

Optimal public debt composition during debt crisis: A review of the theoretical literature

Abstract

In the light of recurrent sovereign debt crises over the last decades and the evidence on the critical role played by the composition of public debt portfolio during debt crisis, this paper surveys the theoretical literature on the optimal public debt composition during debt crisis. The public debt composition refers to the characteristics of public debt portfolio such as debt maturity, currency composition and types of creditors. This survey adopts a broad definition of sovereign debt crisis which encompasses both a post-default phase of debt crisis in which the crisis country enters into debt renegotiations and restructuring, and a pre-default phase in which the crisis country either takes a large non-concessional loan from the International Monetary Fund (IMF) to avoid debt default and restructuring, or experiences critically high bond spreads and default risk. Our survey collects the dispersed literature on the theoretically optimal public debt composition choices from the sovereign borrower's perspective in both phases of sovereign debt crisis. The surveyed theoretical literature reveals several trade-offs underlying the sovereign's public debt composition choices during debt crisis.

Keywords

public debt composition; debt crisis; default risk; debt restructuring

1. Introduction

Recent decades have witnessed several sovereign debt crises in both developing and advanced countries such as the Latin American debt crises that originated in the early 1980s (e.g. Argentina, Brazil, Mexico) and the Eurozone debt crisis in the aftermath of the financial crisis 2008-2009 (e.g. Greece, Portugal, Spain). Furthermore, due to the worldwide coronavirus pandemic which has led to dramatic increases in government expenditures and fall in revenues, public debt levels are soaring all over the world and new debt crises are highly expected (Arellano, Bai and Mihalache, 2021; Oldekop et al., 2020). Evidence suggests that public debt composition can play a crucial role in averting or mitigating sovereign debt crisis through its effects on lenders' perceptions of sovereign's credibility and default risk (Afonso and Jalles, 2017; Dell'Erba, Hausmann and Panizza, 2013; Jarmuzek and Vesperoni, 2018), on the size of public debt burden and debt sustainability (Sinha, 2015; Sunder-Plassmann, 2020), and on the effectiveness of fiscal policy in stimulating economic growth during crisis recovery (Çufadar and Özatay, 2017). Therefore, this survey focuses on the optimal public debt composition during debt crisis.

The composition of public or sovereign debt portfolio¹ refers to its characteristics in terms of debt maturity, interest rate indexation, currency composition, and types of creditors (Missale, 1997; Montiel, 2005; Werner, 2014; Williams, 2013). The optimality of public debt composition is defined in both practical and academic perspectives where the latter will be the focus of our survey. In a practical sense, the official joint guidelines of the International Monetary Fund (IMF) and the World Bank (2003) define it as raising the required amount of funding at a minimum cost, subject to a prudent degree of risk in order to reduce government's vulnerability to macroeconomic shocks and financial crises. In line with these guidelines, debt management offices focus on the concepts of cost and risk and the inherent trade-off between them. This trade-off arises, for instance, because governments may prefer large volumes of

short-term or foreign currency debt with the aim of minimising borrowing costs; however, this comes at the expense of more risk vulnerability due to unexpected changes in interest or exchange rates.

Regarding the theoretical or academic perspective, public debt composition optimality is usually analysed using an optimal taxation viewpoint where debt instruments should minimise the welfare costs associated with distortionary taxes (e.g. Barro, 1979; 1999; Bohn, 1988; Lucas and Stokey, 1983). During a negative budget shock, the payments made by government on its debt instruments should decrease so as to avoid any unplanned increases in tax rates that can be caused by an increase in financing needs (Missale, 1997; Montiel, 2005). This is known as the insurance function of debt instruments (Faraglia, Marcet and Scott, 2008). The optimal taxation perspective to public debt composition has been theoretically examined by a considerable number of studies under the important assumption of government's full commitment to repay its debt (e.g. the literature surveyed by Missale (1997, 1999) and Montiel (2005)). In contrast, a growing body of academic public debt literature which assumes lack of commitment to debt repayment has emerged due to recurrent debt crises (e.g. Arellano and Ramanarayan, 2012; Boz, 2011; Dellas and Niepelt, 2016; DAVIS, 2019; Werner, 2014). While the main focus of our paper is on the latter literature which assumes risk of default on debt obligations, the former group of studies assuming full commitment to repayment will also be briefly reviewed in section two.

The contribution of our survey is to provide the first comprehensive review on the theoretically-optimal public debt composition choices during debt crisis. While sovereign debt crisis is typically perceived as the outright default on debt obligations, our survey will depend on a broader definition of sovereign debt crisis. A country is defined to be in a state of debt crisis in the following cases: first, the case of outright default on debt obligations which refers to the sovereign failure, either due to inability or unwillingness, to pay its debt obligations on due

date, or the sovereign announcement of restructuring its debt at less favourable terms than the original contract (Marchesi and Masi, 2020; Reinhart and Rogoff, 2011; Trebesch and Zabel, 2017); second, the case of receiving a large (i.e. exceeding 100% of its quota) non-concessional loan from the International Monetary Fund (IMF), so that the default or debt restructurings events which were avoided only through large IMF financial package are taken into account (Manasse and Roubini, 2009); third, the case of high default risk when bond spreads (i.e. difference between interest rates on defaultable and riskless bonds of same maturity) are above a critical threshold², which indicates higher interest costs demanded by lenders on the crisis country due to their perception of its high risk of debt default (Dvorkin, Sanchez, Sapriz and Yurdagul, 2020; Pescatori and Sy, 2007).

This broad definition of sovereign debt crisis assumes a pre-default phase of debt crisis when bond spreads and default risk are critically high, and a post-default phase of debt renegotiations and restructuring. The aim of this survey is to collect the dispersed theoretical literature on the optimal public debt composition choices by a benevolent sovereign borrower in both phases. It is worth noting that the real strategies applied by debt management offices are not necessarily shaped by the theoretical optimality of public debt composition choices from a benevolent sovereign borrower's perspective, but they may be highly affected by creditors' decisions, political interests and institutional constraints (Broner, Lorenzoni and Schmukler, 2013; Cormier, 2020; Dreher and Vaubel, 2004). This survey attempts to provide a comprehensive overview of only the theoretical trade-offs involved; however, other factors (e.g. political, institutional) should be taken into account in explaining real public debt composition choices in different countries at different stages of development.

The remainder of the paper is organized as follows: Section 2 gives a brief overview of the public debt literature from the optimal taxation perspective under the assumption of government's full commitment to repay its debt versus the lack of commitment assumption.

Section 3 then reviews the optimal public debt composition under high default risk in the pre-default phase of debt crisis, and how this optimal composition theoretically differs from the literature under the precommitment to repayment assumption. This section focuses on the choices of public debt maturity, currency composition, and type of creditors³. It also sheds light on the sovereign's choice to have recourse to the IMF as a special type of creditor during debt crisis. Section 4 covers the sovereign's choices in the post-default phase of debt crisis, namely debt renegotiations and restructuring. This section elucidates how the existence of public debt restructuring options can alter the optimal public debt composition choices by the sovereign ex-ante and surveys theoretical contributions on the sovereign's choices of its debt restructuring strategies. Section 5 concludes by summarising the main theoretical trade-offs faced by sovereign borrowers in making public debt composition choices during debt crisis and pointing out some areas for future research.

2. Public debt composition from an optimal taxation perspective

Although our survey focuses on the optimal public debt composition in the context of sovereign debt crisis or outright default risk, it is important first to briefly review other closely related strands of literature that assume full commitment to debt repayment. While the outright default refers to the government's failure to pay the contracted debt obligations which accordingly leads to debt renegotiations and default costs in terms of trade sanctions, output losses and exclusion from capital markets, there are still alternative 'disguised' default options without violating sovereign debt contracts and incurring outright default costs (Cochrane, 2001; Reinhart and Rogoff, 2011; Sim, 2013). Governments fully committed to repay their debt obligations can exploit the fluctuations in inflation or interest rates to reduce their real payments of debt obligations during adverse budget shocks. This is explained in the academic literature

using an optimal taxation approach, which was introduced in the eighties and nineties of the past century (e.g. Barro, 1979; 1999; Bohn, 1988; Lucas and Stokey, 1983) and has become widely adopted in the analysis of optimal public debt composition as discussed below.

From an optimal taxation perspective, an optimally chosen debt instrument should provide an insurance or hedging function by helping tax smoothing through avoiding an increase in distortionary taxation that can be caused by fluctuations in financing needs (Faraglia et al., 2008; Montiel, 2005). This occurs when the payments made by governments on this debt instrument decreases with a negative budget shock (or in bad states) as quoted by Missale (1997, p.236) ‘the objective of minimizing the welfare loss from distortionary taxation calls for indexing debt returns positively to productivity shocks and negatively to public spending shocks. This design of public debt avoids having to increase tax rates on labour income when bad shocks to output and public spending occur’. Given the limited practicality of explicitly linking the returns on debt instruments to the states of the economy (i.e. complete market outcome)⁴, an implicit contingent approach is usually employed. In this approach the real public debt obligations are designed to be implicitly contingent on the prevailing state of the economy in the sense that they negatively covary with the government spending and budget deficit (Angeletos, 2002; Bhandari, Evans, Golosov and Sargent, 2017; Marcet and Scott, 2009). Under the assumption that governments can fully precommit to repay their debt obligations, tax smoothing can occur in two ways according to academic literature.

First, governments can inflate away its nominal debt burden during adverse budget shocks by increasing the inflation rate and thus reducing the real value of its nominal outstanding debt obligations (Chari, Christiano and Kehoe, 1991; Leeper and Leith, 2016). There is nonetheless a trade-off between this tax smoothing benefit of state-contingent increase in price levels and the associated costs due to the possible price rigidity (sticky prices set by firms) leading to price adjustment costs or misallocation of real resources (e.g. over-or under- productions of certain

goods) in case of inflationary surprises (Faraglia, Marcet, Oikonomou, and Scott, 2013; Schmitt-Grohe' and Uribe, 2004; Siu, 2004). Besides, the lack of commitment to monetary policy raises additional costs because it leads to a strong credibility or time-inconsistency problem as investors perceive the optimal debt instruments (from the tax smoothing perspective) as creating incentives for engineering inflationary surprises (Leeper and Leith, 2016). This consequently leads to costly increase in inflationary expectations especially at high debt levels and higher compensatory borrowing costs demanded by investors from sovereign borrowers (Leeper, Leith and Liu, 2021; Missale, 1997; 1999; Niemann, Pichler and Sorger, 2013).

Second, the variation in the market value of outstanding debt through fluctuations in real interest rate and debt price during budget shocks can also play the insurance role through avoiding tax volatility and enhancing tax smoothing (Angeletos, 2002; Buera and Nicolini, 2004). This strand of literature abstracts from the costly inflation surprises and nominal rigidities by assuming a real economy where the price of government debt is expressed as a function of household consumption levels (bond price at date 0 is directly related to the ratio of consumption at date 0 and consumption at future date t). According to this theoretical literature, the change in intertemporal consumption levels during an adverse budget shock leads to a fall in the price and market value of outstanding obligations of the optimally chosen debt instruments, and therefore leads to a capital gain for the borrowing sovereign that helps avoid increasing distortionary taxation (Angeletos, 2002; Buera and Nicolini, 2004).

