Sovereign Debt Without Default Penalties*

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Abstract

We develop a theory of sovereign borrowing where default penalties are not implementable. We show that when debt is held by both domestic and foreign agents, the median voter might have an interest in serving it. Our theory has important practical implications regarding a) the role of financial intermediaries in sovereign lending; b) the effect of capital flows on price volatility including the possible over-valuation of debt to the point that the median voter is priced out of the market; and c) debt restructuring where creditors are highly dispersed.

Kewods: Sovereign debt, order flow, median voter

JEL Classifications: D72, F32, G15, H63

1. Introduction

It is widely recognized that sovereign debt differs from corporate debt in that the debtor cannot grant the creditor enforceable property rights over fixed assets or cash flows.[1] Instead, the literature tends to assume that sovereign debt is enforced under the threat of penalties such as reduced access to capital markets or trade sanctions; see Eaton and Gersovitz (1981) or Bulow and Rogoff (1989a, b) for classic references. As a result, the formal structure of sovereign-debt theories is very different than that of corporate-debt theories. Surprisingly, however, the practical and policy implications are actually quite similar. One example is Krueger's (2002) proposed Sovereign-Debt Restructuring Mechanism that emulates Chapter 11 of the US Bankruptcy Code. This is because the issues raised by some corporate-debt theories are, upon closer inspection, actually similar to those raised in the sovereign-debt literature. For example, Hart and Moore (1998) argue that cash is *not verifiable* so that only fixed assets can be secured. Given that liquidation values are typically quite low, the main role of foreclosure is to deter strategic default by inflicting a default penalty in the form of (inefficient) liquidation in response to a temporary cash shortage. Hence, in existing

[1] For an exceptional case where a creditor managed to enforce repayment upon a sovereign by threat of liquidation see "Elliot Associates vs. the Republic of Peru", discussed at length in IMF (2001). See also Zettelmeyer (2003), who estimates that, for a large pool of developing and emerging market countries, only 6.2% of outstanding debt is collateralised.

theories both sovereign and corporate debt repayments are made incentive compatible by the imposition of a default penalty.

In this paper we consider an alternative case where no penalty for sovereign default is implementable, so that sovereign debt must be supported by an entirely different incentive scheme. The main idea is that sovereign debt is held by both locals and foreigners, which might give the median voter an interest in serving it. Hence, the median voter has to net out the cost of debt service (paying higher taxes) against its benefit (maintaining the value of his claims). Debt service is an equilibrium outcome when the interests of the median (or pivotal) voter are more closely aligned with foreign debt holders than with local taxpayers. The main point is that repaying sovereign debt is a political issue and should be analyzed as such. As noted by Bulow (2002), when Argentina defaulted, it could have fully paid its debt and still enjoy a higher standard of living relative to many of its neighbors but a "stream of payments of that magnitude is a sure recipe for political crisis and default".

This special incentive structure has far-reaching practical implications. For example, we show that financial intermediaries who tend to strengthen the incentive to repay *corporate* debt can weaken that incentive in the case of *sovereign* debt. This is because bank debt is non-tradable, so that the bank cannot sell out its position before 'polling day'. We analyze the effect of the *order flow* on the pricing of sovereign debt. Since in our setting the order flow is the same as capital inflows, we point out the a combination of a weak local demand and a strong inflow of capital may price the median voter out of the market and lead to default. Another implication is that price volatility may sharply increase (and market liquidity drop) in response to a low *level* of capital flows, which we interpret as a *sudden-stop* phenomenon *à la* Calvo (1998). We also argue that unlike corporate debt, dispersed sovereign debt may be quite easy to restructure, which is consistent with recent experience. We argue that such a restructuring may actually be a unilateral write down, only that the borrower has no reason to carry it down to zero but only to the point that suits the interests of the median voter. Hardly any negotiations between debtor and creditor are required, and as a result, the coordination problems that plague similar corporate-debt restructuring do not arise.

Our work is partially motivated by a growing unease regarding default penalties for sovereign borrowers.[2] While it is widely agreed that sovereign default tends to disrupt the debtor's economic activity, there is a widespread feeling that the penalties are hard to coordinate and that their magnitude is insufficient to support the level of activity that is

[2] For a recent expression of this, see Sandleris (2005) who also proposes a model of sovereign debt payment without default penalties. In his paper the government has private information about the fundamentals of the economy and can use its repayment behavior as a signal of such information. The mechanism is thus very different from the one put forward in our paper.

observed in the market. For example, Eichengreen (1988) finds no evidence for a negative relationship between pre-WWII default and post-war lending.[3] Bulow and Rogoff (1989a) comment that, "admittedly, there are many uncertainties surrounding the actual damage which a lender can inflict on an LDC" following default. Hence, they dismiss reputational models – where sovereigns repay just in order to preserve the capacity for further borrowing.[4] Instead, Bulow and Rogoff (1989b) suggest that sovereign debt is enforced by penalties that creditors can enforce within their own jurisdictions, like trade sanctions. However, Tirole (2002) points out that these suffer from similar weaknesses, particularly a severe free-rider problem amongst creditors, combined with a strong incentive to renegotiate ex-post-inefficient sanctions. Note that all these problems result from the sharp separation between domestic and foreign creditors, so that all domestic interests are unanimously aligned against serving the debt. We avoid the difficulty by assuming that *some* domestic agents hold *some* "foreign" debt, which breaks the unanimity and gives the median voter a genuine interest in serving the debt.

Supporting our theory with statistics about the domestic-foreign ownership composition of sovereign is undermined by the scarcity of data.[5] Often, debt is held by custodians who will not reveal the identity of the ultimate creditor even during "renegotiations" (see Gray, 2003). Yet, there is a widespread feeling, that a "large fraction of the [foreign-currency denominated] government debt was issued domestically and purchased by domestic banks"; see Roubini (2002).[6] Perhaps more revealing is some anecdotal evidence. For example, on May 7, 1999 the Russian government announced that it would pay $333m interest on five out of seven tranches of bonds up for service. The announcement was a great surprise as "none expected to get any money in May".[7] A month later *The Economist* commented cynically that now that "a big chunk of ex-Soviet debt ... is held not by the original banks, but by hedge funds and other individuals" the repayment was actually "to the benefit of wealthy

[3] Rose (2005) finds significant long-term decrease in bilateral trade flows following sovereign default. Martinez and Sandleris (2004), however, argue that this should not be interpreted as a penalty, because trade declined across all trading partners indicating that the decline might just be the result of the same crisis that caused the default.

[4] Whether reputational concerns are sufficient to enforce repayment hinges to some extent on the question whether a country can save the funds that were scheduled for repayment. Kletzer and Wright (2000) argue that default is made sufficiently costly to prevent default if a country cannot access capital markets as a lender and therefore cannot save.

[5] One exception is IMF (2003) Figure 4.15, which reports a sharp increase in domestic positions among emerging markets, reaching 40% by 2003. The data is provided by PIMCO, a leading fixed-income firm.

[6] See also Cline (2002) who stipulates that the primary subscribers to Argentina's 'megaswap' of June 2001 were domestic pension funds.

[7] See Reuters report by Julie Tolkacheva on May 7, 14:51, 1999.

Russian individuals and institutions".[8] Needless to say, our modeling abstracts from much detail of specific political systems. The assumption that political decisions are taken by the majority can be relaxed: a minority of any size may be empowered. It is important, however, that decisions are taken by voting and that every voter is atomistic (regardless of the size of the decision-making minority) so that there is no incentive to engage in strategic behavior.

We derive four main results. First, we develop the basic setup. In a two-period economy the government offers sovereign debt for initial trading (IPO). We show that without any external penalty, service of the debt depends on the size of the debt in relation to the position of the median voter. The home bias emerges naturally as a condition for debt enforcement.

Second, through a modest extension of the setting, we show that the IPO may be reinterpreted as secondary trading. This extension allows us to make the important distinction between tradable bonds and non-tradable bank debt. We then analyze the role of financial intermediaries in sovereign lending and argue that – contrary to corporate debt – intermediaries may exacerbate agency problems. We relate this result to some historical observations that imply that the sovereign-debt crisis of the 1980s was essentially a bank-debt crisis.

Third, we relax the assumption that domestic and foreign positions are common knowledge. Like in Kyle (1985), a market maker uses order-flow information to infer the position of the median voter and price the debt. As noted above, in our setting the order flow is equivalent with the flow of capital into the economy. It follows that whether capital flows are "fundamental" or not, they are an important determinant of the equilibrium. For example, upon a weak local demand and a strong inflow of capital, the market maker may rationally infer that local demand is strong, which can support a high amount of borrowing. But this very optimistic valuation prices the median voter out of the market and pushes the whole economy towards default. Another implication is that not only capital flows affect pricing, volatility itself varies with the level of the order flow, non monotonically. Hence, at a strong level of capital inflow the market is liquid and variations in flow are absorbed with only modest price effects, while at a lower level equivalent variation causes strong price fluctuations. (At an even lower level of the order flow, the price of debt is depressed, but volatility is again low.) We interpret this result as a "sudden stop" phenomenon (see Calvo, 1998). It arises in our model from the integration of political-economy and market-microstructure modeling. To our knowledge this is the first attempt to combine aspects of both these fields in one model.

