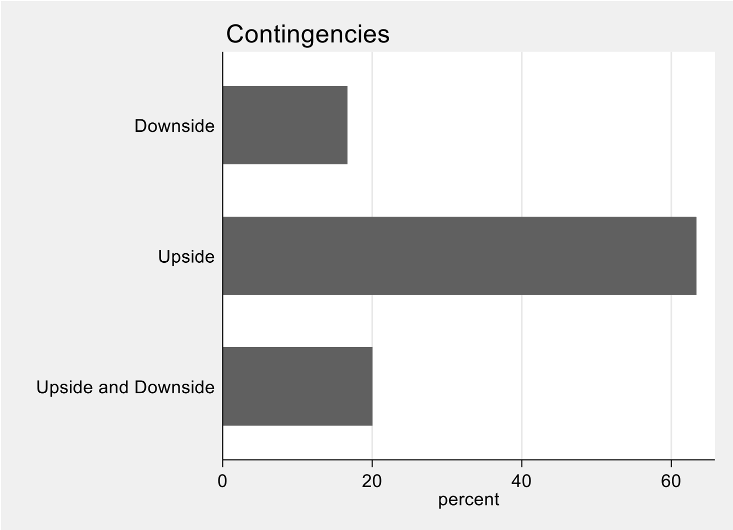
Note(s): Proportion of state-contingent assets linked to plain vanilla bonds or loans.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 6: State-Contingent Debt Linked to Uncontingent Debt



Note(s): Proportion of state-contingent assets that are traded in secondary markets.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 7: Tradability of State-Contingent Debt



Note(s): Type of explicit contingency included in instrument in percent of total.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 8: Contingencies

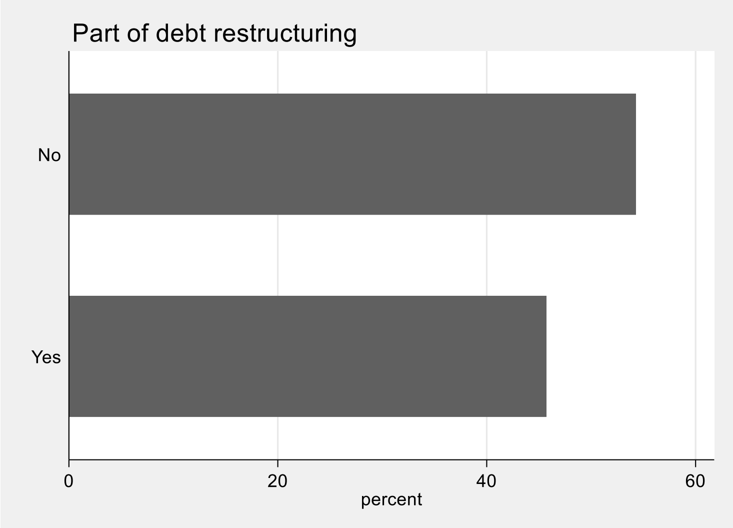
The next characteristic recorded in the dataset refers to the type of contingency provided by the debt instrument: upside, downside or both. The definition of contingency is based on the economic consequences for the sovereign issuing the asset. If the instrument explicitly pays more or reduces the maturity of the asset only in good times, it is recorded as an upside contingency. If it pays explicitly less or extends maturity in bad times, it is recorded as a downside contingency. This definition is somewhat arbitrary as thresholds for upside or downside should be defined relative to fundamental trends. In other words, consider a bond that is indexed to real GDP growth and pays 1 if real GDP growth is zero and 2 if real GDP growth is equal to 2 %. If trend real GDP growth is 1 %, this bond would reflect some level of downside and upside contingency. However, the database would record it as having only upside contingency. Given that forecasting fundamental trends for these variables is a non-trivial exercise, the database records the contingency that is made explicit in the contract and does not estimate implicit contingencies. This approach results in a stronger requirement to extract the type of contingency in these issuances. Figure 8 shows the distribution of assets across this dimension. Most assets allow only for explicit upside contingencies.

Finally, the database records several additional characteristics for these assets: Callable, Redeemable, Sinking fund, Grace period, Description of the payout mechanism. These characteristics are harder to summarize using visual evidence and therefore are not presented here.