However, in analogy to the time-inconsistency problems resulting from the lack of policy commitment in the inflation literature, the lack of commitment to fiscal policy can similarly induce governments facing an adverse budget shock to manipulate tax rates. In doing so they attempt to alter consumption levels in favour of reducing the market value of debt (e.g. announcing a tax cut at date t leads to higher consumption at that date and thus lowers current

market value of debt) (Debortoli, Nunes and Yared, 2017; 2021; Faraglia, Marcet, Oikonomou and Scott, 2016). Because of this costly distortion in terms of tax volatility, which is primarily meant to be minimised in the optimal taxation approach, the lack of policy commitment is sufficient to alter the optimal public debt composition (Debortoli et al., 2017; 2021). The optimal composition according to the model assumptions in Angeletos (2002) and Buera and Nicolini (2004) additionally necessitates unrealistically huge debt levels and volatility. This is because the volatility in debt price level is small, which requires that the amount of debt has to be large enough to generate the targeted fall in market value of debt obligations (Faraglia, Marcet and Scott, 2010). More importantly, the theoretical recommendations of these two models are not robust to relaxing some model assumptions such as the assumption that governments repurchase all outstanding debt and reissue new debt every period, which results in enormous transaction costs (Faraglia, Marcet, Oikonomou and Scott, 2019).

To conclude, under the lack of commitment to debt repayment assumption governments determine its optimal public debt composition in the light of the available option of outright default on debt obligations with bearing the consequent default costs. Governments fully committed to debt repayment can likewise choose the optimal debt portfolio that enable them to exploit fluctuations in inflation rate or market value of debt to reduce their debt obligations during bad shocks. For example, the governments of the US and Euro area countries (where the full commitment assumption is more applicable than riskier emerging or developing countries) are found to benefit from their public debt composition in insuring their budgets against negative shocks since 1946 and in the period 1999-2008 respectively (Berndt, Lustig and Yeltekin, 2012; Equiza-Goni, Faraglia and Oikonomou, 2018). This comes however at the expense of possible associated costs due to market frictions (e.g. sticky prices) or lack of policy commitment. Therefore, under both assumptions of commitment to repayment, governments face trade-offs in their choice of optimal public debt composition where in some cases the tax

smoothing or shock absorbing benefit of the optimally chosen debt instruments can encourage governments tolerate the increase in borrowing or any associated costs, while in other cases the costs dominate. This theoretically depends on factors such as the level of outstanding public debt and the composition of the inherited debt, inter alia (Leeper and Leith, 2016; Sim, 2013).

3. Optimal public debt composition under outright default risk

Based on the broad definition of sovereign debt crisis, a sovereign facing high bond spreads and high risk of defaulting on its debt obligations is considered to be in a pre-default phase of debt crisis. It is important to analyse public debt composition choices during this phase in order to help avert or at least mitigate the adverse effects associated with debt default. This section reviews the theoretical literature on sovereign's public debt composition choices under the risk of default, with a brief reference to studies which assume precommitment to repayment for the sake of a self-contained review. The public debt composition choices surveyed in this section are public debt maturity, currency composition, and type of creditors (i.e. foreign versus domestic creditors, banks versus bondholders, private versus official creditors, and the IMF as a special official creditor) respectively.

3.1 Maturity composition of public debt

Theories on the optimal maturity choice of public debt instruments have received considerable attention in the public debt academic literature (e.g. Dovis, 2019; Missale and Blanchard, 1994; Nosbusch, 2008; Perez, 2017; Sanchez, Saprizza and Yurdagul, 2018). Under the implicit contingent approach, debt with long-term maturity is recommended because it helps maximise budgetary benefits when the government uses inflation rate for tax smoothing in contrary to short-term debt which is rolled over at shorter intervals (Cochrane, 2001; Missale, 1997; 1999; Montiel, 2005). In spite of the associated costs discussed in section two, long maturity is still

recommended by some studies in the inflation-based tax smoothing literature due to the compensating insurance gains in terms of welfare (Lustig, Sleet and Yeltekin, 2008; Nosbusch, 2008). This is especially plausible in examining the optimal maturity choice because the costs of inflation are expected to be lower in a two-period model unlike the models of price stickiness by Schmitt-Grohe' and Uribe (2004) and Siu (2004) which allow only for one-period debt (Leeper et al., 2021; Sim, 2013).

With regard to the real economy studies of tax smoothing under full commitment to debt repayment, longer maturities of real securities are recommended under a set of assumptions in the pioneering models of Angeletos (2002) and Buera and Nicolini (2004) mentioned in section two. However, this result is contradicted in many later studies that argue instead in favour of shortening debt maturity. For example, when the lack of policy commitment is introduced to the above theoretical models, the increase in distortionary costs (due to more tax volatility as explained in the previous section) resulting from issuing long-term debt may outweigh its insurance benefits (Debortoli et al., 2017; 2021; Faraglia et al., 2016). The relaxation of other model assumptions such as the repurchasing and reissuing the whole debt stock every period similarly supports the shortening of optimal public debt maturity because it accounts for the cash flow smoothing advantage of short-term debt relative to the long-term debt under the more realistic no buyback assumption (Faraglia et al., 2019).

In the above studies, only lack of policy commitment is emphasized while governments are assumed to fully commit to repay debt. When the lack of commitment to debt repayment is introduced, the role of default risk in the optimal maturity choice by sovereigns is highlighted. Related studies can be classified into two groups: the first group deals with the case of exogenous risk resulting from the inability of governments to repay its debt and it recommends long debt maturities to avoid rollover and interest rate risks, except when these longer maturities are associated with quite high interest costs (e.g. Alesina, Prati and Tabellini, 1990; Cole and

Kehoe, 2000). The second group focuses on the endogenous (strategic) default risk based on the governments' willingness to repay and it argues that shortening debt maturity is the optimal choice under high default risk (e.g. Arellano and Ramanarayan, 2012; DAVIS, 2019). Following is a detailed survey of both groups of studies.

3.1.1 Optimal maturity under exogenous default risk

The optimal debt maturity is long when exogenous default risk is introduced because the short maturity worsens vulnerability to debt crisis (Drudi and Giordano, 2000). As maturity shortens, the probability of exposing the borrowing government to both rollover risk and interest rate risk increases, and hence the risk of sovereign default increases (Alesina et al., 1990). Regarding rollover risk, if the average maturity of public debt is short and if the public lacks confidence in the government's ability to rollover the maturing debt, then the public will be reluctant to buy the newly-issued government's securities, and the government will not find the sufficient resources to repay the maturing debt, and hence the public's expectations become self-fulfilling (Alesina et al., 1990). In contrast, longer maturities offer more insurance because they reduce the amount of debt maturing at each date and consequently the probability of having rollover risk and self-fulfilling or confidence debt crisis (Alesina et al., 1990; Dooley, 2000).

Moreover, lengthening debt maturity can even reduce the debt servicing costs due to the lower risk premia demanded by investors as a result of lower probability of default due to self-fulfilling crisis (Alesina et al., 1990). Longer maturities can thus be optimal with regard to both objectives of insurance and cost-minimisation. Cole and Kehoe (2000) highlighted the concept of 'crisis zone', which is encountered when certain indicators such as public debt level or maturity structure lie within a particular unsafe range (e.g. high debt levels, short maturity). Once a country reaches this crisis zone, then the default risk can be determined according to the

public expectations, which turn to be self-fulfilling. For example, Cole and Kehoe (2000) attributed the inability of the Mexican government to issue new debt, despite the moderate debt-to-GDP ratio, during the 1994 crisis to the lack of investors' confidence due to the very short average debt maturity. Therefore, the only way to avoid such self-fulfilling crisis is to avoid reaching the crisis zone by public debt composition choices including lengthening maturity (Cole and Kehoe, 2000).

With regard to interest rate risk, the investors' lack of confidence in the ability of governments to repay debt can be translated into higher interest rates (risk premia) required by them rather than an immediate refusal to buy the newly issued debt (Lorenzoni and Werning, 2019). The former behaviour will accordingly lead to fast accumulation of debt and ultimately to a self-fulfilling crisis which is more 'slow-moving' than the latter case of immediate default. Long debt maturity helps reduce the risk of rolling over government debt at higher interest rates, and therefore it plays important role in avoiding debt crisis in the light of both roll-over and interest rate risks (Cole and Kehoe, 2000; Lorenzoni and Werning, 2019). Some studies have nevertheless highlighted the case of very high risk premia embedded in long-term interest rates (due to lenders' risk aversion for example) which force the sovereigns to issue only short-term debt (Broner et al., 2013; Drudi and Giordano, 2000). However, Missale (2012) warned that public debt managers should never shorten maturity with the target of minimising debt servicing costs as long as the higher risk premia are only the fair price for insurance.

3.1.2 Optimal maturity under endogenous default risk

Eaton and Gersovitz (1981) consider the decision of repayment/default on public debt as an endogenous variable in a government's optimization problem. This indicates that a government which has the ability to repay its debt can choose to default based on the benefits and costs associated with this decision. There is a quasi-consensus in the endogenous default studies that although short term debt is believed to raise vulnerability to crisis, shortening maturity appears

to be the best choice by sovereigns under default risk (e.g. Arellano and Ramanarayan, 2012; Dovis, 2019; Perez, 2017). This is in line with the data of emerging countries approaching default such as Argentina which is found to shorten its average debt maturity in 2000 before defaulting on its debt obligations in 2002 (Dovis, 2019). The academic literature assumes that there are lump sum costs associated with debt default, which are commonly represented by output or income losses and/or temporary exclusion from international credit markets⁵.

Endogenous default studies have different theoretical explanations for shortening debt maturity under high default risk. For example, it can be explained based on the hedging or insurance benefit of long-term debt and the incentive benefit of short-term debt (Arellano and Ramanarayan, 2012; Dovis, 2019). Long-term debt has a hedging advantage that arises due to the relatively high price sensitivity of long-term debt to new debt issuances. This is defined by Hatchondo, Martinez and Sosa-Padilla (2016) as the sovereign debt dilution which refers to the reduction in the price and hence the value of outstanding debt as a result of new debt issuance because investors are willing to pay lower price for new sovereign debt as the total indebtedness level increases. The reduction in the value of outstanding long-term debt as a result of issuing new debt acts as a capital loss for long-term bondholders and hence mimics debt relief for the borrowing sovereign (Hatchondo et al., 2016; Dovis, 2019).