Fourth, we relax the assumption that the repayment of sovereign debt is funded by lump-sum taxes and we allow for a productivity shock. In such a setting a non-trivial partial

[8] See *The Economist*, 3 June 1999.

default may occur, which we interpret as debt restructuring. We use this result in order to resolve a puzzle in the sovereign-debt literature: how can sovereign borrowers "renegotiate" debt with a huge number of creditors, a phenomenon unheard of in corporate borrowing (see evidence below). Our explanation is simple: these renegotiations are in fact unilateral write-offs, down to the point that best suits the interests of the median voter, but no further.

The paper is organized as follows. After a short review of the literature in Section 2, Section 3 describes the basic set-up. We then proceed through three extensions of that setting. In Section 4 we analyze the role of financial intermediaries in sovereign lending. In Section 5 we analyze price volatility and the "sudden stop". In Section 6 we provide a theory of debt renegotiation. Section 7 concludes.

2. Related literature

There is a certain body of literature that deals with the political economy of inter-generational redistribution (for an overview see Persson and Tabellini, 2002).[9] In the context of domestic government debt, Tabellini (1991) points out that repayment may not be credible, if a large fraction of agents at the time of voting belongs to a young generation who does not hold bonds, but who is taxed if repayment occurs. Tabellini also shows that when the young generation cares about their parents' welfare then the children of the rich may vote in favor of repayment, which can tip the voting balance and render re-payment credible. In Dixit and Londregan (2000) repayment of domestic debt may be time inconsistent, if a political minority were to choose to hold bonds. This problem is mitigated if those agents who have an interest in holding bonds are also agents with a lot of political clout. Dixit and Londregan's model generates this correlation under a plausible set of assumptions. Aghion and Bolton (1990) argue that domestic public debt can play an important strategic role in electoral competition. This is because parties cater to constituencies who have different preferences over repayment. One party can then use public debt strategically so as to reduce the chances of its competitor being elected in the future.

In contrast to the above papers, we focus specifically on a government's ability to raise foreign debt. This allows us to derive new results regarding security design and debt restructuring in the context of sovereign debt. Moreover, the inclusion of a market microstructure mechanism to price sovereign debt is novel to our model. This enables us to derive further results from the interaction between the voting and the pricing mechanisms.

[9] In addition our paper raises another important political economy question: how does securities trading prior to an election affect the median voter's preferences and therefore the voting outcome? This question has been addressed by Musto and Yilmaz (2003) in the context of a security whose payoff is directly contingent on the identity of the winning party.

Drazen (1996) analyzes the political economy of the ex ante choice of foreign versus domestic debt. He assumes that a country can segment the market by issuing different instruments to domestic and foreign residents. Because enforcing repayment carries different (un-modelled) costs on the two tranches of debt, the ex ante choice between domestic and foreign debt is determined by domestic preferences over the rate of return on savings and government spending.

A few papers have looked at the implications of having a government that can affect the settlement of private financial claims between domestic residents and foreigners. Tirole (2003) highlights that a government's actions can affect a corporate borrowers' ability to honor foreign payment obligations, for example by changing the tradable / non-tradables mix in the economy. Corporate debt repayment is thus subject to a moral hazard problem on the part of a government once financing arrangements are in place. Broner, Martin and Ventura (2006) look at a setting in which a sovereign who maximizes the average utility of domestic residents, can directly enforce (or not) payments of financial claims of locals to foreigners. Like us, they find that the existence of a secondary market for claims improves the ability to honor claims ex post. Their result is based on a very different mechanism from ours. Broner et. al. assume that payments can be made contingent on the identity of the claimant and thus foreigners can sell their claims to locals in secondary markets, who are likely to be reimbursed. Secondary markets thus serve the purpose of transferring claims to agents who get reimbursed. Our point is that a government can (imperfectly) commit to honor its re-payment obligation by designing claims such that discriminatory repayment becomes impossible. This is because we model explicitly the reason for repayment via the voting mechanism. Under this mechanism it may happen, for example, that even purely domestic debt is not repaid, which would never be the case in Broner et. al.

Finally, Amador (2003) and Gonzalez-Eiras (2003) introduce political economy considerations into a reputational cost model of sovereign debt. Amador (2003) shows that the Bulow-Rogoff critique of the reputational cost model may lose its bite, if political competition leads to overspending. In that case, a government cannot credibly save the funds that it gains from default. Losing access to capital markets therefore inflicts a cost on the country and repayment becomes sustainable. Gonzalez-Eiras (2003) explores the reputational cost of default when the population consists of overlapping generations of agents with heterogenous interests.

3. The basic setting

In this section we describe the basic model. In a two-period economy, the government offers bonds for initial trading (IPO). The levels of local and foreign demand are both common knowledge. Ex post, voters decide whether to serve or default on the *entire* debt; lump-sum taxes are imposed later on to finance debt repayments. We present our "enforcement mechanism" in the simplest-possible manner, and discuss some of its implications. This simple formalization serves as a basis for subsequent extensions, where the policy implications are developed.

3.1 *The structure*

In period $t = 0$ the sovereign offers B units of one-period-maturity bonds, each having a face value of one unit of the numeraire. The numeraire is denominated in terms of consumption goods and is normalized – for convenience of interpretation – to one "dollar". On the demand side there are both domestic agents and foreigners. The domestic population is of measure one. Agents are indexed by $i \in [0,1]$ and are ordered according to their period-0 income endowment, $\widetilde{w}_i$. Income is distributed as follows: agents $i \in [0, \mu_l]$, $\mu_l < 1/2$, have a zero income, while agents $i \in [\mu_h, 1]$, $\mu_h > 1/2$, have $W > 0$ income (in terms of the numeraire). The remaining agents, $i \in (\mu_l, \mu_h)$, have an income endowment of $\widetilde{w}_i = \widetilde{\delta} W$, where $\widetilde{\delta}$ is the realization of a binary shock that equals $\delta \in [0,1)$ with probability γ and 1 with a probability $1 - \gamma$. Domestic agents care only about period-1 consumption. To make things simple, we assume that sovereign bonds are the only store of value so that savings are:

$$\widetilde{s}_i = \widetilde{w}_i. \tag{1}$$

The demand of the foreigners (not fully modelled) is $\widetilde{f}$ dollars, which is the realization of a random variable with a density function $h(f)$. Note that both $\widetilde{f}$ and $\widetilde{\delta}$ are already realized at the time when the bond-market opens, and the realization is common knowledge to all market participants.

Conditional on supply and demand, a risk-neutral market maker determines a fair price P for the bond, and takes on the entire slack between supply and demand. A common justification of the fair-pricing assumption is that the market maker represents a reduced form of a competitive industry (or, equivalently, an oligopolistic industry competing Bertrand); see Kyle (1985). If the market maker is a domestic agent, his weight within the voting population is still of measure zero. Without loss of generality – and more realistically – we may thus assume that the market maker is a foreigner, perhaps an investment bank.

Obviously, the market maker will become a more interesting entity in Section 5 where we relax the assumption that the realization of both $\widetilde{f}$ and $\widetilde{\delta}$ is common knowledge at the time of trading.

At the first stage of period 1, the decision whether to fully serve ($\alpha = 1$) or completely default ($\alpha = 0$) is put forward for a vote; no generality is lost by ignoring – at this stage – the possibility of partial default or debt restructuring. Each agent votes according to the personal benefit – and cost – that he draws from serving the debt. The cost is bearing a lump-sum tax, T, which is levied in order to redeem the debt; the benefit is obtaining service on the bonds that he bought previously. According to the assumptions made so far, agent-i's benefit from debt service equals the face value of his position, namely the number of bonds he purchased at period 0, $\frac{w_i}{P}$. It follows that he votes in favor of repayment if

$$\frac{w_i}{P} > T. \tag{2}$$

and against repayment if the inequality is reversed. In case of equality, we allow voters to play mixed strategies; moreover, we allow indifferent voters to correlate their voting, so that the probability of the mix is actually the probability of default. (These strong assumptions are made redundant later on.) As expected, the median voter plays a critical role in our analysis; we denote him by $m = 1/2$.[10]

At the second stage of period 1 the voters' decision is implemented and the government levies a lump sum tax, T, in order to redeem the debt; the government's budget constraint is

$$T = \alpha B. \tag{3}$$

We assume that by this time all agents are endowed with additional income, equal or above W. Hence, regardless of the realization of period-0 endowment, and subject to the constraint that taxes are lump sum, the maximum per-capita tax is $T \leq W$. In Section 6 we relax the unrealistic assumption of lump-sum taxation in favor of a relative consumption tax, which also forces us to model period-1 endowments more carefully.