3. Performance

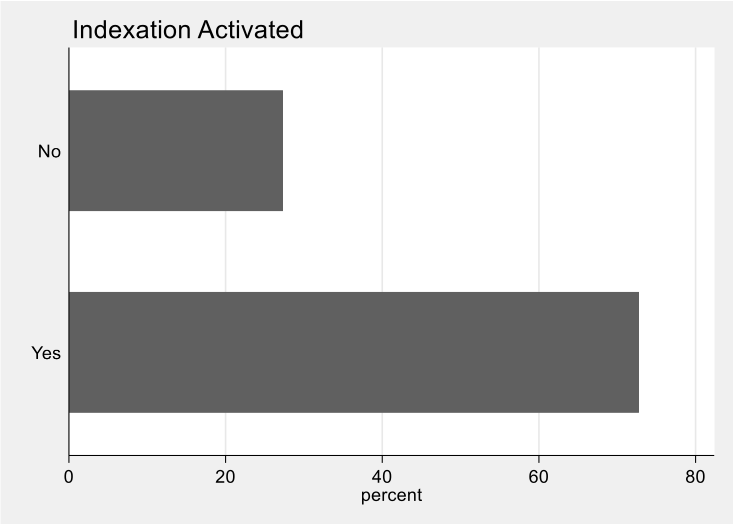
The database collects information on the following dimensions regarding the performance of these assets: Part of debt restructuring (yes/no), Brady Bond (yes/no), Volume at issuance, Volume detail, Base annual interest rate, S&P rating, Indexation activated (yes/no, by June 2021), Indexation activation (detail), Problems/Benefits, ISIN codes/URL, and Country-specific sources.

Figure 9 records whether an asset is part of a debt restructuring, in other words, whether it is issued in normal times or following a crisis period that led to default and/or debt restructuring. The first big wave of instruments issued with state-contingent features were part of the Brady bond restructurings. Recent large issuances, for example, in Greece and Ukraine, were also part of debt restructurings. The figure shows a close to even split of issuances in and out of debt crises. However, note that this figure is likely to be biased towards non-debt restructurings because it is based on unweighted averages and does not consider the volume issued for each instrument, which is traditionally larger in debt restructurings.



Note(s): Issuance part of debt restructuring in percent of total.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 9: Issuance Part of Debt Restructuring



Note(s): Indexation activated by June 10, 2021 in percent of total.
Source(s): Author's calculations based on the State-contingent debt database that accompanies this paper.

Figure 10: Indexation Activated

The database also records data, when available, on the volume issued, the base interest rate and the credit rating. Figure 10 summarizes the proportion of instruments where the indexation was activated by June 2021, which for most instruments is equivalent to whether the indexation was paid. Payment details are available for a subset of observations. Some of the debt instruments were called or bought back in order to avoid payments to creditors, and these data are also recorded.

Finally, the database collects information on problems associated with specific instruments related to their design or performance. These data are not codified as these issues tend to be country specific. They include unclear contracts, statistical disputes, delays and lags in payments relative to the state of the economy. For an example of uncertainty regarding the indexation variable, Bulgaria's GDP-linked bond issued in 1994 was initially linked to data published in a periodical that was eventually discontinued, with the data moving online and then more frequently updated. Following the discontinuation of the original data, the Bulgarian government chose a new series based on constant-value local currency units that did not trigger indexation. As an example of statistical disputes, a hedge fund has filed suit against Argentina in January 2019 over missed payments in 2013 related to a change in the base year used to compute GDP, which took place in 2014 and reduced estimated growth just below the payment threshold. Finally, for an example in delays in payment of indexation relative to the state of the economy, in January 2005, Standard & Poor's cut Venezuela's rating to selective default, following a delay in calculating and paying its Oil Indexed Obligations. These were eventually paid with interest in March 2005. Some of these aspects are described in more detail in the next sections.

IV. Overview of Experiences with State-Contingent Debt

This section reviews the performance of the most important state-contingent debt instruments included in the database. The goal is to highlight some of the successful cases, but also the challenges associated with state-contingent debt, and to extract lessons for policy makers and market participants interested in these debt instruments. Detailed references for each of these debt instruments are available as part of the database.

1. Early State-Contingent Government Debt

The first instance of government state-contingent debt for which there is available data was the 20-year bond issued by the Confederate States of America in 1863, during the American Civil War. These bonds were convertible into a warrant and then into a predetermined amount of cotton at 6 pence per pound.