On the other hand, short-term debt has an incentive benefit as it provides sovereigns with incentives to repay because it does not entail the same uncertainty and dependence on future new debt issuances like long-term debt. During good states of low default risk, long-term debt is preferred to short-term debt in order to exploit its hedging advantage given that the incentives to repay are already high (Arellano and Ramanarayan, 2012). In contrast, as the debt levels and default risk increase, the sovereign's incentives to repay become lower due to higher benefits of defaulting on a large outstanding debt (i.e. the sovereign is more willing to bear the default costs given the high budgetary benefits of defaulting) (Aguilar, Amador, Hopenhayn and

Werning, 2019). Consequently, the sovereign under high default risk shifts to short maturity because the incentive benefits of short-term debt become more valued than the hedging benefits of long-term debt (Arellano and Ramanarayan, 2012).

Another theoretical interpretation of shortening debt maturity during debt crisis is that there can be an optimal insurance level in terms of an optimal reduction in the value of outstanding long-term debt during bad states (Dovis, 2019). Since the value of outstanding debt is calculated by multiplying debt amount and price, therefore the optimal level of reduction in debt value can be achieved either by issuing large amounts of long-term debt or by high sensitivity of long-term bond prices. Given higher price sensitivity of long-term bonds during bad states due to greater investors' fear of debt dilution, the amount of long-term debt will not increase because the increase in price sensitivity is sufficient to generate the needed optimal reduction in the value of debt (Dovis, 2019). This indicates that as long as the total level of indebtedness increase during bad states, it must be that the short-term rather than long-term debt causes this increase, and this explains the observed shift to short-term debt under high risk of default (Dovis, 2019).

Table 1 summarises most of the above-mentioned theoretical arguments underlying the optimal public debt maturity choice. It is worth noting that most studies of the endogenous default group completely ignore the risk of rollover or self-fulfilling crisis which accompanies shorter debt maturities and emphasized in the exogenous default studies. Introducing only a small probability of rollover crisis is sufficient to show that long-term debt is superior to short-term debt in spite of its higher costs (Chatterjee and Eyigungor, 2012). Increasing roll-over risk, especially under the assumption of sovereign's high risk aversion, can lead to valuing the hedging benefits of long-term debt more, and thus leads to lengthening debt maturity during bad times (Sanchez et al., 2018). However, while longer maturity helps avoid rollover risk resulting from investors' self-fulfilling expectations, it may not protect the sovereign from the

Table 1 Optimal public debt maturity in the theoretical literature

		Optimal maturity choice
Under full commitment to debt repayment	Tax smoothing using inflation rate	- Lengthening maturity helps maximise budgetary benefits from inflationary surprises - Shortening maturity if inflation costs (e.g. price stickiness, credibility problems) outweigh insurance benefits
	Tax smoothing in real economy	- Lengthening maturity is the optimal choice to exploit fluctuations in real interest rates and bond prices - Shortening maturity in the light of lack of policy commitment and robustness to model assumptions
Under lack of commitment to repayment (default risk)	Exogenous default risk	- Lengthening maturity to avoid self-fulfilling debt crisis by minimising roll-over and interest rate risks - Shortening maturity in case of unjustifiably high long-term borrowing costs
	Endogenous default risk	- Shortening maturity due to its incentive benefits

negative impact of a news shock and it may even exacerbate the default risk (Dvorkin et al., 2020). In case of bad news about future adverse macroeconomic shock, the long maturity implies smaller current debt repayments but larger deferred payments when the bad news is probably realized, and consequently it can increase the cumulative default risk (Dvorkin et al., 2020).

3.2 Currency composition of public debt

The choice of sovereign debt currency denomination is a second central element of public debt composition choices (e.g. Bohn, 1990; Gumus, 2013; Korinek, 2011). Domestic currency debt plays a hedging or insurance role during bad states of the economy through movements in inflation or real exchange rates, while foreign currency debt exposes the sovereign to an exchange rate risk and increases the sovereign's vulnerability to financial or debt crises. However, foreign currency debt, being denominated in a unit that is not controlled by the borrowing government, can help solve credibility problems and avoid inflationary costs and

real exchange rate distortions associated with domestic currency debt (Korinek, 2011; Leeper and Leith, 2016; Ottonello and Perez, 2019; Sim, 2013).

Returning back to the implicit contingent approach, Bohn (1990) and Miller (1997) argue that in the absence of precommitment to inflation rates governments can use surprise inflation to reduce the real value of nominal debt denominated in domestic currency in case of adverse shocks. Nominal domestic currency debt can thus play an insurance role. However, in case of credibility problems, foreign currency denominated debt (i.e. indexed to the exchange rate to foreign currency) serves as an inflation-insensitive instrument in order to enhance sovereign's credibility (Mandilaras and Levine; 2002). In spite of the credibility-enhancing role of foreign currency debt, most studies have pointed to its associated risk due to unexpected appreciation in the currency in which the debt is denominated (i.e. exchange rate risk) which leads to an increase in the debt servicing costs in terms of domestic currency (Bohn, 1990; Goldfajn, 2000).

In later theoretical models on the currency composition of sovereign debt over the last two decades, there has been more consideration for the exchange rate risk and the consequent vulnerability to financial crisis (e.g. Aizenman and Hutchison, 2012; Dell'Erba et al., 2013; Ogrokhina and Rodriguez, 2018). Foreign currency debt aggravates the negative response of the economy to adverse shocks because its value is countercyclical to the aggregate state of the economy, which means that during bad states the value of foreign currency debt repayment (in terms of domestic currency) increases due to domestic currency depreciation (Claessens, Klingebiel and Schmukler, 2007; Korinek, 2011). This happened to many emerging Eastern European countries in the aftermath of the global financial crisis 2008 where high exposure to foreign-currency debt imposes strong pressure on their exchange rates and further declines in economic activity (Korinek, 2011).

Foreign currency debt is described as a dangerous form of borrowing (Jeanne, 2000). It is often termed in the literature as the 'original sin' which refers to the inability of sovereigns to borrow

on international capital markets in their own currency. They are thus obliged to borrow in foreign currency, which makes them more vulnerable to financial crisis and further reduces their ability to borrow from abroad (Claessens et al., 2007; Jeanne, 2005; Ogrokhina and Rodriguez, 2018). To overcome this original sin, monetary policy credibility should be enhanced (Falcetti and Missale, 2002; Ogrokhina and Rodriguez, 2018). If the sovereign borrowers can credibly commit not to use surprise inflation to reduce the real value of nominal debt, then they can gain foreign investors' confidence in domestic currency securities and avoid credibility problems. This can commonly occur through inflation targeting (Ogrokhina and Rodriguez, 2018) or monetary policy delegation to independent central banks (Falcetti and Missale, 2002).

Aside from the surprise inflation channel, domestic currency debt can play an insurance role through real exchange rate movements (Korinek, 2011; Ottonello and Perez, 2019). Real exchange rate is defined, for simplicity, as the relative price of non-tradable goods in terms of tradable goods (Korinek, 2011). During bad states, government will have an incentive to induce a negative shock to the tradable sector, which leads to tradable goods being relatively scarcer, and thus real exchange rate depreciates because the relative price of tradables increases (and relative price of nontradables decreases). Accordingly, the real value of domestic currency debt owed to foreign investors is reduced, which is in line with the implicit contingent approach (Korinek, 2011; Ottonello and Perez, 2019). Movements in inflation and real exchange rates are costly and distortionary because they are anticipated by foreign investors who will consequently charge higher compensatory risk premia on domestic currency debt. Governments may thus prefer foreign currency debt so as to avoid inflationary costs and real exchange rate distortions during recessions (Ottonello and Perez, 2019).

It is worth noting that so far the outright default risk is not explicitly modelled in the optimal choice of sovereign debt currency composition. When default risk is introduced, foreign

currency debt is found to increase the risk of a crisis (Da-Rocha, Giménez and Lores, 2013) and lead to higher macroeconomic volatility and thus higher risk of default during recessions (Gumus, 2013). The higher macroeconomic volatility causes an increase in risk premia demanded by investors due to their expectations of sovereign default, and hence leads to an increase in the debt servicing costs and default risk. Gumus (2013) concludes that domestic currency debt is preferable during low-output states because it offers more insurance, reduces macroeconomic volatility and improves welfare via tax smoothing.

Although there is a consensus in the above studies that foreign currency debt increases the sovereign's vulnerability to financial or debt crises, there is another strand of literature that links this effect to the size of the sovereign's international reserves. On the one hand, international reserves can act as a hedge against rollover risks and provide the necessary liquidity to increase foreign currency debt sustainability and reduce vulnerability to crisis (Bianchi, Hatchondo and Martinez, 2018; Bird, 2007; Bordo, Meissner and Stuckler, 2010). On the other hand, Alfaro and Kanczuk (2019) interestingly show that very large holdings of international reserves may decrease foreign currency debt sustainability. Large international reserves can compensate the defaulting sovereign for being excluded from international capital markets, and thus sovereigns may find it optimal to default on its foreign currency debt under these lower default costs. Alfaro and Kanczuk (2019) alternatively recommend joint issuance of domestic currency debt and international reserves because reserves provide a stabilizing function as they help domestic currency debt in its insurance role when the exchange rate is depreciated during bad states⁶.

3.3 Types of creditors

The third element of the public debt composition debates is on the type of creditors. The literature on the risky sovereign's choice among various types of creditors is relatively scarce and is focused on the choice between foreign versus domestic creditors, banks versus bondholders, and private versus official creditors. Besides, the sovereign's choice of the IMF as a special official creditor is also reviewed.

3.3.1 Foreign versus domestic creditors

In the light of increasing financial globalization, it is necessary to distinguish between the debt which is held by non-residents (foreign creditors) regardless of the currency in which debt is denominated, and the debt which is denominated in a foreign currency regardless of the residence of creditors. Real-world examples (such as sovereign debt crises in Argentina 2001 and Russia 1998) reveal that foreign and domestic creditors are not always treated equally (Vasishtha, 2010). For a welfare-maximising government, the choice between domestic and foreign creditors may theoretically depend on the way they enter the government's objective function (Gros, 2013). While foreign creditors, according to Gros (2013), enter only as debtholders receiving interest payments and imposing sanctions in case of default, domestic creditors enter as taxpayers in addition to their creditors' role. Therefore, one advantage of choosing domestic over foreign creditors is that a higher interest payment on sovereign debt in case of domestic creditors is considered as redistribution or transfer from domestic tax-payers to domestic debt-holders, while in case of foreign creditors it is regarded as a transfer abroad and a welfare loss. More importantly, Gros (2013) assumes, at least theoretically, that the sovereign will never default on its domestic debt due to the ability of government to tax domestic debt-holders who will in turn vote for any new tax measures needed to repay their debt. In contrast, foreign creditors cannot be taxed by domestic government, and hence constitute a riskier borrowing option.

Another benefit of borrowing from domestic creditors is derived from the strategic selective default option. The default costs are classified in two components; the first is a deadweight cost which is incurred by a government in case of any default, and the second is sanctions imposed on government only in case of default on foreign creditors' debt (e.g. trade sanctions) (Vasishtha, 2010). Therefore, if the government decides to default on foreign debt, it will always be optimal to default on domestic debt as well because it has already incurred the first deadweight cost. On the other hand, a government can selectively default on domestic debt in bad states so as to avoid raising distortionary taxes (tax smoothing objective) without incurring the full costs of default. This means that domestic debt can provide an insurance benefit to governments (Vasishtha, 2010).