We do not explicitly model the expenditure side of the government's budget, namely the good use to which the revenue from selling the bonds $K = B \cdot P$, is put. Implicitly, we assume that the funds are invested in a development project that carries a "high" social rate of return, from which all domestic agents benefit equally at period 1. Hence, ex ante, domestic agents are unanimously in favor of fully utilizing the economy's debt capacity, $\overline{K} = \max_B K$. We define by $\overline{B}$ the number of bonds at which full capacity is reached, namely $\overline{B} = \arg\max_B K$. As we shall see below, the latter may be a large set, so (with a

[10]The model can be easily adapted to incorporate other than a majority rule.

certain abuse of notation) we use $\overline{B}$ as the minimal element in this set, namely the threshold at which borrowing capacity is reached.

3.2 *Equilibrium*

Given the realization of $\widetilde{\delta}$ and thus the level of local demand, the equilibrium price P^* implies a certain allocation of the bonds across the domestic population. Given that allocation, agents vote according to (2). Their voting patterns are rationally foreseen, so that the market maker can price the bonds fairly at:

$$P^* = E[\widetilde{\alpha}|\widetilde{\delta}].$$

Hence,

Proposition 1 *There exists a mixed-strategy equilibrium where P^* is both the fair price of the bond and the probability of serving the debt, such that*

$$P^* = \begin{cases} 1 & \text{if} \quad B \leq w_m \\ \frac{w_m}{B} & \text{if} \quad B > w_m \end{cases}. \tag{4}$$

Proof. Consider the case where $B \leq w_m$. Since $\widetilde{\alpha}$ is bounded (from above) by 1, its expected value P^* cannot exceed 1. Hence, condition (2) holds, repayment occurs with certainty and $P^* = 1$.

Now consider the case where $B > w_m$. The price of the bond cannot be 1, for then condition (2) is reversed and default occurs with certainty, which contradicts a fair price of 1. Similarly, the price of the bond cannot be zero, for then the median voter is allocated an infinite number of bonds and therefore votes for repayment. It follows that the price is between zero and one, which implies that default is random and the middle-income group plays mixed strategies. For that to happen, the median voter must be indifferent between default and repayment, so condition (2) should hold with equality and $P^* = \frac{w_m}{B}$. ■

3.3 *Debt Capacity*

It follows immediately from Proposition 1 that

Corollary 1 *Conditional on the realization of $\widetilde{\delta}$, debt capacity, $\overline{K}$, is reached at $\overline{B} = w_m$ where $P^* = 1$, so that $\overline{K} = w_m$.*

For $B < \overline{B}$ and $P^* = 1$, the sovereign can increase B without affecting the price of the bond thereby increasing the amount borrowed, K, by one dollar per bond that is issued. But for $B > \overline{B}$ any increase in B is followed by a proportional decrease in the equilibrium price without any change in revenue. When $w_m = \delta W$ that means that although the sovereign has a period-1 taxing capacity of W, his borrowing capacity is lower than that because it cannot commit itself – politically – to tax the economy to its full capacity and pay the debt. Note that the relationship between debt capacity and the median-voter's income is not merely a statistical correlation: the median voter should actually hold his savings in the form of his sovereign's bonds, so that the bias towards the home market is built into our theory.[11] At the same time, in order to utilize fully its capacity the sovereign does not need to cross the $\overline{B}$ threshold, which would push the median voter towards default. In that respect, the basic model does not explain why sovereigns default in equilibrium. This analysis is relegated to Sections 5 and 6.

Borrowing capacity is not affected by the usual macroeconomic variables, e.g. per-capita income, but rather by the income of the median voter. To see this more clearly, consider an economy where $\widetilde{\delta}$ has been realized at the level of δ. Now consider the following comparative statics: increase W and decrease δ proportionately by the same factor of, say, two. The median voter's income remains unchanged, but the richer agents $i \in [\mu_h, 1]$ double their wealth. The whole economy grows by an additional $(1 - \mu_h)W$, but borrowing capacity is not affected at all.

In a sense, it is *income distribution* rather than aggregate income that determines borrowing capacity, although the effect need not be monotonic. To see this more clearly, define *external* borrowing capacity as

$$\overline{E} = \overline{B} - \int_{i=0}^{1} \frac{w_i}{P^*} di, \tag{5}$$

and consider the case where $\widetilde{\delta} = 1$ and $\mu_h = 1$, so that there are only two income classes (in period 0) – with zero-income and the W-income. When μ_l increases above 1/2 and the zero-income class becomes a majority, the median voter favors default, so that any attempt to raise debt (internal or external) is doomed to fail.[12] At the other extreme, when $\mu_l = 0$ and society becomes completely egalitarian, the government cannot raise any external debt either. Between these two extremes, external-debt capacity increases linearly (see Figure 1).

[11] Kremer and Mehta (2000) identify a related reason for home bias: since repayment and the amount of tax are negatively correlated for locals, their risk exposure from holding the domestic bond is smaller than for foreigners, who are not 'hedged' through tax savings in the case of default. Hence, home bias may also result from risk sharing. In the context of equity, Biais and Perotti (2002) investigate the political economy considerations of share allocations in privatizations.

[12] For the sake of this discussion and the diagram below we relax the assumption that $\mu_l < 1/2$.

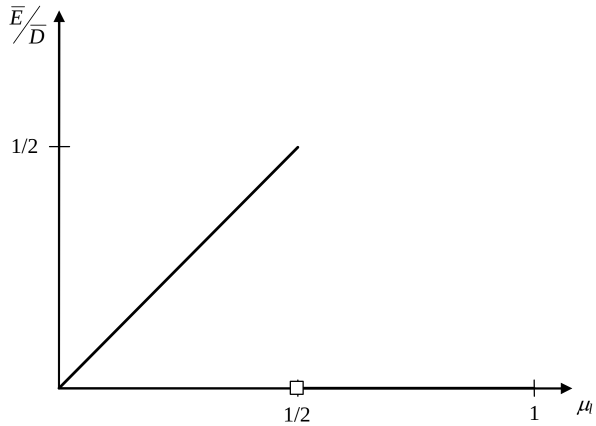

Figure 1: Shows the degree to which a country can leverage up its domestic debt capacity as a function of the fraction μ_l of domestic agents who are bondholders. Leverage is maximized when default generates a strong redistribution of wealth from domestic bondholders to domestic tax payers. This aligns the median voter's interest with that of the foreign creditors and thereby makes repayment of larger amounts of external debt credible.

This comparative statics highlights the basic mechanism of our model. On aggregate, serving the debt drains resources from the economy, which implies that at least some agents would vote for default. At the same time, debt is served when it is in the best interest of the median voter. It follows that sovereign debt can be "enforced" only through a certain conflict of interests between domestic agents. Since in our model interests diverge as a result of differences in income, some inequality is essential in order to generate external debt capacity. At the same time, if income distribution is so unequal that it is in the interest of only a small minority to serve the debt, capacity drops to zero.

4. Extension: the role of financial intermediaries

Our first extension involves hardly any formal elaboration of the model; we argue that the results of the previous section would still go through if period-0 trading is interpreted as a reallocation of old debt via a secondary market rather than an IPO of new debt. Crucially, however, this reinterpretation allows us to make the important distinction between tradable bonds and non-tradable bank debt and thus analyze the role of financial intermediaries in sovereign lending.

The extension is motivated by the observation that tradable sovereign debt is "easier" to enforce relative to bank debt. Indeed, Beers and Chambers (2003) point out that the primary channel of sovereign lending during the 19th century was through tradable bonds. Banks entered the market during the second half of the 20th century, only to suffer the effect of the 1980s debt crisis. Interestingly, while default rates on bank lending increased sharply, default rates on bonds remained low. Moreover, there were quite a few cases where sovereign debtors defaulted on their bank debt, but served their bonds. Recently, maybe as a reaction to that experience, the structure of the sovereign-debt market has changed significantly. An IMF (2003) publication reports that "the traditional syndicated loan market shrank in the second half of the 1990's ... [and] the role of the lead bank has shifted ... from that of the agent of the lending group to the underwriter of the deal". At the same time, there was a sharp fall in interest-rate spreads, which is consistent with a lower probability of default.[13] A related finding is provided by Easty and Magginson (2001) who study the international syndicated loan market – for corporates. We may conjecture a continuum between corporate and sovereign loans so that the weaker is the enforcement of property rights, the more creditors have to rely on a political mechanism for repayment. Indeed, the paper's main finding is that the dispersion of debt decreases in various measures of the "effectiveness of legal enforcement". In the spirit of our theory we shall argue that with weaker enforcement of property rights the markets have to rely more heavily on political mechanisms, and these operate better when the interests are more dispersed.