Prices for cotton in Liverpool were considerable higher at the time, as much as five times the price determined by the bond, making this an attractive asset. Accordingly, 22.4 % of the bonds were converted into cotton warrants and there is some evidence that the indexation was activated, although exact numbers are not available (*Weidenmier* 2000). However, several logistical and design difficulties likely reduced the amount of redemptions into cotton. First, investors needed to obtain the warrants from the Confederate European representative in Paris. Second, they had to wait up to 60 days to receive the cotton after exercising the warrant. Third, upon receiving the cotton they would have to run the blockade by the opposing Union government as cotton would be delivered to a point in Confederate territory within ten miles of ship access. Finally, if the investors decided to wait for the end of the war to convert the bonds, they would have 6 months following the peace agreement to convert them into cotton under different terms. Otherwise, they would be redeemable only at maturity or until their bond was retired by the lottery provision (2.5 % of the bond issue was paid off semiannually). This early state-contingent instrument highlights some of the logistical difficulties with using commodities as a means of payments in a war context. However, it also showcases the potential benefit for a commodity exporter from issuing bonds linked to the price of that commodity in order to raise funds in international markets in difficult times. Demand for these bonds, which were trading in secondary markets at positive prices for much of the Civil War, was substantial (*Weidenmier*, 2000).

The next instances of state-contingent bonds recorded in the dataset were in France. First, the Pinay 1952 bonds, worth 429b francs in 1952, included a clause in the prospectus that linked cash flows to the price of gold. A similar bond was issued in 1958.[5] These bonds were issued following the Breton Woods agreement, at a time when France maintained external exchange rates under bands related to the price of gold. The end of the Breton Woods system in the 1970s lead to an increase in the price of gold and these bonds resulted in very large payments by the French government. These bonds were eventually converted in 1973. Also, in 1973, and before an even larger increase in the price of gold, the French government issued the Giscard Bond in 1973, again with a payment linked to gold. This bond was exchangeable for gold at 32 dollars an ounce. Unfortunately for the French government, gold prices were about 200 dollars an ounce in 1978. Given the massive increase in the price of gold this debt ended up being extremely expensive for the French government, which highlights the perils of indexing debt to a commodity that does not directly reflect economic conditions. At this time, gold was not an important part of France's production and gold prices changed dramatically following Bretton Woods, as the price of this commodity reflected a new monetary policy regime in the world economy.

[5] See *Deacon* et al. (2004) for details on these bonds.

In other words, this increase in the price of gold reflected a new state of the world, but not one that was positively related with the state of the French economy. That made payments on this bond countercyclical, with very high payments in a period of low economic growth. The collapse of Bretton Woods, and its effect on gold prices, was likely neglected in the bond design, showcasing that state-contingent debt may be prone to neglected risks.

Another French bond issued in 1956 was the first precursor of GDP-linked bonds. This bond included an additional payment that was linked to industrial production. The indexation mechanism was base interest 5 % per annum plus 0.05 % for every point industrial production index exceeds 1955 level. This indexation was activated and appeared to work well. The larger Ramadier Loan in 1956, worth 320b francs, had interest payments and redemption value linked to the average price of shares on the Paris Bourse. Another bond issued in 1957 had fixed interest rate but its' redemption value linked to the annual change in the average value of the price indices of fixed and variable interest French securities.[6] These three instruments are noteworthy in that they represent the closest to GDP-linked bonds being proposed today, with the caveats that industrial production is only a fraction of economic activity and the stock market may fluctuate due to non-fundamental reasons. They were also much more successful than the gold-linked bonds, although this success was overshadowed by the negative impact that gold state-contingent debt had on the government's finances.

In 1977 Mexico issued $50b of Petrobonos, the largest ever issue of bonds linked to the state of the economy ($78b in 2018 prices). These bonds had 3-year maturity and were linked to the local price of oil. At maturity, they could be redeemed for the maximum between the bond face value and the market value of oil, with a 1000-peso bond linked to 1.95354 barrels of oil. Oil prices increased 43 % but foreign investors still made a loss on these bonds. Even though inflation from mid-1978 to mid-1980 in Mexico was about 20 percent per year, the nominal exchange rate between pesos and dollars was kept constant, and investors were forced to use the official exchange rate when converting pesos to dollars.

2. *The Brady Plan*

The first major multinational push for state-contingent government debt came with the Brady Plan of sovereign debt restructurings in the late 1980s and early 1990s.[7] Some included warrants, often called value recovery rights, which were initially attached to bonds and promised additional payments depending

[6] See *Rozental* (1959) for details on these bonds.