However, domestic debt can be criticized due to its crowding-out effect (Broner, Erce, Martin and Ventura, 2014). During bad states of low output, high debt and high default risk, domestic investors usually have more incentives to buy domestic debt than foreign investors do. This is due to the former's higher expected returns explained by factors such as the political difficulty of defaulting on domestic debt. This leads to crowding-out private domestic investment due to the shift of resources to public debt, and this consequently leads to lower investment, growth rates and welfare (Broner et al., 2014). In contrast, borrowing from foreign creditors can lead to an increase in private investment, growth and welfare (Phan, 2017). In the light of asymmetric information in the cross-border credit relationships regarding the economic fundamentals or political institutions in the borrowing country, borrowing and then repaying high amounts of debt to foreign creditors despite the lack of precommitment to repayment serve as a signal of the borrowing country's good conditions. This will attract foreign investors to invest more foreign capital in the borrowing country, and hence improve growth and welfare (Phan, 2017).

3.3.2 *Banks versus bondholders*

Few studies have built theoretical models that can help explain the rapidly diminishing importance of bank loans in total public debt and its replacement with bonds; for instance the Eurobonds' share in international debt issuance by emerging countries rose from 4% in 1980 to about 90% in 2005 (Tanaka, 2006). Tanaka (2006) analyses the optimal choice between bank loans and bond issuance in a theoretical model with endogenous default risk and concluded that the availability of credit rating agencies as public monitors of the borrowing government makes the long-term bond issuance cheaper for the government than the long-term bank loans due to more bond marketability under the rapid information dissemination. However, the short-term bank loans still have an advantage over short-term securities due to the ease of rolling over bank loans compared to the difficulty of coordinating a large number of bondholders (Tanaka, 2006).

In spite of the deteriorating share of bank loans in total public debt that may be attributed to cost considerations, there are several theoretical advantages of depending on bank loans as a better substitute for the widespread bond finance in order to solve or mitigate the negative impact of a debt crisis (Werner, 2014). These include: first, the non-tradability of bank loans protect a crisis country from speculative attacks, which exacerbate debt crisis. In case of tradable securities, the collective action of immediately selling securities by speculators (in order to raise the yield and lower the price of securities) will induce other investors to do the same and thus further increase the debt servicing costs and make the government debt more unsustainable (Della Posta, 2019). Second, bank loans are not affected by the deteriorating sovereign credit rating during crisis unlike tradable securities, and this can make bank loans cheaper in contrary to the argument made by Tanaka (2006). Third, bank loans are available domestically so they provide greater financial stability and lower vulnerability to crisis than securities owned by foreign investors.

Werner (2014) additionally argues that borrowing from domestic banks can boost the domestic demand and increase overall economic growth. In contrast, when the governments' loans constitute a large part of domestic banks' assets, the financial solvency of the banking sector can be undermined during sovereign debt crisis leading to lower lending to the private sector, and hence lower investment, employment, output and further deterioration in the crisis government's solvency (Battistini, Pagano, Simonelli, Ilzetzki and Zettelmeyer, 2014). This is described in the academic literature as a vicious loop between sovereign debt crisis and banking crisis, and it originates in this case from the increased exposure of domestic banks' balance sheets to government debt in the pre-default phase of sovereign debt crisis (Battistini et al., 2014; Gennaioli, Martin and Rossi, 2014). This negative effect on the domestic banking sector can be alternatively perceived as an extra default cost borne by the domestic economy, and therefore it induces governments to repay their debt and helps reduce the risk of endogenous sovereign default (Gennaioli et al., 2014).

3.3.3 Private versus official creditors

To examine the optimal sovereign choice between private and official creditors, the standard theoretical sovereign debt model with homogenous private creditors is extended to include official creditors as well (Boz, 2011; Dellas and Niepelt, 2016). This occurs by introducing heterogeneity among creditors with respect to their enforcement powers. Official creditors are characterized by their stronger enforcement power which is reflected in more severe sanctions in case of default, and hence in higher default costs compared to private creditors. According to Dellas and Niepelt (2016) this leads to a trade-off between the cheap official loans due to lower default probabilities and risk premia, and the flexible privately held bonds that make a strategic default decision easier especially in bad states. Under the assumption of perfect elasticity of official and private credit supply, the optimal government's choice associated with

this trade-off will depend on factors such as the urgency of financing needs and the credibility level. Governments facing liquidity problems (i.e. large financing needs) will favour the official lending especially under the private investors' bad expectations (i.e. credibility problems) which will make private lending more expensive, while governments facing bad macroeconomic fundamentals will favour the private lending which offers better insurance in case of the highly probable default (Dellas and Niepelt, 2016).

In contrast, Boz (2011) shows through her theoretical model that borrowing from private creditors is procyclical and a sovereign will find it optimal to borrow from official creditors only when the output level is sufficiently low (i.e. bad macroeconomic fundamentals). She focuses on the case when the official creditors are international financial institutions, taking the IMF as an example. Boz (2011) models the IMF interest rate on non-concessional loans as a risk-free rate as opposed to the private interest rate with default risk premia. The inelasticity of the IMF interest rate to the country's macroeconomic fundamentals explains the optimality of choosing IMF loans in bad states to avoid the high-risk premia on privately held bonds. On the other side, it is optimal to benefit from the lower rates on private bonds in good times and to avoid the costs associated with IMF lending. Following is a more detailed analysis of the sovereign's choice of the IMF as a special official lender during debt crisis.

3.3.4 Choice of the IMF as a special type of lender during debt crisis

In the context of public debt composition during debt crisis, the special role of the IMF as the world's premier international financial institution cannot be overlooked. During debt crisis, the IMF provides a program where financial credit is given to the crisis country in the form of tranches, which are disbursed if this country meets policy-reform conditions that are believed to be adequate to overcome crisis (Bird, 2007; Conway, 2006). Although it is sometimes

assumed that a crisis country is forced to have recourse to IMF lending due to its inability to borrow on private capital markets (Jeanne and Zettelmeyer; 2005), this is not always valid because the exhaustion of the private credit route can be gradual and the option of not turning to the IMF and rather search for alternative crisis-resolution mechanisms always remains (Bird, 2007). This indicates that at one point of time during a debt crisis, a country can choose between the IMF and other types of creditors, where such choice is affected by trade-offs related to the IMF catalytic effects and conditionality (Bird and Rowlands, 2010; Boz, 2011; Marchesi and Thomas, 1999).

As already mentioned above for the sovereign's choice of any official creditor, there is a trade-off between costs and flexibility due to stronger enforcement powers of official creditors, and the choice may be ultimately determined based on liquidity problems and credibility level (Dellas and Niepelt, 2016). For the IMF lending specifically, it can provide the necessary liquidity to countries suffering from liquidity problems, and more importantly, it can enhance the borrowing government's credibility and have catalytic effects by encouraging private investors to rollover their credit and avoid a self-fulfilling confidence crisis for a solvent government (Corsetti, Guimarães and Roubini, 2006; Jorra, 2012; Tanaka, 2006). However, the IMF strong enforcement powers imply an IMF seniority over private creditors such that an increase in the official IMF lending may lead to crowding out private investors due to the increasing probability of selective sovereign default on their debt, which is contrary to the catalytic effects of IMF lending (Boz, 2011; Dellas and Niepelt, 2016).

In the borrowing country's evaluation of the IMF catalytic role, the theoretical literature suggests conditions for the IMF success in this role. For example, the IMF lending can have catalytic effects only under the condition that the borrowing country's economic fundamentals are not very weak (Corsetti et al., 2006). The investors' perceptions of the very weak economic fundamentals can offset the IMF catalytic effects. Furthermore, the IMF liquidity provision to

an insolvent government with weak economic fundamentals can be perceived as an incentive for debtor moral hazard problem such that the borrowing governments reduce their adjustment efforts (Corsetti et al, 2006; Dreher, 2006) or act less prudently in their borrowing decisions (Conway, 2006; Dreher and Vaubel, 2004).

The IMF conditionality can address this moral hazard problem and act as a commitment device to avoid the risk that the borrowing countries change their policies in the future, and this can achieve the target of crowding-in private investors by raising the investors' expectations of future good policies (Conway, 2006; Vaubel, 1983). Besides, the IMF policy-reform conditions can help remove the root cause of the crisis by helping the country's economic fundamentals to adjust (Dreher, 2009; Morris and Shin, 2006). Assuming the success of the IMF conditionality (which is not a consensus view in the theoretical and empirical literature), a borrowing government still faces a trade-off between the conditionality benefits just mentioned and the conditionality costs defined by Bird and Rowlands (2010) as the size of gap between a country's preferred economic policies and those that have to be accepted with conditionality. Besides, the political costs of conditionality may discourage the crisis country from demanding IMF support because conditionality undermines the crisis country's ownership of reform policies and can hinder democracy in the recipient countries (Bird, 2007; Dreher, 2009).

In sum, the literature survey in section two shows that the public debt composition choices of a risky sovereign in the pre-default phase of debt crisis always involve trade-offs. It is worth noting that in the surveyed theoretical models the borrowing government is assumed to be benevolent where the government's objective is to smooth taxes at different states of nature so as to maximise individuals' total welfare. There exists another strand of literature concerning the political economy underlying public debt composition choices. In this literature, the government's benevolence assumption is relaxed and self-interested policymakers are assumed

instead, which can significantly alter the previous analysis (Bolton and Jeanne, 2007). One interesting example is the increasing demand for IMF lending in the light of political business cycle theory. The IMF liquidity provision can facilitate expansion before elections while the IMF conditions facilitates contraction afterwards and can act as a scapegoat for any unpopular policies (Dreher and Vaubel, 2004). However, a detailed review of the political economy literature is beyond the scope of this study.

4 Optimal public debt composition and debt restructuring

In the previous section, the sovereign debt game was assumed to end by either the sovereign repaying or not repaying its debt obligations. However, according to real-world debt crises, the game does not usually end by the government explicitly and fully defaulting on its debt (Arellano, Ríos-Rull and Mateos-Planas, 2019; Asonuma and Trebesch, 2016). Rather, it often ends by a post-default phase of debt renegotiations to resolve the debt crisis so as to avoid full non-repayment to lenders and to reduce default costs borne by borrowers (Marchesi and Masi, 2020; Trebesch and Zabel, 2017). It is important to distinguish here between three overlapping concepts related to the outcomes of debt renegotiations. These are debt rescheduling, debt relief and debt restructuring, where the latter will be our focus in this section due to its significant implications on the optimal public debt portfolio. Debt rescheduling is defined as the postponement of debt principal and interest repayment without entailing any losses for the creditors in terms of reduction in the debt nominal value (Consiglio and Zenios, 2015; Marchesi, 2003). In contrast, both debt relief and debt restructuring involve losses to creditors (i.e. haircuts) in the form of reduction in the stated nominal value of debt (Dvorkin, Sanchez, Sapriza and Yurdagul, 2018). Marchesi (2003) defines debt relief to be offered at concessional terms (i.e. below-market interest charges), and it is commonly used in the case of heavily indebted

low-income countries. On the other hand, debt restructuring involves debt swaps or buybacks at non-concessional market rates (Consiglio and Zenios, 2015).