Suppose that at time $t = -1$ a certain amount of sovereign debt, $B < w_m$, was issued. The debt had two components: non-tradable *foreign* bank debt, $B_{BK} > 0$, and tradable bonds $B_{TR} > 0$, so that $B_{BK} + B_{TR} = B$. The remaining set-up is as in the previous section. Note, particularly that the domestic population receives its income endowment at $t = 0$, so that at the time of the IPO (i.e. at $t = -1$) the debt had to be taken by either the foreigners or the market maker. Note also that political decisions still take place at $t = 1$, which captures the reality of a higher frequency of trading relative to political decisions. However, voters have to make two separate decisions, one with respect to the bank debt and the other with respect to the bonds.

It thus follows that when the period-0 market opens, the domestic agents spend their endowment buying sovereign debt – the only store of value available to them. By assumption, the banks cannot sell their debt, but the bondholders can sell either all or part of it. Doing so, they will find themselves in exactly the same situation as in the previous section. Since $B_{TR} < B < w_m$, the debt would be traded at a price of 1 in (perfect) foresight that it

[13] See also Bolton and Jeanne (2005) .

would be served at $t = 1$. Hence, the bondholders would be fully served, either by holding the bonds to maturity or by selling them at face value at $t = 0$. At the same time, it is not in the interest of any domestic agent to serve the bank debt. Note, however, that had the foreign banks held their debt in the form of bonds they could have participated in the interim trade and obtain full service.[14]

Note that at period 0 it is already in the best interest of domestic agents to collude against the foreigners, abstain from trade and default on the debt ex post. Hence, this extension of the model highlights another important aspect of our mechanism: which is the role of competitive markets in breaking potential collusion of domestic agents against foreigners? Technically, collusion is excluded from the analysis by the assumption that the political process is restricted to voting and that voters are atomistic and thus have no incentive to engage in strategic behavior. An analysis of a potential collusion-formation process and its limitations may be a worthy topic for further research. From a practical point of view, a long history of failed attempts to regulate, control or even enforce disclosure on capital flows and other FX-related markets should indicate that omitting potential collusion from this preliminary stage of the analysis may be a minor offence.

5. Extension: price volatility and the "sudden stop"

Price volatility in the basic model is zero. Moreover, if the sovereign's only objective is to utilize its borrowing capacity to the full, it need not cross the $\overline{B}$ threshold, so that the price of the bond is 1 in all states of nature and default is never observed in equilibrium. Another implication is that f has no effect on pricing. As it happens, all three results are altered radically, when the common-knowledge assumption is removed. More specifically, we assume that $\widetilde{f}$ and $\widetilde{\delta}$ are realized before period-0 trading starts, but the market maker – who still observes the order flow in total – can no longer distinguish the foreign from the domestic component. Clearly, his "guess" regarding the size of the domestic position still plays a critical role in pricing.

There is little doubt that the extension adds realism to the analysis. First, as already mentioned above, it is often the case that citizens of emerging markets hold "foreign" debt of their own countries via custodians, who resolutely protect the confidentiality of their clients. (Crucially, "hiding" behind custodians does not affect the voting incentives of the ultimate debt holders.) This pattern of debt-holding is partly due to currency controls, but may

[14] We ignore the question why the banks agreed to lend at $t = -1$; either another mechansim, e.g. the threat of sending "gun boats", existed then but vanished later, or the analysis may be viewed as an off-the-equilibrium-path analysis of the impossibility of soverign bank lending.

also reflect the insight gained in the previous section, that solid lines between "foreign" and "domestic" debt should better be avoided. As a result, all the orders that are submitted abroad are accounted for as "foreign" capital flows, keeping the dealers in these markets genuinely ignorant about the true domestic-foreign composition of ownership. Second, and more importantly, there is a widespread feeling that the price of sovereign debt – as well as related instruments, including the FX – is extremely sensitive to capital flows, even if these flows are just "noise" and do not coincide with any visible change in economic fundamentals. Indeed, Calvo's (1998) "sudden-stop" analysis of the Russian-Asian financial crises implies not just that the market may be extremely volatile at times, but that volatility itself is determined by the level of capital flows: at some level of capital flows – in our model the order flow – the market is liquid and can absorb fairly significant fluctuations in the flow with only a modest price impact, but then at lower levels liquidity dries up and even modest changes in the flow may cause erratic price fluctuations.[15]

Suppose that in period-0 the first mover is the sovereign who decides how many bonds, B to IPO. Then, after the realization of $\widetilde{\delta}$ and $\widetilde{f}$, agents submit orders.[16] The market maker observes the entire order flow

$$d = f + l, \tag{6}$$

where $l = \int_0^1 w_i di$ is its domestic component. The market maker then prices the bond and takes on the slack between B and d. On the basis of d he also updates his expectations using his knowledge about the unconditional distribution of these variables. As in the basic setting, voting takes place at period 1, by which time the realization $\widetilde{\delta}$ is already common knowledge. The existence of equilibrium requires that mixed strategies are still used. Unlike in the basic setting, the relationship between prices and default probabilities is not as direct. Hence, define by $\theta_{\widetilde{\delta}=1}$ and $\theta_{\widetilde{\delta}=\delta}$ the equilibrium mix, namely the probability with which the middle-income class vote for service, conditional on the realization of the state.

Denote by $g(d)$ the market-maker's conditional probability that $\widetilde{\delta} = 1$. To derive g, remember that for $\widetilde{\delta} = 1$, domestic demand is

$$l_{\widetilde{\delta}=1} = W\left(1 - \mu_l\right),$$

and for $\widetilde{\delta} = \delta$ domestic demand is

$$l_{\widetilde{\delta}=\delta} = W\left[1 - \mu_h + \delta\left(\mu_h - \mu_l\right)\right].$$

[15] See also Kaminsky and Reinhart's (1999) exploration into the interrelations between balance-of-payment and banking crisis; see also Detragiach and Spilimbergo (2001).

[16] As in the basic model, there is no meaningful portfolio decision; it follows that the order flow is independent of any information that they may have or their inferences regarding other agents' decisions.

So applying Bayes' rule,

$$g(d) = \frac{(1-\gamma)\, h\left(d - l_{\widetilde{\delta}=1}\right)}{(1-\gamma)\, h\left(d - l_{\widetilde{\delta}=1}\right) + \gamma h\left(d - l_{\widetilde{\delta}=\delta}\right)}. \tag{7}$$

We can now prove:

Proposition 2 *There exists a unique mixed strategy equilibrium as follows:*
if $B \leq \delta W$, $P = 1$ and $\theta_{\widetilde{\delta}=1} = \theta_{\widetilde{\delta}=\delta} = 1$ so that the debt is fully served, unconditionally.
If $B > \delta W$, then

$$P^* = \begin{cases} \frac{\delta W}{B}, & \text{if } g(d) \leq \frac{\delta W}{B}, \text{ with service strategies } \theta_{\widetilde{\delta}=\delta} \in (0,1] \text{ and } \theta_{\widetilde{\delta}=1} = 1 \\ g(d) & \text{if } \frac{\delta W}{B} < g(d), \text{ with service strategies } \theta_{\widetilde{\delta}=\delta} = 0 \text{ and } \theta_{\widetilde{\delta}=\delta} = 1 \end{cases}. \tag{8}$$

Proof. The first part of the proposition is obvious: if $B \leq \delta W$ the middle-income group votes for repayment unconditionally, so that $P = 1$.

Alternatively, the equilibrium must have one of the following configurations:
either $\frac{\delta W}{P} = B$, $\theta_{\widetilde{\delta}=\delta} \in (0,1]$, $\theta_{\widetilde{\delta}=1} = 1$ and $P^* = g + (1-g)\,\theta_{\widetilde{\delta}=\delta}$;
or $\frac{\delta W}{P} < B < \frac{\delta W}{p}$, $\theta_{\widetilde{\delta}=\delta} = 0$, $\theta_{\widetilde{\delta}=1} = 1$ and $P^* = g$;
or $\frac{W}{P} = B$, $\theta_{\widetilde{\delta}=\delta} = 0$, $\theta_{\widetilde{\delta}=1} = (0,1]$ and $P^* = g \cdot \theta_{\widetilde{\delta}=1}$.