[7] For an overview of the Brady plan see *Cline* (1995).

on the state of the economy. Although they shared their main characteristics, for example, they were initially attached to plain-vanilla bonds but later detachable, and included only upside contingencies, these sweeteners were indexed to variables that best described the state of each economy. They depended on GDP (in Bulgaria, Costa Rica, Ivory Coast), commodity prices (in Mexico, Nigeria, Venezuela), or terms of trade (in Uruguay, defined as the ratio of the price of Uruguay's main exports – wool, beef and rice; and the price of its main imports – crude petroleum).

Although the design of these warrants had some innovative features, and contingent payments were activated, these assets were plagued by several issues. For oil producers, the surge in oil prices in 2000 led to higher payments than anticipated, and many attempted to buy back the warrants. There is anecdotal evidence that lenders were not taking these warrants into account when pricing the bonds before the surge in oil prices. Initially, many of these options were well out of the money while still attached to the bonds. Following detachment and the rise of oil prices in the 2000s, payments were triggered, and taking for example Nigeria and Venezuela, a large backlog of unreconciled trading positions meant that it was often unclear who to pay them to. Furthermore, there were payment delays, which were justified by confusion over how to calculate them.

Warrants linked to GDP were even more problematic. For example, in Bulgaria's case, the GDP statistic to which the warrant was linked was poorly defined. It was initially based on a periodical that had since moved online and was now more frequently updated. The Bulgarian government decided then to use a constant-value local currency unit as a measure of GDP and the warrant payments were never triggered. Bosnia and Herzegovina issued a GDP-linked bond in 1997 that was poorly designed, with issues related to low quality statistical data and unclear treatment of data revisions. The bonds were eventually activated in 2007 and 2008, although some lenders disagreed and calculated the activation period to be 2006 and 2007.

3. The Singapore Experiments

A unique experiment took place in Singapore in the 2000s, with the New Singapore Shares (NSS, issued 2001) and Economic Restructuring Shares (ERS, issued 2003). These were shares that were given out by the government to lower income groups in order to compensate them for structural changes, particularly, the increase in sales taxes. Crucially, these shares earned annual dividends of at least 3% plus the real GDP growth rate of the preceding calendar year. Real GDP growth was larger than zero for all years covered by these shares, fluctuating between 4.2% in 2002 and 9.5% in 2004. They were discontinued in 2007.

4. Argentina, Greece and Ukraine's GDP-Linked Warrants

In 2005, Argentina issued GDP-linked warrants as part of a debt restructuring. These warrants would pay if real GDP was larger than a specific threshold and annual growth rates of real GDP exceeded 4.3 % in 2005, and then slowly declining to 3 % from 2014 onwards. Limits on cumulative payments were included in the warrants. Economic conditions improved in Argentina in the mid-2000s and the warrants paid for most years up to 2011. However, lags in payments meant that some payments were due while Argentina was experiencing a recession, which created public pressure not to pay. An important issue was that the base year to compute GDP was changed in March 2014 from 1993 to 2004, which reduced estimated growth in 2013 to 3 percent, almost half of what was initially forecasted and just below the trigger for warrant payment. Aurelius, a hedge fund, filed suit in January 2019 in New York regarding missed payments in 2013, arguing that there was statistical manipulation in the change of the base year. Although the case is still in court, this litigation risk appears to have shunned interest in the Argentine GDP-warrants and poses an important challenge for these assets elsewhere. Greece and Ukraine have also issued GDP-warrants as part of debt restructurings recently. In the Ukrainian case, payouts are capped between 2021 and 2025 at 1 percent of nominal overall GDP, but not afterwards, until 2040. Recent economic performance suggests that the cap will be hit, raising the question whether these bonds represent a looming fiscal risk once the cap is withdrawn. Greece's warrants include a cap on payments for all years.

5. Portuguese Experience with GDP-Linked Treasury Certificates

Portugal created two GDP-linked treasury certificates. Initially in 2013, with a maturity of 5 years (CTPM), then in 2017 with a maturity of 7 years (CTPC), both certificates are redeemable after one year. Contrary to the Brady bonds or the recent GDP-warrants, they were not issued as part of a debt restructuring. These retail certificates target domestic savers, are non-tradeable and can be subscribed on a continuous basis. They include a fixed rate step up structure for the base interest rate and additional payments linked to real GDP growth. Payments are not updated due to revisions of GDP statistics.

These certificates were innovative and did not experience major issues. They represented 6.7 % of total government debt in May 2019, about € 17 billion. The indexation was always activated, and additional payments linked to GDP have been sizable as real GDP growth has exceeded expectations from 2014 until 2019. However, the Covid-19 pandemic saw the additional payments in 2020 and 2021 revert to zero.