This section focuses on the relationship between the sovereign's debt composition choices and debt restructuring, which theoretically occurs along two phases. First, the presence of a debt restructuring option in case of default can affect the choices of public debt instruments at the time of initial issuance (ex-ante). Second, a sovereign closely approaching default will need to make certain choices related to its debt restructuring strategy and will need to decide the optimal composition of its exchanged debt (swaps) at the end of restructuring.

4.1 Restructuring and ex-ante public debt composition choices

While studies in section three have analysed the optimal public debt composition choices under the risk of defaulting on debt payments, there is another strand of literature that examines whether introducing the risk of debt restructuring acts in the same way on the composition choices as the risk of default. The restructuring option renders high significance to the risk of debt dilution and the expected heterogeneity in haircuts among creditors (Bi, 2006; Borensztein, Chamon, Jeanne, Mauro and Zettelmeyer, 2005). Hatchondo et al. (2016) define debt dilution as the reduction in the value of outstanding debt due to the increase in default risk by the new debt issuances. But in case of restructuring, debt dilution refers to the negative impact that the new debt issuances would have on the claim that existing lenders can hope to recover in the event of a default (Borensztein et al., 2005). Lenders will therefore consider this risk of debt dilution and consequently try to insure full repayment of their claims by making their claims hard to restructure and hence less likely to be selectively repudiated in an endogenous strategic default (Bolton and Jeanne, 2007; 2009).

Lenders will accordingly demand higher costs on debt instruments that are easier to restructure to compensate them for the risk of debt dilution, and thus the sovereigns attempting to lower its borrowing costs may ultimately prefer instruments that are harder to restructure. Therefore, sovereigns may issue debt that is denominated in foreign currency, shorter in maturity or privately held by a multitude of bond holders (Bolton and Jeanne, 2007; 2009). The public debt theoretical literature is almost silent concerning the relationship between debt restructuring and currency denomination except for the fact that the sovereign may have jurisdictional advantage when restructuring domestic-currency debt (Chamon, Schumacher and Trebesch, 2018; Erce, 2013). Therefore, foreign currency debt (if governed by foreign law) is considered to be harder to restructure and thus has lower borrowing costs at times of debt crisis such as the foreign-law bonds in the Euro area in the period 2006-2013 (Chamon et al., 2018). Unlike currency composition, there are some contributions on the relationship between debt restructuring and the sovereign's ex-ante choices of maturity and type of creditors.

Regarding the latter, Bolton and Jeanne (2009), Tanaka (2006) and Hale (2007) consider bank loans to be more renegotiable and hence easier to restructure than bonds. Bolton and Jeanne (2009) attribute the relatively larger difficulty in restructuring sovereign bonds to the bondholders' greater power of nuisance, which provides them with implicit seniority over other lenders. Bank loans are additionally characterized by more easiness in coordinating small number of creditors in a debt restructuring agreement in contrary to the privately held securities, which are harder to restructure based on the creditor coordination risk argument (Hale, 2007; Tanaka, 2006). Nevertheless, Bai and Zhang (2012) and Tanaka (2006) assume this to be true only in case of short-term debt, while long term bonds have an advantage over bank loans because of the former's marketability that provides information on its market prices and thus reduce the monitoring costs borne by lenders before default and the renegotiation duration and costs after default. Furthermore, based on the fact that almost all bond restructurings in the

emerging economies since 1998 were undertaken both quickly and with high investor participation, Bi, Chamon and Zettelmeyer (2016) show in their theoretical model that the prompt bondholders' participation is the equilibrium outcome as long as their incurred losses (haircuts) and the probability of free-riding by some of them are not too high.

With regard to debt maturity, Bolton and Jeanne (2007; 2009) believe that sovereigns might prefer to issue short-term renegotiable debt (e.g. bank loans), which is harder to restructure, than long-term renegotiable debt in order to avoid the increasing borrowing costs due to debt dilution risk. Short-term lenders have higher bargaining power during debt renegotiation due to their ability to change the terms at which they rollover their debt. According to Bolton and Jeanne (2009), short-term debt can solve the debt dilution problem and reduce the borrowing costs but at the expense of increasing the vulnerability to rollover crisis. On the other hand, they consider that longer maturities are intuitively better in case of non-renegotiable debt (i.e. bonds) which is assumed to be immune to selective default and restructuring. Therefore, combining the contributions by Tanaka (2006) and Bolton and Jeanne (2009), it is better for the sovereigns from a restructuring perspective to issue either short-term bank loans or long-term bonds than to issue long-term loans and short-term securities.

Given the unrealism of the assumption on non-renegotiable debt immunity by Bolton and Jeanne (2009), Bi (2006) concludes that the risk of restructuring will also lead to shortening maturity of sovereign bonds and not only bank loans. Since any new debt issuances will reduce the amount to be recovered by the existing long-term bondholders in case of restructuring, shorter-maturity debt is preferred because it is more likely to mature before being diluted and facing large haircuts. While Bi (2006) favours short-term securities due to the expected magnitude of haircuts during restructuring, Asonuma and Ranciere (2015) alternatively view short-term securities as a 'curse' in light of the bond swaps or exchanges during debt restructuring. They focus on the difference between the net present value of cash flows accruing

to both long- and short-term bondholders from their new debt versus their old debt (if the sovereign would have kept servicing it). They find that holders of short-term securities bear significantly higher losses during debt restructuring although all bondholders are assumed to face the same nominal haircut and to receive the same new bond in exchange. Therefore, Asonuma and Ranciere (2015) interpret the increase in short-term bond spreads during debt crisis due to lenders' anticipation for the risk of restructuring and the associated losses for short-term debtholders.

4.2 Public debt composition and debt restructuring strategies

The risk of selective public debt restructuring in the previous subsection has altered the initial public debt composition choices by the sovereign by biasing the public debt towards hard-to-restructure composition. This subsection alternatively surveys the few studies on the sovereign's selectivity in designing restructuring strategies. The sovereign faces a trade-off in the choice to restructure public debt owed to foreign versus domestic creditors (Erce, 2013). If the sovereign decides to default and restructure only domestic debt, it will impose greater burden on the already turbulent domestic economy and will undermine the solvency of domestic financial creditors, but it will not lose its access to international capital markets and it will enjoy more flexibility in inducing or even forcing domestic participation in debt swaps during restructuring. If, on the other hand, the sovereign decides to restructure only foreign debt, it will mitigate the impact on domestic economy but at the expense of losing access to international capital.

Another trade-off confronted by sovereigns during restructuring lies in the choice between restructuring private (i.e. bank loans or privately held bonds) versus official debt. Restructuring bilateral official debt often involves an agreement with the Paris Club which is an informal

forum designed to deal with debtor countries' repayment problems (Marchesi and Masi, 2020). A comparability of treatment clause, which commits the crisis country to treat both the official creditors involved in the Paris Club arrangements and any other uninvolved creditors on comparable terms, is usually attached to the Paris Club agreements (Erce, 2013). Therefore, before engaging in the Paris Club arrangements for official debt restructuring, the sovereign may have an incentive to start with private debt restructuring in order to retain the advantage of selectivity among investors, which is prohibited by Paris Club (Erce, 2013). In contrast, starting with private debt restructuring may not be the optimal choice because it is more visible to investors and thus more likely to negatively affect credit ratings and hence bond spreads and future access to capital markets, while official debt restructuring especially with Paris Club involvement will have very little reputational costs (Marchesi and Masi, 2020).

Aside from the sovereigns' selectivity of specific debt instruments to restructure during debt crisis, the literature still includes another important debt restructuring choices where the pros and cons of some of them are summarised in Table 2 before discussing them in more detail. For example, the sovereign has to choose whether to initiate debt renegotiations and restructuring with the creditors after default or in a pre-emptive manner (i.e. without missing any contractual payments towards those creditors) (Asonuma and Trebesch, 2016). It can be optimal for the risky sovereign to restructure its debt pre-emptively. This has been the case for 38% of all sovereign debt restructurings with private foreign creditors between 1978 and 2010 (Asonuma and Trebesch, 2016). The sovereign borrower will then bear lower default costs in terms of output losses and duration of exclusion from international capital markets than under the highly probable post-default restructuring. However, this comes at the expense of lower debt relief (haircuts) because of the sovereign's higher repayment capacity and the creditors' higher bargaining power (they still have the option to wait and see) in case of pre-emptive restructuring (Asonuma and Trebesch, 2016).

Table 2 Pros and Cons of debt restructuring strategies

Debt restructuring strategy		Pros	Cons
When to initiate debt restructuring?	Pre-emptively	Lower default costs	Lower haircuts
	Post-default	Larger haircuts (borne by creditors)	Higher default costs
How to carry out debt restructuring?	Creditor-friendly procedures	Lower default costs and easily re-access capital markets	Higher burden on domestic economy
	Hard procedures	Reduce the burden on domestic economy	Higher default costs and reputational losses
How much to pay during restructuring? (performing self-financed cash buybacks at market price)		- Stimulate domestic investment - Increase repayment capacity for the remaining debt - Lower bargaining costs - Signalling function	- Sacrifice scarce resources - Benefit accrue to creditors

Under the assumption of variable default costs, the sovereign will also need to decide whether to follow hard versus soft post-default restructuring procedures (Trebesch and Zabel, 2017). A sovereign faces a trade-off between taking a hard or coercive position against foreign lenders through larger haircuts or premeditated delays in renegotiations on one hand (e.g. Argentina 2002, Ecuador 2008-2009), and a soft or creditor-friendly position on the other hand (e.g. Uruguay 2003). The former option can mitigate the burden on the domestic economy but at the expense of larger default costs or reputational losses that can negatively affect trade, direct investments and access to international capital markets, while the latter option will lead to the opposite (Trebesch and Zabel, 2017).

Another choice by sovereign borrowers during debt restructuring is whether to engage in debt buybacks where they can repurchase part of their debt in secondary markets in order to reduce the amount of outstanding debt taking advantage of the discount (i.e. lower debt price) during debt crisis (Cabral, 1996; Krugman, Froot, Claessens and Diwan, 1991). The extent to which sovereign borrowers benefit from repurchasing their own debt, and thus their willingness to

undertake buyback operations, has always been a debatable issue in the existing theoretical literature which mainly focuses on repurchasing foreign debt (Cabral, 1996; Eaton, 1993; Fernandez-Ruiz, 2000; Froot, 1989; Krugman et al., 1991). Domestic investment is supposed to be stimulated as a result of debt buybacks because investment returns will no longer accrue to international lenders (Acharya and Diwan, 1993; Krugman, 1988). The reduced debt due to buybacks is also supposed to reduce governments' incentives to accumulate more debt in order to dilute the large existing debt especially when current creditors are granted seniority over future potential creditors (Detragiache, 1994). Stimulating domestic investment and growth and decreasing government borrowing can accordingly enhance the governments' ability to repay their remaining debt (Krugman et al., 1991). Besides, buybacks can help lower bargaining costs that are assumed to increase as the level of outstanding debt increases during debt renegotiations (Rotemberg, 1991).