Clearly, these equilibrium conditions must satisfy the feasibility conditions that $\theta_{\widetilde{\delta}=\delta}$ and $\theta_{\widetilde{\delta}=1}$ are in $[0,1]$. Solving out for $\theta_{\widetilde{\delta}=\delta}$ one can verify that $\theta_{\widetilde{\delta}=\delta} \leq 1$ holds only for $g(d) \leq \frac{\delta W}{B}$. Solving for $\theta_{\widetilde{\delta}=1}$ one can verify that $\theta_{\widetilde{\delta}=1} \leq 1$ holds only for $g(d) \geq \frac{W}{B}$. Note, however that since period-1 tax limit is W, and since B has to be within that limit, $B \leq T$ so that the third configuration is not feasible. It thus follows that one – and only one – of the top two configurations of equilibrium conditions above exist for any $g(d)$, so that for any realization of the order flow there exists a unique mixed-strategy equilibrium. ■

A special case of this equilibrium with $B = W$ (and a normal distribution, see below) is provided in Figure 2. The "break" in the pricing function reflect the two equilibrium "regimes" identified in Proposition 2: for a weak order flow $g(d) < \delta$ the price drops to the flat segment with $P = \delta$, and for stronger order flows, $P = g(d)$.

Unlike in the basic setting, for any $B > \delta W$ there is a positive probability of default. One might get the impression that default occurs just because the sovereign can no longer cut down the IPO, B, in response to a weak order flow in a manner of "book building". (Remember that under common knowledge, the sovereign could achieve full capacity and zero default rate by implementing the policy $B = \widetilde{\delta} W$.) Note, however, that any reactive policy would prevent the sovereign from utilizing its full borrowing capacity. To see that, just consider a given realization of $\widetilde{d}$ and observe that $P \cdot B$ is (weakly) increasing in B. It thus follows that debt capacity is utilized by issuing up to the period-1 taxation constraint, T, so that

$$\overline{B} = W,$$

with conditional dollar borrowing of

$$\overline{K} \mid_{g(d)\leq\delta} = \delta W \quad \text{and} \quad \overline{K} \mid_{g(d)>\delta} = g\left(d\right) W.$$

It may be noted that in our model, default *per se* comes at no cost (social or private), so that just minimizing its incidence cannot be justified as a policy objective. Default is welfare decreasing only to the extent that it undermines the ability to borrow and fund economic-development projects. Thus, the debt-capacity result above implies that although by reacting to the order flow the sovereign can actually increase the probability of repayment conditional on d (which is still equal to P), the net effect of decreasing the quantity and increasing the "quality" is to decrease dollar borrowing.

Perhaps the most interesting implication of the results above is the effect that capital flows have – via the price mechanism – on the incentives to serve the debt. Consider an economy with a $\widetilde{\delta} = \delta$ realization. Could the market maker observe the realization directly he would price the debt at δ (assuming $B = W$), which would leave the median with a (weak) incentive to employ mixed strategies and serve the debt with a probability of P. But then, suppose that a strong inflow of capital prevents the market maker from recognizing this fact. Moreover, if f is strong enough to push the equilibrium into the regime where $P = g(d)$, the overvaluation of the debt would price the median voter out of the market, leaving him with no incentive to serve the debt.

5.1 *Price volatility and debt capacity*

We proceed with the special case where $B = W$ and f is normally distributed with mean zero and variance σ^2, which allows us to express the market-maker's Bayesian update function (7) and the price function (8) parametrically. Figure 2 simulates the price as a function of the order flow; the foreign variability component ($\sigma = \sqrt{0.2} = .4472$) is somewhat higher than of the domestic component (binary with $\sigma_l = 0.36$).

Evidently, the price is highly non-linear in the order flow.[17] When the order flow is high the price of the bond is close to 1 because the market maker is fairly confident that local

[17]Such non-linearity is scarce in market microstructure theory; see O'Hara (1995) for an overview. For an exception see Germain and Dridri (2004) who assume binary signals where we derive the binary return endogenously from the political structure.

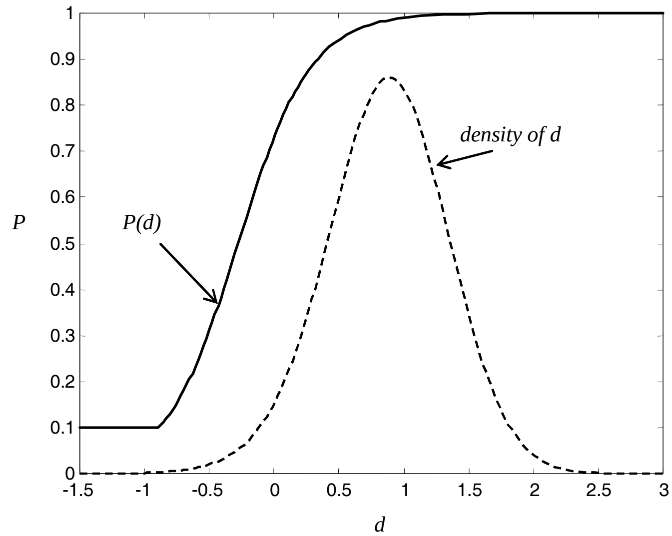

Figure 2: Shows the price of the the bond as a function of the order flow (solid line) and the density of the order flow (dashed line). Parameter values are $W = 1$, $\sigma^2 = 0.2$, $\gamma = 0.05$, $\delta = 0.1$, $\mu_l = 0.1$, and $\mu_h = 0.9$, which implies that $Var\,(l) = 0.1296$. Price-volatiliy itself is a function of the order flow.

demand is strong. Moreover, variations in the order flow will not have a significant effect on the market-maker's inference, allowing him to maintain a liquid market and absorb the flow with fairly modest price adjustments. But then, when the order flow is lower, not only is the price lower, the market also becomes less liquid and small changes in the flow generate strong price fluctuations. This is because at these levels the order flow carries a lot of information about the position of the median voter. Note, however that since the price is bounded from below by δ, at low levels of the order flow market liquidity is restored.

It is legitimate to interpret these variations in the order flow as random non-fundamental portfolio re-allocations by either domestic or foreign agents. Thus, for example, although $\widetilde{\delta}$ is an endowment shock, it may be interpreted as a liquidity – rather than a productivity – shock. To see that, notice that against the drop in period-0 endowment we could assume an increase in period-1 endowment with no significant effect on long-run productivity. Hence, the market maker cannot use the fact that he got no "bad news" in order to infer that the weak order flow originates in foreign noise and thus requires no price adjustment. We thus argue that both the pattern of price volatility and the nature of the factors underlying the variations in the order flow are consistent with the "sudden stop" phenomenon.

We have mentioned above that borrowing capacity is maximized at $\overline{B} = W$. However, the dollar amount borrowed is affected by model parameters, particularly by the variability of foreign component of the order flow. Denote by $H(f)$ the distribution function of $\widetilde{f}$: $H(f) = \int_{-\infty}^{f} h(s)ds$. Moreover, define $\underline{d}$ by $\delta = g(\underline{d})$. We can then calculate the expected price at which the government can issue the bond.

Remember that in the current context borrowing capacity should be defined in terms of *expectations*, with $E\left(\overline{K}\right) = B \cdot E(\widetilde{P})$. Hence,

Lemma 1 *If the sovereign issues at full capacity* ($B = W$) *the expected price will be*

$$\begin{aligned} E(\widetilde{P}) &= (1-\gamma)\left[1-(1-\delta)\,H\left(\underline{d}-l_{\widetilde{\delta}=1}\right)\right] \\ &\quad +\gamma\delta H\left(\underline{d}-l_{\widetilde{\delta}=\delta}\right). \end{aligned} \tag{9}$$

Proof see Appendix.

Maintaining the normality assumption, we derive:

Proposition 3 *At full capacity, an increase in the variability of the foreign component of the order flow, σ, decreases expected debt capacity.*

Proof see Appendix.

Figure 3 provides three simulations. Expected price, which in this case equals capacity since $W = 1$, is plotted on the vertical axis while the standard deviation of f is plotted on the horizontal axis. The three graphs are plotted for three sets of parameters. δ is kept constant across the simulations so that under the common-knowledge benchmark debt capacity is the same for the three sets of parameters. Note also that the lower and the upper bounds of the graphs are determined by γ, δ and W alone; e.g. $\gamma \cdot \delta \cdot W + (1-\gamma) \cdot W = 0.72$. This is because toward the point where $\sigma = 0$ the three structures converge to the common-knowledge benchmark, which is independent of f. The only difference between the three structures is in the values of μ_h and μ_l, namely the size of the middle-income class. Since the $\widetilde{\delta}$ shock affects that class alone, the three structures imply a different standard deviation of the domestic component, l, which is decreasing from the top to the bottom graph with values of 0.35, 0.21 and 0.14, respectively.