6. Catastrophe Bonds

A growing example of state-contingent debt is the market for catastrophe bonds, or cat bonds, which are securities indexed to natural events. These are examples of state-contingent debt where the exogeneity of the state variable is more likely and where there are no concerns regarding moral hazard from policy makers. Contrary to GDP or other macroeconomic variables, policy makers have no influence on the occurrence of natural catastrophes. Because these events are potentially very costly for the economy and unlikely to be correlated with the return of other assets, they represent an almost ideal setting for state-contingent government debt.

In 2006 Mexico issued a $160 million non-tradeable cat bond that included a decrease in payment in case of an earthquake with a certain magnitude and depth occurring in any of three pre-defined geographical zones in Mexico. It followed up with a similar issue in 2009 worth $290 million, but now tradeable. The 2009 issue saw the indexation activated. Investors in the $100m tranche of MultiCat Mexico Ltd. (Series 2012-1) Class C catastrophe bond notes faced a 50 % loss of principal in 2016. Both the 2006 and the 2009 issues were rated by S&P above BB- and as high as BB+. The 2009 issue was oversubscribed and very successful but there were some problems with the trigger design and with investor losses. It took around three and a half months following the event to determine the exact indexation and there was uncertainty about the size of the loss for investors, either 50 % or 100 %. Finally, there was a problem with the measurement of landfall pressure from storm chasers, which differed from the official measurement.[8] These instruments show that the correct and timely measurement of the relevant state, which was so prevalent under debt relying on GDP statistics, is also present in catastrophe bonds.

Grenada issued a bond with a hurricane clause in 2015. If the indexation was activated, Grenada would see deferred payments for up to two payment periods, but no nominal principal or interest rate reduction. This indexation can be triggered a maximum of 3 times. There would be a 6-month deferral if loss between is $15m and $30m, and 12-month deferral if loss is greater than $30m. A one-off trigger of the hurricane clause could also provide a cash flow relief. In 2018 Peru, Colombia, Chile, and Mexico have issued cat bonds that involve a decrease in payment in case of a natural disaster above a specific threshold. The amounts were modest. Peru issued $200m, Colombia $400m, Chile $500m and Mexico $260m. Details for the indexation mechanism are available in the database.

[8] http://www.artemis.bm/news/multicat-mexico-2012-class-c-cat-bond-notes-officially-a-50-loss/.

Catastrophe bonds are not limited to natural disasters. In 2017, following the Ebola crisis, the World Bank issued bonds linked to disease outbreaks through the Pandemic Emergency Financing Facility (PEF). Contingencies are applied if an outbreak takes at least 20 lives in a minimum of two countries. These contingencies were activated during the Covid-19 pandemic.

V. Discussion

In this section, I discuss lessons from past experiences with state-contingent debt that may be relevant for policy makers and market participants. Ultimately, the crucial empirical question is whether a sufficiently large market for state-contingent debt, capable of materializing the benefits of state-contingent debt, exists. The main benefits from issuing state-contingent debt for borrowers are the reduction in risk associated with sovereign debt, in particular, the stabilization of the level of debt as a share of GDP, especially after large shocks. The main benefits for lenders come from the potential diversification gains provided by this type of debt, and of course, the relatively expected higher interest rate, as the return on state-contingent bonds is likely higher than that of traditional bonds.

Section II shows conditions for both borrowers and lenders that make this market feasible. On the borrower side, risk aversion, correlation between contingencies and the state of the economy, both in terms of the shocks and other debt payments, are first order determinants of the benefits of state-contingent debt. The costs, in particular the numerous premia described there, also play a crucial role. As any insurance contract, state-contingent debt is more expensive than traditional debt. For lenders, a crucial determinant of the benefit of this debt is the diversification gains that it provides. The larger these are, the more willing investors will be to hold this debt. Time-varying risk aversion, however, interacts with diversification. For example, during a global financial crisis, risk aversion is relatively high, while returns on state-contingent debt are positively correlated with other returns, in this case investor losses. This poses a challenge for state-contingent debt, making it particularly suited for countries that experience idiosyncratic shocks. As Section II. notes, the conditions for existence of a market of state-contingent debt are more likely to hold for smaller debt volumes, when investors are not too exposed to country risk.