There are nevertheless significant opportunity costs for self-financed cash buybacks by a liquidity-constrained government during debt crisis due to sacrificing scarce resources (Bulow and Rogoff, 1991; Fernandez-Ruiz, 2000). Another problem of buybacks is the refutation of the discounted price advantage because the discount is only included in the pre-buyback secondary market price, while the post-deal market price increases as a result of lower debt, lower default risk and higher probability of debt repayment by the borrowing country (Bulow and Rogoff, 1991; Krugman et al., 1991). Buybacks cannot continue afterwards at the discounted price due to the free-riding behaviour where some lenders prefer not to sell debt in order to benefit from the higher post-buyback market price (Bulow and Rogoff, 1991; Diwan and Spiegel, 1994). Therefore, based on this argument, creditors, rather than debtors, are the actual beneficiaries of buybacks through price changes. Aguiar et al. (2019) similarly oppose buybacks due to price reactions while taking the debt maturity structure into account. They argue that although shorter maturities are preferred under default risk because of their incentive

benefits mentioned in section three, repurchasing long-term bonds in exchange for short-term debt will be costly to the government due to increasing the relative price of long-term bonds.

Unlike the market-based self-financed buyback discussed above, buybacks at a concessional price, which is sufficiently below market price (debt relief) are theoretically recommended because in this case debtor countries can effectively gain from buybacks (Bulow and Rogoff, 1991; Detragiache, 1994). Market-based buybacks of a first part of debt can nonetheless be advantageous for the borrowing government when these buybacks play a signalling role that encourage creditors to provide debt relief for a second part of debt (Acharya and Diwan, 1993; Fernandez-Ruiz, 2000). Under the assumption of creditors' imperfect information about debtors' willingness to invest and undertake economic reforms that help increase their ability to repay the remaining part of their debt, self-financed cash buybacks can signal this willingness and hence eligibility for debt relief (Fernandez-Ruiz, 2000; Marchesi, 2006).

Buybacks may also be financed by donor countries or organizations in the form of grants in order to help crisis countries reduce the outstanding debt without sacrificing their scarce resources for creditors' benefits (Rotemberg, 1991). Furthermore, debtor countries can benefit from leveraged buybacks (which means that countries borrow the required resources to repurchase part of their debt owed to private lenders from an international organization) under the condition that the new official lender has stronger enforcement powers (i.e. seniority) over private creditors (Baglioni, 2015). Although the new lending occurs at non-concessional rate, the debtor country will benefit because while the level of outstanding debt and default risk are reduced through leveraged buybacks, the price of debt will not increase in the secondary market thanks to the official creditor's seniority condition. The seniority condition implies lower expected debt repayment to private creditors during restructuring, and therefore the discounted price advantage of buybacks in the secondary market is maintained even with lower outstanding debt (Baglioni, 2015).

Our last example of sovereign debt restructuring choices concerns debt swaps which refers to the repurchase of existing debt in exchange of new debt instruments instead of cash (Krugman et al., 1991; Rotemberg, 1991). The theoretical literature on the sovereign choice of the composition of new debt instruments is relatively scarce except for very few contributions such as Mihalache (2020). Mihalache (2020) analyses a theoretical sovereign debt game that explains the observed larger share of long-term bonds during the bond swaps after debt renegotiations compared to the relatively larger share of short-term securities during debt crisis in line with the endogenous default literature in section two. His model depends mainly on the realistic assumption of post-renegotiation sovereign delays in regaining access to international capital markets (i.e. continued market exclusion even after bond swaps). Based on this assumption, short-term debt would force the sovereign to make relatively large debt repayments at time when it cannot borrow abroad, while the long-term debt is much better from a tax-smoothing perspective due to smaller due payments. Therefore, according to Mihalache (2020), lengthening maturity during restructuring acts as a hedge against the risk of delay in re-entering international capital markets. Furthermore, the long-term bondholders will also be safe from the risk of debt dilution due to the sovereign's inability to accumulate new debt under this assumption.

5 Conclusion

The purpose of this paper is to survey the growing theoretical literature on the optimal public debt composition during debt crisis. Unlike the public debt academic literature that assumes full commitment to debt repayment and refers to the optimal public debt composition as the one exploiting the fluctuations in inflation or real interest rates in smoothing taxes and avoiding welfare losses, the literature of debt crisis builds on the lack of commitment to debt repayment

assumption motivated by the recurrent incidents of debt default. Our survey focuses on the benevolent sovereign's choices of the optimal debt maturity, currency composition, and types of creditors when there is a high risk of default on public debt (pre-default phase of debt crisis). Besides, it surveys how these choices would theoretically differ when there is an ex-ante available option of debt restructuring in case of default, and it additionally reviews the sovereign's choice of the best debt restructuring strategy (post-default phase of debt crisis). The surveyed theoretical literature reveals several trade-offs underlying the sovereign's debt composition choices related to the pre- and post-default phases of debt crisis (Table 3).

For example, while long-term debt provides more insurance against welfare losses due to distortionary taxation (through bond price sensitivity or larger haircuts) and reduces vulnerability to crisis, it can increase the borrowing costs demanded by creditors because it reduces the sovereign's incentive to repay and maximises debt dilution risk both before and after default. Likewise, domestic currency debt is better than foreign currency debt from an insurance perspective because the former enables the sovereign to use real exchange rate and surprise inflation movements during debt crisis, but it is worse in terms of cost minimisation. The borrowing sovereign additionally confronts several trade-offs in choosing among various types of lenders. For instance, the crisis country should compare between the more flexible private lending and cheaper official lending (including the IMF lending which additionally plays a catalytic role) during debt crisis. The lower costs of official lending come at the expense of lower insurance in case of default due to stronger enforcement powers, in addition to the conditionality costs and the possible crowding out of private investors associated with the IMF lending.

Moreover, the defaulting governments have to balance the advantages and disadvantages of alternative debt restructuring strategies. Then they can decide whether to pre-emptively

Table 3 Summary of trade-offs in choosing optimal public debt composition

Public debt composition choice	Trade-offs	
Maturity	Long-term debt - Provides more insurance to the crisis country pre- and post-default due to bond price sensitivity, larger haircuts during restructuring, and avoiding large repayments in case of post-renegotiation delay in market access - However, it is associated with higher risk premia (costs) due to pre- and post-default debt dilution risk	Short-term debt - Increases the incentives to repay and reduces the borrowing costs due to lower risk premia demanded by lenders given both the risk of debt default and restructuring - However, it increases vulnerability to roll-over and interest rate risks
Currency	Domestic currency debt - Provides more insurance to the crisis country pre-default through movements in inflation and real exchange rates, and post-default by being easier to restructure - However, it is associated with higher risk premia	Foreign currency debt - Reduces the borrowing costs (risk premia) due to avoiding inflationary costs and real exchange rate distortions, and being harder to restructure - However, it increases vulnerability to exchange rate risk and debt crisis
Creditors' residence	Domestic creditors - Provide more insurance to the crisis country due to the ability to tax domestic debtholders, and the higher flexibility of selective default option without incurring full default costs. - However, borrowing from domestic creditors may crowd out domestic private investment and reduce welfare, and selectively restructuring their debt imposes additional burden on domestic economy	Foreign creditors - Borrowing from foreign creditors can play a signalling role in attracting foreign investment, and helps avoid the crowding-out effect - However, it is riskier due to higher default costs including loss of access to international capital markets
Banks versus bondholders	Bank loans - Bank loans protect crisis country from speculative attacks and effects of poor credit ratings on borrowing costs. Besides, they provide more easiness in debt restructuring agreements - However, the non-tradability of bank loans may lead to increasing borrowing costs due to higher monitoring costs by lenders pre-and post-default	Marketable securities - Issuing marketable securities may reduce borrowing costs due to the availability of credit rating agencies as public monitors, and due to lower risk of selective restructuring - However, the tradability of securities expose the crisis country to speculative attacks and to large increases in bond spreads due to poor credit ratings
Private versus official creditors	Private creditors - Borrowing from private creditors offers more insurance to the crisis country due to their relatively weak enforcement power - However, this comes at the expense of higher borrowing costs in the pre-default phase. Besides, it involves	Official creditors - Borrowing from official creditors reduce borrowing costs in the pre-default phase due to lower selective default probabilities - However, it involves lower flexibility for the crisis country in the pre-default phase due to

	higher reputational costs during restructuring due to more visibility	higher default costs, and in the post-default phase due to Paris Club involvement
--	---	---

restructure its debt obligations or wait until default, to adopt hard or soft restructuring procedures with creditors, and whether to pay cash to buyback part of their liabilities during restructuring or exchange them with new debt instruments. It is worth noting that the government facing debt default can also adopt a menu approach to debt restructuring. This approach combines more than one strategy in order to partially deal with the creditor coordination problem and to match the probably different creditors' preferences (e.g. prefer receiving cash or exchange the debt with new one) based on their expectations about the future performance of the crisis country (Diwan and Spiegel, 1994).

The theoretical trade-offs explained in our survey can act as a guide on the pros and cons of different public debt composition choices, however, the optimality of choices is also affected by several factors which play a special role in taking certain decisions, such as the monetary and fiscal policy credibility and the level of international reserves in the choice of debt maturity and currency denomination, and the sovereign reputation and the urgency of financing needs in deciding to have recourse to the IMF lending. Furthermore, debt management offices are influenced by the prevailing macroeconomic situation in the crisis countries and their tolerance to risks and to higher debt servicing costs and larger budget deficits. Returning back to the coronavirus pandemic example mentioned at the beginning of the introduction section, while it is usually argued in the theoretical literature that international lenders benefit from buybacks at the expense of crisis governments (e.g. Aguiar et al., 2019; Bulow and Rogoff, 1991), this should be tolerated, according to Arellano et al. (2021), when weighed against the crisis governments' gains from buybacks in terms of lower output losses and more lives saved.

Some gaps in the public debt composition theoretical literature remain, suggesting possible areas for future research. For example, the literature on the optimal choice between nominal and inflation-linked sovereign debt under the risk of outright debt default and restructuring is scarce. In addition, while there are studies on the optimal currency composition of public debt under the risk of default, there are no available studies on how the risk of debt restructuring would theoretically affect the optimal currency choice. The public debt theoretical literature is additionally almost silent concerning the buybacks of domestic public debt and the optimal composition of debt swaps during restructuring except for very few studies. Finally, empirical analyses of countries' case studies are crucial to examine the extent to which the theoretical trade-offs are reflected in real public debt portfolio composition in risky emerging or developing economies.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Notes

1. The two terms public debt and sovereign debt are used interchangeably throughout the paper.
2. For example, Pescatori and Sy (2007) consider that a spread of 1000 basis points (10 percentage point) is the critical threshold.