Why should debt capacity decrease in σ where all players are risk neutral, debt is fairly priced and uncertainty is exogenous? One might think that the market maker commits errors in both directions, so that overpricing is netted out against underpricing with no effect on debt capacity. The reason why this is not the case is that mispricing is not just redistributive, it also affects equilibrium incentives. We have already argued above that when the market maker over-values the bond in the $\widetilde{\delta} = \delta$ state (due to a high realization of $\widetilde{f}$), he prices the

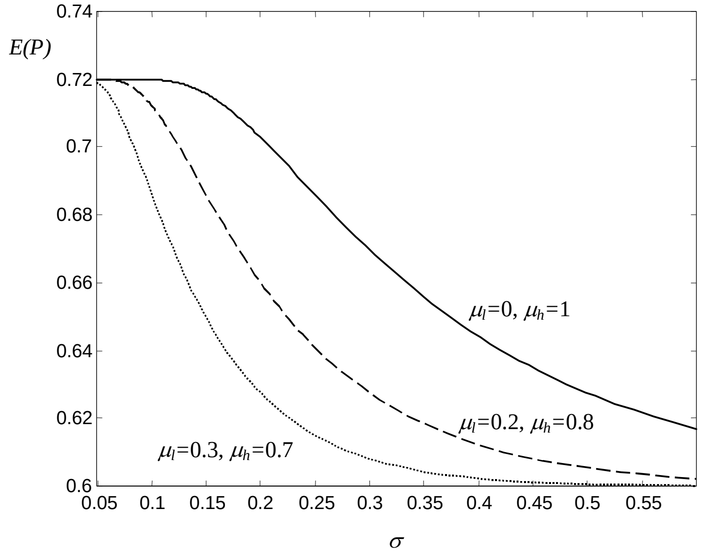

Figure 3: Shows the expected bond price and debt capacity as a function of σ, the standard deviation of f. Parameter values are $\gamma = 0.4$, $\delta = 0.3$ and $W = 1$. The solid, dashed and dotted line have the following values for (μ_l, μ_h), respectively: $(0, 1)$, $(0.2, 0.8)$, and $(0.3, 0.7)$, which imply a standard deviation for l of 0.35, 0.21 and 0.14, respectively.

median voter out of the market, which leaves him with a strong incentive to vote for default (in pure strategies). In contrast, when the market maker under-prices the bond in the $\widetilde{\delta} = 1$ state of nature (due to a low realization of $\widetilde{f}$) he allocates bonds towards the median voter, leaving him with the same incentive to serve the debt. Hence, the two types of errors do not cancel out and debt capacity falls.

Another effect that is clearly noticeable in Figure 3 is that debt capacity is increasing in the variability of $\widetilde{l}$ – the top curve represents the highest variability. The reason for that is obvious: the stronger is the signal coming from the domestic component of the order flow, the "easier" it is for the market maker to make the right inferences from the total order flow vis a vis its component and thus avoid pricing errors.

6. Extension: debt restructuring

In the basic set-up of Section 3, we ignored the possibility of partial default, focusing instead on the case where $\widetilde{\alpha} \in \{0, 1\}$. It is actually possible to reinterpret this result as a partial default. Suppose that $B > \overline{B} = w_m$ so that $P^* < 1$. Since the median voter is risk neutral, he is indifferent between *either* mixing $\widetilde{\alpha} = 1$ and $\widetilde{\alpha} = 0$ with a probability of P^* *or* serving a fraction P^* of the debt with certainty. For similar reasons, the market maker would equally price debt with a P^*-probability of default and fraction-P^* service; that completes the reinterpretation argument. Like the mixed-strategies, however, such an outcome is hard to coordinate because – in equilibrium – the pivotal voters are indifferent between full service, full default and any level of partial default.

The object of this section is provide an extension of the basic model where in equilibrium voters strictly prefer a particular level of partial default relative to any other level of service. Essentially, debt is written down to the point that serves the interests of the median voter but no further. Unlike in the basic model, the sovereign can actually increase debt capacity by defaulting in "bad" states of nature. An additional bonus of the extension is the substitution of the lump-sum tax with a more realistic relative consumption tax. We also model explicitly period-1 income and augment it with a productivity shock.[18]

This extension is motivated by an unresolved puzzle in the sovereign-debt literature. It is a well-established wisdom that corporate debt cannot be renegotiated when there is a multitude of bond-holders; see Bolton and Jeanne (2005) for a reinterpretation within the context of sovereign debt. Surprisingly, however, Roubini (2002) reports a number of "recent cases where there were thousands of bondholders (Ukraine, Pakistan, Ecuador, Russia) [and yet] unilateral exchange offers have had overwhelming success with 99% plus creditors accepting the offer".[19] We suggest that it is more appropriate to regard these episodes as "confiscatory restructuring" schemes[20] rather than renegotiations in the usual sense of the word, with alternating offers and threat-points that provide the parties with strong incentives to reach a compromise. In our setting, the restructuring requires no communication between debtor and creditors. Even more importantly, the restructuring does not require any form of creditors' consent – say, by majority or unanimity – and hence does not create the coordination problems that typically arise in corporate-bond restructuring. Particularly, a rogue creditor cannot undermine the deal, for his only alterative is to reject the offer and be left with nothing.[21] Though the restructuring is implemented unilaterally, it is not in the best interest of the pivotal decision maker to push the write-off down to zero.

Consider the basic model – with common-knowledge – and assume that $\delta = 1$ so that there are only two income classes $[0, \mu_l]$ and $(\mu_l, 1]$ and no period-0 uncertainty. We add structure, however, on period-1 endowments. Suppose that those agents who have no initial

[18] Another interesting question is what kind of tax regime would make sovereign debt most stable. We will not attempt to answer this question here.

[19] Sturzenegger and Zettelmeyer (2005) estimate that the (discounted) write-downs "clustered in the 25-35 percent range".

[20] The term is used by *The Economist*, June 3, 1999.

[21] See Gray (2003).

income have a positive *random* second period income $y_i^s = Y^s > 0$, s being the state-of-nature index. By contrast, those agents who have initial income W have no period-1 income, i.e.,

$$w_i = \begin{cases} 0 & \text{for} \quad i \in [0, \mu_l] \\ W & \text{for} \quad i \in (\mu_l, 1] \end{cases},$$

$$y_i^s = \begin{cases} Y^s & \text{for} \quad i \in [0, \mu_l] \\ 0 & \text{for} \quad i \in (\mu_l, 1] \end{cases}.$$

This structure lends itself to a generational interpretation. Agents $i \in n = [0, \mu_l]$ are interpreted as period-1 young (denoted as the n income class); they carry no assets from the past, but are currently productive and generate taxable income. Agents $i \in o = [\mu_l, 1]$ are period-1 old (denoted as the o income class); they do carry assets from the past, but are no longer productive. Obviously, the two classes have conflicting interests: since the young hold no bonds they care only about minimizing the tax burden, while the old have to balance off the cost of taxation against the benefit of preserving the value of their assets. We also assume that the economy is exposed to a productivity shock $s \in \{L, H\}$ affecting the young agents so that $Y^L \leq Y^H$ with probabilities π and $(1 - \pi)$ respectively. The shock is realized and publicly observed at period 1 before the repayment decision comes up for a vote. Denote domestic per-capita income at periods 0 and 1 by

$$\overline{w} = (1 - \mu_l) W,$$

$$\overline{y}^s = \mu_l Y^s.$$

As before we assume that all agents care only about period-1 consumption and that the only store of value is the government bond. It therefore follows that (1) holds.

Suppose that the government finances the bond repayment through a consumption tax at rate τ^s. If an α repayment is approved by the voters, the government needs to raise tax income $T = \alpha B$ and set the tax rate τ^s such that

$$\tau^s \left(\overline{y}^s + \alpha \frac{\overline{w}}{P} \right) = \alpha B. \qquad (10)$$

As the vote is no longer of a "service: yes or no" type but rather a decision over a continuum of service rates, one needs to elaborate upon the political structure that puts those αs up for a vote. Consider a set-up as in Persson and Tabellini (2002), where following the realization of the productivity shock, two parties a and b compete in the election by simultaneously proposing their electoral platform α_a^s and α_b^s, respectively. Each party chooses its platform so as to maximize its probability of winning the election given the other party's platform.