The experiences to date suggest that the market is relatively limited, at least without coordination or a policy push from official lenders like the IMF. Although testing for hypothetical market size is far from trivial, the information collected in this database may provide a starting point for future research. More immediately, it is still possible to draw a number of lessons from existing issuances of state-contingent debt, which I turn to next.

Given the complexity of these debt instruments it is crucial to limit any ambiguity regarding the computation of state-contingent payments and the potential to default on previously established commitments. The prospectus of the debt instrument should clearly define which statistic determines the state contingency and what happens if there are changes to the way this statistic is computed. This is harder for longer maturity assets, but it is crucial for policy makers to minimize any confusion on this matter and mitigate potential litigation risk. Argentina's GDP-warrant is a case in point. In 2019, the Argentine government was back in court, after years of litigation over defaulted bonds, now due to a lawsuit regarding a change in the base year it used to compute GDP statistics that determined coupon payments on its GDP-warrants. The database highlights several countries where statistical ambiguity, and short-run opportunism, played a role in making these debt instruments less effective in the long-run. Furthermore, there is an externality every time a sovereign uses a loophole or manipulates statistics. Other countries wishing to issue this type of instrument will likely experience a chilling effect on the demand for their own state-contingent assets. Because individual sovereigns do not take the external effects of their actions into account, this externality may limit the markets for state-contingent debt.

On top of the risks that are already present in traditional debt, contingent debt is likely to expose lenders to several additional risks and their associated premia. These may further interact and make contingent debt more expensive. Some of these have been shown to matter in empirical work. For example, there is novelty premia associated with first-mover costs related to writing up new contracts, marketing and pricing. Looking at Argentina's GDP-linked warrants, *Ricci* et al. (2008) document significant novelty premia. Liquidity premia would also likely play a role, although it is common to small issuances of noncontingent bonds.

State-contingency will likely include additional premia related to implementing the indexation. For example, if the contingency is established in terms of commodities, it will matter how easily these assets can be converted into commodities or their equivalent international value. This was an issue with the Cotton bonds in 1863 or the Petrobonos in 1977. If the contingency is related to GDP, and even if the terms of the asset clearly state which statistical series is the relevant one, there is likely a reputational effect that makes debt costlier at start. Fears of statistical manipulation will play a role, even before any manipulation occurs. Regarding bonds that are linked to natural disasters, uncertainty about measurement of an event may lead to uncertainty after the event took place. This uncertainty may interact with statistical manipulation risk as the measurement is not exogenous, contrary to the natural disaster.

State-contingent debt may interact with other risks, for example, currency risk or capital controls. It is then crucial to estimate the covariance of these risks in order to correctly price these assets. For example, in good states of the world, where payments for the sovereign are expected to be large, the government may impose conditions on the payments that are unfavorable for investors. This happened in 1980 when the Mexican government forced investors to convert pesos to dollars at the official rate which was overvalued relative to the market rate, such that even though the price of oil increased dramatically, foreign investors still experienced losses from the oil-linked bonds.

Whether these costs are prohibitive is ultimately an empirical question. *Pouzo/Presno* (2016) show that uncertainty premia are sizable in the context of sovereign borrowing with default. Furthermore, the experiences reviewed in this database suggest that accounting for all these costs is still an ongoing exercise by market participants. Getting to the correct debt terms is a learning process. Some examples of successful state-contingent government debt have been described as overly generous ex-post. This may prove problematic at a time when noncontingent debt is being issued at historical minimum interest rates, making contingent debt relatively more expensive. Note however, that many of the potential risks and associated premia described above were also present for inflation-indexed bonds, which managed to thrive in recent years, and are certainly present for equities and derivatives, which are currently much larger asset classes.[9]

The goal of state-contingent debt is to index payments to a variable that accurately and timely reflects the state of the economy and the government's finances. However, if the indexed variable diverges from the state of the economy, then contingencies may induce very high payments that were unexpected or that occur at the wrong time. This problem is compounded when maturities are very large as it is then harder to gauge relevant risks or what will be the relevant variables in the future. For example, France linked long-term debt to the price of gold, but a change in global monetary arrangements after the end of Bretton Woods, meant that the price of gold increased dramatically relative to other prices and output, which made the French gold-linked bonds extremely expensive for the French government. A commodity-rich country may index debt to the price of a commodity. However, the depletion of commodity stocks in the country, or temporary shocks that determine the production of the commodity, for example, weather shocks or political instability, may mean that the international price of oil is not the relevant variable to capture the state of the economy. Export revenues would combine prices and quantities, and better summarize

[9] See *Chamon/Mauro* (2006), *Schinckus* (2013) and *Consiglio/Zenios* (2018) for examples of papers pricing state-contingent government debt.

the state of that economy. More generally, long-term state-contingent debt is particularly prone to neglected risks.