3. We will not include in our survey the indexation to price levels (nominal versus indexed securities or fixed-rate versus floating-rate securities) due to the scarcity of theoretical contributions on this topic in a debt crisis context over the last two decades.
4. Despite the theoretical advantages of state-contingent debt instruments, they have been rarely issued by governments due to some practical constraints (Blanchard, Mauro and Acalin, 2016). Taking the GDP-indexed bonds as an example, linking the returns paid by governments to their realized GDP levels can lead governments to manipulate or misreport GDP data. This can also lead to moral hazard problems in terms of lower incentives to grow rapidly. Moreover, the novelty of such instruments leads to complexity in pricing and very high premia demanded by investors, which discourage governments from issuing these instruments (Blanchard et al., 2016; Borensztein, Mauro, Ottaviani and Claessens, 2004).
5. This assumption is relaxed in section three on debt restructuring to allow for varying default costs according to the severity of default.
6. During bad states, the insurance benefit of domestic currency debt through exchange rate depreciation comes at the expense of more foreign currency needed to pay for other sovereign's obligations such as imports. These needs can be partially covered by international reserves. This can explain the puzzling finding by Aizenman and Hutchison (2012) that countries prefer to devalue its exchange rate rather than to use its international reserves in times of crisis despite the remarkable buildup of reserves prior to crisis.

References

- Acharya, S. and Diwan, I. (1993) Debt Buybacks Signal Sovereign Countries' Creditworthiness: Theory and Tests. *International Economic Review* 34: 795-817.
- Afonso, A. and Jalles, J.T. (2017) Sovereign debt composition and time-varying public finance sustainability. *North American Journal of Economics and Finance* 42: 144-55.
- Aguiar, M., Amador, M., Hopenhayn, H. and Werning, I. (2019) Take the short route: Equilibrium default and debt maturity. *Econometrica* 87: 423-62.
- Aizenman, J. and Hutchison, M.M. (2012) Exchange market pressure and absorption by international reserves: Emerging markets and fear of reserve loss during the 2008-2009 crisis. *Journal of International Money and Finance* 31: 1076-91.
- Alesina, A., Prati, A. and Tabellini, G. (1990) Public Confidence and Debt Management: A Model and a Case Study of Italy. In R. Dornbusch and M. Draghi (eds.) *Public Debt Management: Theory and History* (pp. 94-118). Cambridge: Cambridge University Press.
- Alfaro, L. and Kanczuk, F. (2019) Debt redemption and reserve accumulation. *IMF Economic Review* 67: 261-87.
- Angeletos, G.M. (2002) Fiscal policy with noncontingent debt and the optimal maturity structure. *The Quarterly Journal of Economics* 117: 1105-31.
- Arellano, C., Bai, Y. and Mihalache, G. (2021) Deadly debt crises: COVID-19 in emerging markets. National Bureau of Economic Research. Working paper 27275, April.
- Arellano, C., Mateos-Planas, X. and Ríos-Rull, J. (2019) Partial default. National Bureau of Economic Research. Working paper 26076, July.
- Arellano, C. and Ramanarayan, A. (2012) Default and the Maturity Structure in Sovereign Bonds. *Journal of Political Economy* 120: 187-232.
- Asonuma, T. and Ranciere, R. (2015) Sovereign debt restructurings and the short-term debt curse. International Monetary Fund. Manuscript, June.
- Asonuma, T. and Trebesch, C. (2016) Sovereign debt restructurings: preemptive or post-default. *Journal of the European Economic Association* 14: 175-214.
- Baglioni, A. (2015) Leveraged buybacks of sovereign debt: A model and an application to Greece. *Contemporary Economic Policy* 33: 87-103.
- Bai, Y., and Zhang, J. (2012) Duration of sovereign debt renegotiation. *Journal of International Economics* 86: 252-68.
- Barro, R.J. (1979) On the determination of the public debt. *Journal of Political Economy* 87: 940-71.
- Barro, R.J. (1999) Notes on optimal debt management. *Journal of Applied Economics* 2: 281-9.
- Battistini, N., Pagano, M., Simonelli, S., Ilzetzki, E. and Zettelmeyer, J. (2014) Systemic risk, sovereign yields and bank exposures in the euro crisis. *Economic Policy* 29: 203, 205-51.
- Bhandari, A., Evans, D., Golosov, M. and Sargent, T.J. (2017) Fiscal policy and debt management with incomplete markets. *The Quarterly Journal of Economics* 132: 617-63.
- Bi, R. (2006) Debt Dilution and the Maturity Structure of Sovereign Bonds. Unpublished.
- Bi, R., Chamon, M. and Zettelmeyer, J. (2016) The problem that wasn't: Coordination failures in sovereign debt restructurings. *IMF Economic Review* 64: 471-501.
- Bianchi, J., Hatchondo, J.C. and Martinez, L. (2018) International reserves and rollover risk. *American Economic Review* 108: 2629-70.
- Bird, G. (2007) The IMF: A bird's eye view of its role and operations. *Journal of Economic Surveys* 21: 683-745.
- Bird, G. and Rowlands, D. (2010) The episodic and unpredictable nature of IMF lending: An empirical analysis. *The World Economy* 33: 1280-1301.
- Blanchard, O., Mauro, p. and Acalin, J. (2016) The case for growth indexed bonds in advanced economies today. Peterson Institute for International Economics, Policy Brief no. 16-2.
- Bohn, H. (1988) Why do we have nominal government debt?. *Journal of Monetary Economics* 21: 127-40.

- (1990) A positive theory of foreign currency debt. *Journal of International Economics* 29: 273-92.
- Bolton, P. and Jeanne, O. (2007) Structuring and Restructuring Sovereign Debt: The Role of a Bankruptcy Regime. *Journal of Political Economy* 115: 901-24.
- (2009) Structuring and restructuring sovereign debt: The role of seniority. *The Review of Economic Studies* 76: 879-902.
- Bordo, M.D., Meissner, C.M. and Stuckler, D. (2010) Foreign currency debt, financial crises and economic growth: A long-run view. *Journal of International Money and Finance* 29: 642-65.
- Borensztein, E., Chamon, M., Jeanne, O., Mauro, P. and Zettelmeyer, J. (2005) Sovereign Debt Structure for Crisis Prevention. International Monetary Fund. Occasional Paper 237.
- Borensztein, E., Mauro, P., Ottaviani, M. and Claessens, S. (2004) The case for GDP-indexed bonds. *Economic Policy* 19: 165-216.
- Boz, E. (2011) Sovereign default, private sector creditors, and the IFIs. *Journal of International Economics* 83: 70-82.
- Berndt, A., Lustig, H. and Yeltekin, S. (2012) How Does The US Government Finance Fiscal Shocks?. *American Economic Journal: Macroeconomics* 4: 69-104.
- Broner, F., Erce, A., Martin, A. and Ventura, J. (2014) Sovereign debt markets in turbulent times: Creditor discrimination and crowding-out effects. *Journal of Monetary Economics* 61: 114-42.
- Broner, F.A., Lorenzoni, G. and Schmukler, S.L. (2013) Why do emerging economies borrow short term?. *Journal of the European Economic Association* 11: 67-100.
- Buera, F. and Nicolini, J.P. (2004) Optimal maturity of government debt without state contingent bonds. *Journal of Monetary Economics* 51: 531-54.
- Bulow, J. and Rogoff, K. (1991) Sovereign debt repurchases: No cure for overhang. *The Quarterly Journal of Economics* 106: 1219-35.
- Cabral, C.C. (1996) Evaluating debt repurchases: What are the alternatives to investment?. *Journal of International Economics* 40: 477-94.
- Chamon, M., Schumacher, J. and Trebesch, C. (2018) Foreign-law bonds: Can they reduce sovereign borrowing costs?. *Journal of International Economics* 114: 164-79.
- Chari, V.V., Christiano, L.J. and Kehoe, P.J. (1991) Optimal fiscal and monetary policy: Some recent results. *Journal of Money, Credit and Banking* 23: 519-39.
- Chatterjee, S. and Eyigungor, B. (2012) Maturity, indebtedness and default risk. *American Economic Review* 102: 2674-99.
- Claessens, S., Klingebiel, D. and Schmukler, S.L. (2007) Government bonds in domestic and foreign currency: the role of institutional and macroeconomic factors. *Review of International Economics* 15: 370-413.
- Cochrane, J.H. (2001) Long-term debt and optimal policy in the fiscal theory of the price level. *Econometrica* 69: 69-116.
- Cole, H.L. and Kehoe, T.J. (2000) Self-Fulfilling Debt Crises. *The Review of Economic Studies* 67: 91-116.
- Consiglio, A. and Zenios, S. (2015) Risk profiles for re-profiling the sovereign debt of crisis countries. *Journal of Risk Finance* 16: 2-26.
- Conway, P. (2006) The International Monetary Fund in a time of crisis: A review of Stanley Fischer's IMF essays from a time of crisis: The international financial system, stabilization, and development. *Journal of Economic Literature* 44: 115-44.
- Cormier, B. (2020) Interests over institutions: Political-economic constraints on public debt management in developing countries. *Governance* 2020: 1-25.
- Corsetti, G., Guimarães, B. and Roubini, N. (2006) International lending of last resort and moral hazard: A model of IMF's catalytic finance. *Journal of Monetary Economics* 53: 441-71.
- Çufadar, A. and Özatay, F. (2017) Sovereign risk, public debt, dollarization, and the output effects of fiscal austerity. *Journal of International Money and Finance* 72: 75-92.
- Da-Rocha, J., Giménez, E. and Lores, F. (2013) Self-fulfilling crises with default and devaluation. *Economic Theory* 53: 499-535.

Debortoli, D., Nunes, R. and Yared, P. (2017) Optimal time-consistent government debt maturity. *The Quarterly Journal of Economics* 132: 55-102.

----- (2021) Optimal fiscal policy without commitment: Revisiting Lucas-Stokey. *Journal of Political Economy* 129: 1640-65.

Dell'Erba, S., Hausmann, R. and Panizza, U. (2013) Debt levels, debt composition, and sovereign spreads in emerging and advanced economies. *Oxford Review of Economic Policy* 29: 518-47.

Della Posta, P. (2019) Interest rate targets and speculative attacks on public debt. *Macroeconomic Dynamics* 23: 2698-2716.

Dellas, H. and Niepelt, D. (2016) Sovereign debt with heterogenous creditors. *Journal of International Economics* 99: 16-26.

Detragiache, E. (1994) Sensible buybacks of sovereign debt. *Journal of Development Economics* 43: 317-33.

Diwan, I. and Spiegel, M.M. (1994) Are buybacks back? Menu-driven debt reduction schemes with heterogeneous creditors. *Journal of Monetary Economics* 34: 279-93.