6.1 *The deterministic case:* $Y^H = Y^L$

For clarity of exposition we start with the deterministic case, dropping the s index for the rest of this sub-section. From equation (10) we determine the tax rate as a function of α:

$$\tau(\alpha, B, P) = \frac{\alpha B}{\overline{y} + \alpha \frac{\overline{w}}{P}}. \tag{11}$$

As a result, agent i will end up with a period-1 consumption of

$$c_i(\alpha, B, P) = \left(y_i + \alpha \frac{w_i}{P}\right)(1 - \tau). \tag{12}$$

As already noted above, young agents have no interest in serving any fraction of the debt, which may be confirmed formally by using equation (12) in order to calculate

$$\frac{\partial c_n}{\partial \alpha} = -Y \frac{\partial \tau}{\partial \alpha};$$

since $\frac{\partial \tau}{\partial \alpha} > 0$ it follows that $\frac{\partial c_n}{\partial \alpha} < 0$.

In contrast, old agents may not favor a corner solution. As before, they need to trade off the net transfer of resources to the foreigners, against the redistribution they impose by taxing the young in order to redeem their-own bonds. The non-linear structure of equation (12) indicates that there might be an internal solution. The following Proposition shows that this is indeed the case.

Proposition 4 *There exists a unique pure-strategy equilibrium such that*

$$P^* = \alpha^* = \begin{cases} 1 & if \quad B \leq \overline{B} \\ \overline{B}/B & if \quad B > \overline{B} \end{cases}.$$

with the restructuring threshold

$$\overline{B} \equiv \frac{(\overline{y} + \overline{w})^2}{2\overline{y} + \overline{w}}.$$

Proof. Note that since the old form a majority, both parties compete for their vote by putting forward a platform that maximizes their consumption. That platform is the unique sub-game perfect equilibrium in the voting game.

The problem now boils down to finding a service rate that maximizes old agents' consumption. Define $c_o(\alpha, B, P)$ by setting $y_i = 0$ and $w_i = W$ in (12). It is easy to see that c_o is concave with respect to α. Compute:

$$\begin{aligned} \frac{\partial c_o}{\partial \alpha} &= \frac{W}{P}(1 - \tau) - \alpha \frac{W}{P} \frac{\partial \tau}{\partial \alpha}, \\ \frac{\partial^2 c_o}{\partial \alpha^2} &= -2 \frac{W}{P} \frac{\partial \tau}{\partial \alpha} - \alpha \frac{W}{P} \frac{\partial^2 \tau}{\partial \alpha^2}, \end{aligned}$$

so that

$$\frac{\partial^2 c_o}{\partial \alpha^2} < 0 \Longleftrightarrow -\alpha \frac{\partial^2 \tau}{\partial \alpha^2} < 2\frac{\partial \tau}{\partial \alpha},$$

which can be confirmed by using the first and second derivatives of (11).

The concavity of c_o with respect to α also implies that no mixed-strategy equilibria exist.

Next, we solve for α^* by calculating

$$\frac{\partial c_o}{\partial \alpha} = 1 - \frac{\alpha B}{\overline{y} + \alpha \frac{\overline{w}}{P}} - \frac{\alpha B \overline{y}}{\left(\overline{y} + \alpha \frac{\overline{w}}{P}\right)^2}, \tag{13}$$

and setting the first order condition to

$$\frac{\partial c_o}{\partial \alpha} \begin{cases} \geq 0 & if \quad \alpha = 1 \\ = 0 & if \quad \alpha < 1 \end{cases}. \tag{14}$$

Moreover, since there is no uncertainty, we must have that in equilibrium $P^* = \alpha^*$. Evaluating condition (14) at that point implies that an internal solution

$$\alpha^* = \frac{\overline{B}}{B} \qquad \text{exists for} \qquad B \leq \overline{B}.$$

■

Note, that the amount borrowed increases by one dollar per bond up to the point $\overline{B}$, and is constant beyond that point. Hence, debt capacity

$$\overline{K} = \overline{B},$$

so that the sovereign has no revenue motive for crossing $\overline{B}$ into the region where it would default. To derive equilibrium default we consider a model with non-trivial productivity shocks in the next sub section.

Beforehand, let us consider another question regarding restructuring and debt capacity. That debt restructuring cannot be used as a means of increasing debt capacity does not imply that the inclusion of partial default in the sovereign's strategy space has no effect on the equilibrium. For one may ask the following question: suppose the sovereign could commit, perhaps constitutionally, not to engage in debt restructuring. In other words, had it been possible to vote on $\alpha \in \{0, 1\}$ alone – rather than $\alpha \in [0, 1]$ – would that affect debt capacity? The answer is yes.

Proposition 5 *A restriction of α to the set $\{0, 1\}$ increases debt capacity.*

Proof. Clearly, for $B < \overline{B}$ the restriction is not binding. Now consider the point $\overline{B}$. Note that by the definition of $\overline{B}$ it follows that for $B = \overline{B}$, c_o is maximized with respect to α at $\alpha = 1$.

From this and the concavity of c_o with respect to α it follows that $c_o\left(0, \overline{B}, 1\right) < c_o\left(1, \overline{B}, 1\right)$. It also follows from the continuity of c_o with respect to B that if the sovereign issues an additional $\epsilon > 0$ bonds, that $c_o\left(1, \overline{B}+\epsilon, 1\right) > c_o\left(0, \overline{B}+\epsilon, 1\right)$. Hence, $B = \overline{B}+\epsilon$ is still a pure-strategy full-repayment point so that $P^* = 1$. But then, revenue at this point is $\overline{B}+\epsilon$, which exceeds the maximum under the no-restriction regime. ■

Since c_o is maximized at $\overline{B}$, issuing a small additional amount, the median voter would still prefer $\alpha = 1$ to $\alpha = 0$ *if he is restricted to choose between these two options alone.* That highlights an intuitive effect: allowing for debt restructuring weakens commitment to full repayment and thus decreases borrowing capacity. In other words, if the borrower could commit not to restructure, that would strengthen his commitment to repay fully even if he is still left with the option to default on the entire amount. At the same time, it is not clear whether it is practically possible to commit not to restructure. In the context of corporate debt, since restructuring requires communication between debtor and creditor, dispersing the debt to the point that effective communication is blocked may achieve that goal. In our model, however, restructuring is a unilateral act, so debt dispersion can no longer achieve that goal. Even if the constitution is amended to prohibit any debt restructuring, it is not clear whether the amendment can survive a consensus against it (note that at point $B = \overline{B}+\epsilon$ both young and old are ex-post better off partially defaulting than fully serving the debt). After all, could the sovereign commit not to restructure, it might as well commit never to default, partially or fully. In that respect, the value of the result above is mainly analytical, so as demonstrate the commitment aspect of debt restructuring.

6.2 *The stochastic case: $Y^H > Y^L$*

So far, we did not provide a reason why debt may be restructured in equilibrium, for neither the sovereign nor the creditors are better off crossing the threshold $\overline{B}$. A motivation for equilibrium restructuring emerges, however, when the economy is exposed to a non-trivial productivity shock, namely when $Y^H > Y^L$.

Define

$$\overline{B}^L \equiv \frac{\left(\overline{y}^L + \overline{w}\right)^2}{2\overline{y}^L + \overline{w}}, \qquad \overline{B}^H \equiv \frac{\left(\overline{y}^H + \overline{w}\right)^2}{2\overline{y}^H + \overline{w}},$$

It is easy to verify that $\overline{B}^L < \overline{B}^H$; intuitively, the more productive the young are, the larger is the redistribution from the young to the old at a given tax rate, and thus the less profitable is the restructuring from the old generation's point of view.

Note also that the previous condition (14) is still valid for $P = 1$, so that debt is fully served if

$$B < \min\left(\overline{B}^L, \overline{B}^H\right) = \overline{B}^L,$$

so that the no-default debt capacity is simply $\overline{B}^L$. The question now is whether the revenue from selling bonds may increase by issuing above $\overline{B}^L$. Intuitively, one may expect that the price of the bonds would fall less steeply in the present setting because

$$P^* \mid_{B>\overline{B}^L} = \pi\alpha^{*L} + (1-\pi)\,\alpha^{*H} \tag{15}$$

and the moderating effect of lower default rates at the H state. More formally, however:

Proposition 6 *Issuing bonds beyond $\overline{B}^L$ and defaulting in some state of nature (rationally foreseen by the market maker), the sovereign can increase the amount borrowed.*

Proof. Suppose that the sovereign restructures in both states of nature; the exact α in each state is determined from the relevant first-order condition (similar to equation 14)

$$\left(\overline{y}^s + \alpha\frac{\overline{w}}{P}\right)^2 - \alpha B\left(\overline{y}^s + \alpha\frac{\overline{w}}{P}\right) - \alpha B\overline{y}^s = 0. \tag{16}$$

We solve

$$\alpha^{*s} = \overline{y}^s Z, \qquad Z = \frac{\sqrt{B\left(B - \frac{\overline{w}}{P^*}\right)} - \left(B - \frac{\overline{w}}{P^*}\right)}{\frac{\overline{w}}{P^*}\left(B - \frac{\overline{w}}{P^*}\right)}$$

Substituting α^{*s} into (15) and defining $\overline{Y} = \pi\overline{y}^L + (1-\pi)\,\overline{y}^H$ yields an equilibrium price

$$P^* = \frac{1}{B}\frac{\left(\overline{Y} + \overline{w}\right)^2}{2\overline{Y} + \overline{w}}.$$

It follows that the revenue from selling the bonds is

$$K \mid_{\alpha^{*L},\alpha^{*H}<1} = \frac{\left(\overline{Y} + \overline{w}\right)^2}{2\overline{Y} + \overline{w}} > \overline{B}^L.$$

■

We have mentioned above the negative effect of partial default on debt capacity. We can now see its positive effect as well. Provided that debt restructuring cannot be restricted constitutionally, and where the sovereign's objective is to raise the maximum-possible amount of funding, it makes no sense to adopt a "never default" policy. From the foreign creditors' point of view, the risk of the write-down is "priced in" so that there is no loss of welfare (ex ante) due to default. From the sovereign's point of view, the only way to commit not to default is to borrow sufficiently small amounts so that the median-voter's benefit from service exceeds the cost in all states of nature. But that can be achieved only by significant reduction in borrowing, which has a direct negative effect on the funding of the development project.