Finally, linking debt payments to GDP-growth is the most common way to issue GDP-linked bonds. However, following a large negative output shock, GDP-growth may be very large as the economy recovers. This would induce large payments on debt while the level of GDP remains substantially below trend. In other words, even though the economy is in a bad state, where private consumption and government revenues are low, this sovereign would have to pay a lot due to contingencies. Indexing payments to the level of GDP, or to an index of consumption, would avoid this issue but seems unpopular for market participants. One alternative is to introduce caps and floors on debt payments, but this further increases the complexity of these assets and would likely translate to higher premia.

Should state-contingent debt link the principal or the coupon to the state of the economy? Linking the coupon makes state-contingent debt closer to a claim on an equity dividend. Linking the principal makes state-contingent closer to an equity asset. Although linking the coupon to the growth of GDP appears to be an easier option to sell these types of assets to investors, note that by linking the coupon to the state of the economy would have a smaller effect on debt sustainability following crises compared to linking the principal. The latter directly affects the total level of debt. Lags may also play a role. Due to publication lags the payments on debt often lag the relevant state variable by a few quarters, sometimes a year. This backward-looking property may be problematic if payments referring to a good state of the world occur during a recession or a crisis, as it was the case in Argentina in the 2000s, or in Ukraine in 2021.

Many state-contingent bonds are attached to other bonds, either directly, or through cross-default covenants, and they cannot be traded or defaulted on without the other. This attachment was one of the novel issues developed by the Brady Plan, where the warrants issued as sweeteners to the restructuring deal were initially attached to the "plain vanilla" traditional bonds. There is anecdotal evidence that these warrants were not used to price these assets and were largely ignored during the 1990s. Initially, this was not a big issue because the contingency was not activated. However, once they were activated in the 2000s, for example in the oil-warrants issued by Nigeria and Venezuela, which by then had been detached, confusion reigned about debt payments. This may decrease trust in this type of assets and reduce their usage by borrowing countries. These issues were not present in non-tradeable or detached debt. Therefore, not attaching state-contingent debt to other assets will likely facilitate the pricing of these assets and the development of these markets.

State-contingent debt is subject to moral hazard. The literature usually discusses one moral hazard problem where having state-contingent debt reduces the incentives for governments to develop the economy as, for example, higher GDP translates to higher debt payments. This is usually discarded with the argument that the incentives to increase GDP are simply too large for this moral hazard problem to be a concern. However, there is potential for statistical manipulation, particularly when the payments are based on the latest figures, and not on revised data. Therefore, the ideal candidates for state-contingencies are exogenous variables over which the government has zero or little control but that still matter for the overall economy. Examples include natural catastrophes, but also variables like exports, or even tourism revenues, which are arguably exogenous in the short run for small open economies that depend on tourism.

VI. Conclusion

This paper presents a database that provides researchers and policy makers with an overview of existing state-contingent government debt. It shows that the design of state-contingent government debt around the world is extremely varied, both in terms of the variable to which debt is indexed to and to the different payout mechanisms used. These issuances of state-contingent debt resemble pilot runs in this new asset class. This paper also documents that several state-contingencies in government debt have been activated. Although this suggests some hope for the success of these debt instruments, this database also documents several issues and challenges related to market penetration, statistical manipulation, and others.

The Covid-19 pandemic increased the interest in state-contingent debt instruments as both the size of the shock and the speed of the recovery is highly uncertain. For example, Italy issued three new bonds linked to nominal GDP-growth between 2020 and 2021. This represents a movement from developing or countries facing payment difficulties, the traditional issuers of state-contingent bonds, towards more developed and stable economies. By reviewing existing examples of state-contingent government debt and codifying the available information, this database is a resource for researchers interested in investigating the design and performance of these debt instruments, and therefore contributes to our understanding of why many of these markets are still relatively limited. Understanding which features are determinant for the success of these markets, and how to design a standardized version of government state-contingent debt that improves on current government borrowing, remains an exciting topic for future research.

References

Atta-Mensah, J. (2004): Commodity-linked bonds: a potential means for less-developed countries to raise foreign capital, Bank of Canada, 20.