Dooley, M.P. (2000) Debt management and crisis in developing countries. *Journal of Development Economics* 63: 45-58.

Dovis, A. (2019) Efficient Sovereign Default. *Review of Economic Studies* 86: 282-312.

Dreher, A. (2006) IMF and economic growth: The effects of programs, loans, and compliance with conditionality. *World Development* 34: 769-88.

----- (2009) IMF conditionality: theory and evidence. *Public Choice* 141: 233-67.

Dreher, A. and Vaubel, R. (2004) Do IMF and IBRD cause moral hazard and political business cycles? Evidence from panel data. *Open Economies Review* 15: 5-22.

Drudi, F. and Giordano, R. (2000) Default risk and optimal debt management. *Journal of Banking and Finance* 24: 861-91.

Dvorkin, M., Sanchez, J.M., Sapriz, H. and Yurdagul, E. (2018) Sovereign debt restructurings: A dynamic discrete choice approach. Federal Reserve Bank of St. Louis. Working Paper 2018-13, May.

----- (2020) News, sovereign debt maturity, and default risk. *Journal of International Economics* 126: 103352.

Eaton, J. (1993) Sovereign debt: A primer. *The World Bank Economic Review* 7: 137-72.

Eaton, J. and Gersovitz, M. (1981) Debt with Potential Repudiation: Theoretical and Empirical Analysis. *Review of Economic Studies* 48: 289-309.

Equiza-Goni, J., Faraglia, E. and Oikonomou, R. (2018) Union debt management. Cambridge Working Papers in Economics 1890, July.

Erce, A. (2013) Sovereign Debt Restructurings and the IMF: Implications for Future Official Interventions. Federal Reserve Bank of Dallas. Globalization Institute Working Paper 143, June.

Falchetti, E. and Missale, A. (2002) Public debt indexation and denomination with an independent central bank. *European Economic Review* 46: 1825-50.

Faraglia, E., Marcet, A., Oikonomou, R. and Scott, A. (2013) The impact of debt levels and debt maturity on inflation. *The Economic Journal* 123: F164-92.

----- (2016) Long term government bonds. London Business School mimeo.

----- (2019) Government debt management: The long and the short of it. *Review of Economic Studies* 86: 2554-604.

Faraglia, E., Marcet, A. and Scott, A. (2008) Fiscal insurance debt management in OECD economies. *The Economic Journal* 118: 363-86.

----- (2010) In search of a theory of debt management. *Journal of Monetary Economics* 57: 821-36.

Fernandez-Ruiz, J. (2000) Debt buybacks, debt reduction, and debt rescheduling under asymmetric information. *Journal of Money, Credit and Banking* 32: 13-27.

Froot, K.A. (1989) Buybacks, exit bonds, and the optimality of debt and liquidity Relief. *International Economic Review* 30: 49-70.

Gennaioli, N., Martin, A. and Rossi, S. (2014) Sovereign default, domestic banks, and financial institutions. *The Journal of Finance* 69: 819-66.

- Goldfajn, I. (2000) Public debt indexation and denomination: The case of Brazil. *International Journal of Finance & Economics* 5: 43-56.
- Gros, D. (2013) Foreign debt versus domestic debt in the euro area. *Oxford Review of Economic Policy* 29: 502-17.
- Gumus, I. (2013) Debt denomination and default risk in emerging markets. *Macroeconomic Dynamics* 17: 1070-95.
- Hale, G. (2007) Bonds or loans? The effect of macroeconomic fundamentals. *The Economic Journal* 117: 196-215.
- Hatchondo, J.C., Martinez, L. and Sosa-Padilla, C. (2016) Debt dilution and sovereign default risk. *Journal of Political Economy* 124: 1383-1422.
- IMF and World Bank (2003) *Guidelines for public debt management*. IMF and World Bank, Washington. Amended on December 9, 2003.
- Jarmuzek, M. and Vesperoni, E.R. (2018) The role of debt profile vulnerabilities in sovereign distress. *Applied Economics Letters* 25: 928-35.
- Jeanne, O. (2000) Foreign currency debt and the global financial architecture. *European Economic Review* 44: 719-27.
- (2005) Why do emerging market economies borrow in foreign currency?. In B. Eichengreen and R. Hausmann (eds.) *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies*. Chicago: University of Chicago Press.
- Jeanne, O.D. and Zettelmeyer, J. (2005) The Mussa Theorem (and Other Results on IMF-Induced Moral Hazard). *IMF Staff Papers* 52: 64-84.
- Jorra, M. (2012) The effect of IMF lending on the probability of sovereign debt crises. *Journal of International Money and Finance* 31: 709-25.
- Korinek, A. (2011) Foreign currency debt, risk premia and macroeconomic volatility. *European Economic Review* 55: 371-85.
- Krugman, P. (1988) Financing vs. forgiving a debt overhang. *Journal of Development Economics* 29: 253-68
- Krugman, P., Froot, K., Claessens, S. and Diwan, I. (1991) Market-based debt reduction: Principles and prospects. World Bank Policy Research Paper 16.
- Leeper, E.M. and Leith, C. (2016) Understanding inflation as a joint monetary-fiscal phenomenon. In J.B. Taylor and H. Uhlig (eds.) *Handbook of Macroeconomics* (pp. 2305-415). Amsterdam: Elsevier Science.
- Leeper, E.M., Leith, C. and Liu, D. (2021) Optimal time-consistent monetary, fiscal and debt maturity policy. *Journal of Monetary Economics* 117: 600-17.
- Lucas, R. E. and Stokey, N. L. (1983) Optimal fiscal and monetary policy in an economy without capital. *Journal of Monetary Economics* 12: 55-94.
- Lustig, H., Sleet, C. and Yeltekin, S. (2008) Fiscal Hedging with Nominal Assets. *Journal of Monetary Economics* 55: 710-27.
- Manasse, P. and Roubini, N. (2009) 'Rules of thumb' for sovereign debt crises. *Journal of International Economics* 78: 192-205.
- Mandilaras, A. and Levine, P. (2002) Public debt and inflation: the role of inflation-sensitive instruments. *The Manchester School* 69: 1-21.
- Marcet, A. and Scott, A. (2009) Debt and deficit fluctuations and the structure of bond markets. *Journal of Economic Theory* 144: 473-501.
- Marchesi, S. (2003) Adoption of an IMF programme and debt rescheduling: An empirical analysis. *Journal of Development Economics* 70: 403-23.
- (2006) Buybacks of domestic debt in public debt management. *European Journal of Finance* 12: 379-400.
- Marchesi, S. and Masi, T. (2020) Sovereign rating after private and official restructuring. *Economics Letters* 192: 109178.

- Marchesi, S. and Thomas, J.P. (1999) IMF conditionality as a screening device. *The Economic Journal* 109: C111-25.
- Mihalache, G. (2020) Sovereign default resolution through maturity extension. *Journal of International Economics* 125: 103326.
- Miller, V. (1997) Why a government might want to consider foreign currency denominated debt. *Economic Letters* 55: 247-50.
- Missale, A. (1997) Managing the Public Debt: The Optimal Taxation Approach. *Journal of Economic Surveys* 11: 235-65.
- (1999) *Public Debt Management*. Oxford : Oxford University Press.
- (2012) Sovereign debt management and fiscal vulnerabilities. BIS Papers chapters, in Bank for International Settlements (ed.) *Threat of fiscal dominance?* (pp. 157-176). Bank for International Settlements.
- Missale, A. and Blanchard, O.J. (1994) The debt burden and debt maturity. *American Economic Review* 84: 309-19.
- Montiel, P.J. (2005) Public debt management and macroeconomic stability: An overview. *World Bank Research Observer* 20: 259-81.
- Morris, S. and Shin, H.S. (2006) Catalytic finance: When does it work?. *Journal of International Economics* 70: 161-77.
- Niemann, S., Pichler, P. and Sorger, G. (2013) Public debt, discretionary policy, and inflation persistence. *Journal of Economic Dynamics & Control* 37: 1097-109.
- Nosbusch, Y. (2008) Interest Costs and the Optimal Maturity Structure of Government Debt. *The Economic Journal* 118: 477-98.
- Ogrokhina, O. and Rodriguez, C.M. (2018) The role of inflation targeting in international debt denomination in developing countries. *Journal of International Economics* 114: 116-29.
- Oldekop, J.A., Horner, R., Hulme, D., Adhikari, R., Agarwal, B., Alford, M., ... Zhang, Y. (2020) COVID-19 and the case for global development. *World Development* 134: 105044.
- Ottonello, P. and Perez, D.J. (2019) The currency composition of sovereign debt. *American Economic Journal: Macroeconomics* 11: 174-208.
- Perez, D.J. (2017) Sovereign debt maturity structure under asymmetric information. *Journal of International Economics* 108: 243-59.
- Pescatori, A. and Sy, A.N.R. (2007) Are debt crises adequately defined?. *IMF Staff Papers* 54: 306-37.
- Phan, T. (2017) Sovereign debt signals. *Journal of International Economics* 104: 157-65.
- Reinhart, C.M. and Rogoff, K.S. (2011) From financial crash to debt crisis. *The American Economic Review* 101: 1676-1706.
- Rotemberg, J.J. (1991) Sovereign debt buybacks can lower bargaining costs. *Journal of International Money and Finance* 10: 330-48.
- Sanchez, J.M., Sapriza, H. and Yurdagul, E. (2018) Sovereign default and maturity choice. *Journal of Monetary Economics* 95: 72-85.
- Schmitt-Grohe, S. and Uribe, M. (2004) Optimal fiscal and monetary policy under sticky prices. *Journal of Economic Theory* 114: 198-230.
- Sims, C.A. (2013) Paper money. *American Economic Review* 103: 563-84.
- Sinha, A. (2015) Government debt, learning and the term structure. *Journal of Economics Dynamics & Control* 53: 268-89.
- Siu, H. E. (2004) Optimal Fiscal and Monetary policy with Sticky Prices. *Journal of Monetary Economics* 51: 575-607.
- Sunder-Plassmann, L. (2020) Inflation, default and sovereign debt: The role of denomination and ownership. *Journal of International Economics* 127: 103393.
- Tanaka, M. (2006) Bank loans versus bond finance: Implications for sovereign debtors. *The Economic Journal* 116: C149-71.
- Trebesch, C. and Zabel, M. (2017) The output costs of hard and soft sovereign default. *European Economic Review* 92: 416-32.

- Vasishtha, G. (2010) Domestic versus External Borrowing and Fiscal Policy in Emerging Markets. *Review of International Economics* 18: 1058-74.
- Vaubel, R. (1983) The moral hazard of IMF lending. *The World Economy* 6: 291-304.
- Werner, R.A. (2014) Enhanced debt management: Solving the eurozone crisis by linking debt management with fiscal and monetary policy. *Journal of International Money and Finance* 49: 443-69.
- Williams, M. (2013) Debt and Cash Management. In R. Allen, R. Hemming and B.H. Potter(eds.) *The International Handbook of Public Financial Management*. London: Palgrave Macmillan.