7. Conclusions

In this paper we address a basic question in the theory of sovereign debt, which is why is it ever repaid, even when the penalty for default is non-existent. The answer is simple: where the debt is held by both locals and foreigners, the median voter might have an interest in serving the debt.

However, the main purpose of the analysis is practical: how should sovereigns – particularly emerging markets – structure their debt so as to utilize their borrowing capacity to the full. Although we have used a conceptual framework inspired by corporate finance, our analysis seems to lead us to the conclusion that in many respects, corporate and sovereign debt are mirror images one of the other. Some of the most sound recommendations in corporate borrowing – e.g. use financial intermediaries or avoid uncoordinated dispersion – seem to be reversed when it comes to sovereign debt. Also, the analysis seems to highlight important factors that determine the sovereign's borrowing capacity, namely income distribution. The analysis also sheds new light on the role of liquidity in sovereign borrowing.

Many questions are left for future research. First is the functioning of our mechanism within more realistic political structures that include both voting and political lobbing. Second is the functioning of the mechanism when agents face non-trivial portfolio decisions. Such choices might exacerbate coordination problems since the intrinsic value of the bond depends on the portfolio decisions taken by domestic investors. Third is the issue of denomination. Domestic currency denomination may have adverse portfolio implications for foreigners, but strengthen the commitment of the sovereign to repay.[22] Fourth is the potential linkage between sovereign default and a crisis within the domestic financial system. This is particularly interesting since our theory implies that the commitment to pay sovereign debt requires a substantial home bias, which puts a restriction on international diversification and makes the domestic economy more vulnerable to an adverse productivity shock. Fifth is the possibility of domestic collusion against the foreigners – as hinted in Section 4 – and the ways to avoid it. Sixth is the application of our theory to private borrowing, particularly among emerging markets where the ineffective property-rights mechanisms might be substituted by

[22] Calvo and Guidotti (1990) point out that the sovereign may have an incentive to devalue its exchange rate if corporations have all their foreign debt denominated in local currency.

a political borrowing mechanism.

8. Appendix

Proof of Lemma 1. Denote by $k(d)$ the density of d. We can write

$$\begin{aligned} k(d) &= (1-\gamma)\, h(d - l_{\widetilde{\delta}=1}) + \\ & \quad \gamma h\left(d - l_{\widetilde{\delta}=\delta}\right). \end{aligned} \tag{17}$$

On the interval $d \leq \underline{d}$, the price is δ and for $d > \underline{d}$ it is $g(d)$. The probability that $d \leq \underline{d}$ is given by

$$prob\,(d \leq \underline{d}) = (1-\gamma)\, H\left(\underline{d} - l_{\widetilde{\delta}=1}\right) + \gamma H\left(\underline{d} - l_{\widetilde{\delta}=\delta}\right)$$

For $d > d^*$ we can calculate the expected price from

$$\int_{\underline{d}}^{\infty} k(s) g(s) ds.$$

Using (7) and (17) this simplifies to

$$\int_{\underline{d}}^{\infty} (1-\gamma)\, h(s - l_{\widetilde{\delta}=1}) ds.$$

This expression can be rearranged to yield

$$(1-\gamma)\left(1 - H\left(\underline{d} - l_{\widetilde{\delta}=1}\right)\right).$$

Adding up $\delta prob(d \leq \underline{d})$ and $(1-\gamma)\left(1 - H\left(\underline{d} - l_{\widetilde{\delta}=1}\right)\right)$ yields $E(P)$. ■

Proof of Proposition 3.

We can calculate expected debt capacity $E(\overline{K})$ as a function of the variance σ^2. With slight abuse of notation denote this function by $\overline{K}\,(\sigma^2)$. Using our result from (9) we can write

$$\overline{K}(\sigma^2) = \int_{-\infty}^{\underline{d}} \gamma\delta h\left(s - l_{\widetilde{\delta}=\delta}\right) - (1-\gamma)(1-\delta) h(s - l_{\widetilde{\delta}=1}) ds.$$

We can then take the first derivative with respect to σ^2 which is

$$\begin{aligned} \frac{d\overline{K}(\sigma^2)}{d\sigma^2} &= \left(\gamma\delta h\left(\underline{d} - l_{\widetilde{\delta}=\delta}\right) - (1-\gamma)(1-\delta) h(\underline{d} - l_{\widetilde{\delta}=1})\right) \frac{\partial \underline{d}}{\partial \sigma^2} \\ &+ \int_{-\infty}^{\underline{d}} \gamma\delta \frac{\partial h\left(s - l_{\widetilde{\delta}=\delta}\right)}{\partial \sigma^2} - (1-\gamma)(1-\delta) \frac{\partial h\left(s - l_{\widetilde{\delta}=1}\right)}{\partial \sigma^2} ds. \end{aligned}$$

Using the definition of $\underline{d}$ it follows that $\gamma\delta h\left(\underline{d}-l_{\widetilde{\delta}=\delta}\right)-(1-\gamma)(1-\delta)h(\underline{d}-l_{\widetilde{\delta}=1})=0$. Taking the normal density for h, we can calculate explicitly the derivative of h with respect to σ^2 and therefore re-write the integral as

$$\frac{1}{\sqrt{2\pi\sigma^2}2\sigma^2}\int_{-\infty}^{\underline{d}}\gamma\delta e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}\left(\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}-1\right)-(1-\gamma)(1-\delta)e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=1}\right)^2}{\sigma^2}}\left(\frac{\left(s-l_{\widetilde{\delta}=1}\right)^2}{\sigma^2}-1\right)ds. \tag{18}$$

In the next step we can calculate the integral $\int_{-\infty}^{\underline{d}}e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}ds$ by making the following substitution: Let $u^{'}(s)=e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)}{\sigma^2}$ and $v(s)=s-l_{\widetilde{\delta}=\delta}$. Using this substitution we know that $u(s)=-e^{\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}$ and $v^{'}(s)=1$. Integration by parts then yields

$$\begin{aligned}&\int_{-\infty}^{\underline{d}}e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}ds\\ =\ &\left[-e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}(s-l_{\widetilde{\delta}=\delta})\right]_{-\infty}^{\underline{d}}+\int_{-\infty}^{\underline{d}}e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}ds.\end{aligned}$$

If we substitute this expression into (18) we can write the condition that $\frac{d\overline{K}}{d\sigma^2}<0$ as

$$\gamma\delta\left[-e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=\delta}\right)^2}{\sigma^2}}(s-l_{\widetilde{\delta}=\delta})\right]_{-\infty}^{\underline{d}}-(1-\gamma)(1-\delta)\left[-e^{-\frac{1}{2}\frac{\left(s-l_{\widetilde{\delta}=1}\right)^2}{\sigma^2}}(s-l_{\widetilde{\delta}=1})\right]_{-\infty}^{\underline{d}}<0.$$

This is the same as

$$\gamma\delta e^{-\frac{1}{2}\frac{(\underline{d}-l_{\delta})^2}{\sigma^2}}(\underline{d}-l_{\delta})-(1-\gamma)(1-\delta)e^{-\frac{1}{2}\frac{\left(\underline{d}-l_{\widetilde{\delta}=1}\right)^2}{\sigma^2}}(\underline{d}-l_{\widetilde{\delta}=1})>0.$$

From the definition of $\underline{d}$ and from $l_{\widetilde{\delta}=\delta}<l_{\widetilde{\delta}=1}$ it follows that the above inequality holds. ■

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