Barr, D./*Bush*, O./*Pienkowski*, A. (2014): GDP-linked bonds and sovereign default. In Life After Debt (pp. 246–275), Palgrave Macmillan, London.

Benford, J./*Joy*, M./*Kruger*, M./*Best*, T. (2016): Sovereign GDP-linked bonds, Bank of England Financial Stability Paper, 39.

Benford, J./*Ostry*, J. D./ *Shiller*, R. J. (eds.) (2018): Sovereign GDP-linked bonds: Rationale and Design. CEPR Press.

Bertinatto, L./*Gomtsyan*, D./*Sandleris*, G./*Sapriza*, H./*Taddei*, F. (2017): "Indexed Sovereign Debt: An Applied Framework", Working Paper.

Blanchard, O./*Mauro*, P./*Acalin*, J. (2016): The case for growth-indexed bonds in advanced economies today, Peterson Institute for International Economics, Policy Brief, 16-2.

Borensztein, E./*Mauro*, P. (2004): The case for GDP-indexed bonds, Economic Policy, 19(38).

Besley, T./*Powell*, A. P./*Mundial*, B. (1989): Commodity-indexed debt in international lending, International Economics Department, World Bank, 161.

Cabrillac, B./*Gauvin*, L./*Gossé*, J. L. (2016): GDP-indexed bonds: what are the benefits for issuing countries, investors and international financial stability?, Quarterly selection of articles-Bulletin de la Banque de France, 44.

Cecchetti, S./*Schoenholtz*, K. (2017): http://voxeu.org/article/gdp-linked-bonds-primer.

Chamon, M./*Mauro*, P. (2006): Pricing growth-indexed bonds, Journal of Banking & Finance, 30(12).

Cline, W. R. (1995): International debt reexamined, Peterson Institute Press: All Books.

Consiglio, A./*Zenios*, S. A. (2018): Pricing and hedging GDP-linked bonds in incomplete markets, Journal of Economic Dynamics and Control, 88.

Costa, A./*Chamon*, M./*Ricci*, L. A. (2008): Is there a novelty premium on new financial instruments? The Argentine experience with GDP-indexed warrants, IMF Working Papers, 109.

Council of Economic Advisors. (2004): "Growth indexed bonds, a primer".

Deacon, M./*Derry*, A./*Mirfendereski*, D. (2004): Inflation-indexed securities: bonds, swaps and other derivatives, John Wiley & Sons.

Dunaway, S./*Rennhack*, R./*Aitken*, B./*Anayiotos*, G./*Andrews*, D./*Aziz*, J./*Laursen*, T. (1995): Private market financing for developing countries, IMF.

Haldane, A. (1999): Private sector involvement in financial crisis: analytics and public policy approaches, Financial Stability Review, 9.

IMF (2017): State-Contingent Debt Instruments for Sovereigns, IMF Policy Paper, May 22.

IMF and World Bank (2011): Managing Volatility in Low-Income Countries: The Role and Potential for Contingent Financial Instruments.

Le Monde (1956), "L'emprunt d'équipement, levier de l'expansion", June 20th 1956, https://www.lemonde.fr/archives/article/1956/06/20/l-emprunt-d-equipement-levier-de-l-expansion_2258121_1819218.html.

Obstfeld, M./*Peri*, G. (1998): Regional Non-Adjustment and Fiscal Policy: Lessons for EMU, Economic Policy, 13(26).

Park, S. K./*Samples*, T. R. (2015): Towards Sovereign Equity, Stan. JL Bus. & Fin., 21, 240.

Pouzo, D./*Presno*, I. (2016): Sovereign default risk and uncertainty premia. American Economic Journal: Macroeconomics, 8(3).

Rozental, A. A. (1959): Variable-Return Bonds – The French Experience, The Journal of Finance, 14(4).

Sandleris, G./*Wright*, M. L. (2013): GDP-Indexed bonds: a tool to reduce macroeconomic risk?, The future of sovereign borrowing in Europe.

Schinckus, C. (2013): How to value GDP-linked collar bonds? An introductory perspective, Theoretical Economics Letters, 3.03: 152.

Shiller, R. (1993): Macro markets: creating institutions for managing society's largest economic risks, Oxford University Press.

Tomz, M./*Wright*, M. L. (2013): Empirical research on sovereign debt and default, Annu. Rev. Econ., 5(1).

Weidenmier, M. D. (2000): The market for confederate cotton bonds, Explorations in Economic History, 37(1).

Williamson, J. (2017): Growth-Linked Securities, Springer.