Central Bank Swap Lines as Bilateral Sovereign Debt*

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Abstract

We study the use, terms, and desirability of central bank swap lines for sovereign borrowing. We find that swaps, a type of bilateral debt, interact strongly with borrowing terms on international capital markets. The high frequency at which swaps can be renegotiated makes their interest rate reflect outside options and market power. We highlight how swaps worsen debt dilution problems and overborrowing, in particular through weakening the threat of autarky which typically sustains sovereign borrowing. Our model is consistent with the prevailing pattern of sovereign borrowing primarily occurring through bond markets, with swap lines serving as a "first line of defense" when debt repayment becomes difficult. Moreover, we identify significant welfare effects associated with having access to swaps.

JEL Classification F34, F41, G15
Keywords Sovereign debt, debt dilution, bilateral bargaining, Central Bank swap lines

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Introduction

Central Bank swap lines have gained prominence after the global financial crisis and the Covid-19 pandemic. The number of outstanding bilateral swap lines reached 91 in 2020, from only a few in the early 2000s (Perks et al., 2021). Contracted amounts are also large: Perks et al. (2021) document that bilateral swap lines amounted to US$ 1.9 trillion, or about 10% of worldwide gross international reserves by end-2020. So far, swap lines have been understood as precautionary instruments, supporting the Central Bank's lender-of-last-resort function with global banks in advanced economies (Bahaj and Reis, 2021; Cesa-Bianchi et al., 2022).

The identities of countries drawing from swap lines have also shifted, from a few advanced economies to emerging and frontier market economies, some of which have limited or no access to international capital markets (Perks et al., 2021; Horn et al., 2023). Finally, the usage of these instruments has shifted, from standing facilities designed to fend off adverse equilibria, similarly to deposit insurance, to drawn instruments potentially raising debt-sustainability questions.

In this paper, we study the role of Central Bank swap lines as alternative borrowing vehicles for sovereigns. We ask which circumstances create incentives for countries to use swap lines when private debt markets are also available. Finally, we investigate the relation between the terms of the swap and those offered by private creditors.

We consider a standard model of sovereign default with long-term debt (Leland, 1998; Hatchondo and Martinez, 2009; Arellano and Ramanarayanan, 2012), augmented with the presence of a monopolist with which it is possible to negotiate a bilateral loan (the swap line). While it is possible to default on private bonds as in other models, the costs of defaulting on the swap line are assumed to be prohibitive for the Central bank. There are three reasons for this assumption: first, reputation and credibility are central to Central bankers' jobs; second, renegotiation of rollover terms with only one counterparty is much simpler than with a multitude of bondholders; and third, most swap lines involve a small country borrowing from a larger one which could enforce punishments in case of default.

Both instances of borrowing interact as outcomes in private markets influence the threat points in the subsequent bilateral negotiation. At the same time, while the monopolist tries to extract surplus from the borrower by raising interest rates, it is constrained in its ability to do so by competition from private markets. However, when default risk pushes up interest rates in private markets, the monopolist is able to follow suit and charge a premium on the bilateral loan. But because there is no default risk on this loan, such a premium only reflects the borrower's (lack of) outside options.

We find that the borrowing government resorts to bilateral loans sparsely and at times when default risk is present. Furthermore, by allowing consumption smoothing (and borrowing) in default, the possibility of bilateral debt raises the value, and hence the frequency, of default. In our parametrization, this leads to welfare losses for the borrowing government. A version of our model in which drawing on the swap during default is limited decreases these welfare losses but does not eliminate them, unless the bargaining power of the lender is small. Finally, we find that with short-term debt the swap can be welfare-improving, which highlights the interaction of debt dilution with the availability of bilateral loans.

Discussion of the Literature To be added.

Layout The rest of the paper is structured as follows. Section 2 introduces our model, starting with the case in which only bilateral loans are available. Section 3 describes the main model with both types of debt coexisting, while Section 4 analyzes its equilibrium. Finally, Section 5 concludes.

2. Model with bilateral loans only

We begin our analysis by studying a simple model in which only bilateral loans are possible. This first model serves to clarify the dynamics of bilateral lending and the strategy through which the monopolist extracts surplus from the borrower: subsidized terms while debt accumulates, combined with high interest rates when the debt stock becomes large and the borrower attempts to delever.

We model a small open economy borrowing from a monopolist. Loans (the swap line) are short-term and therefore effectively continuously renegotiated. At the start of t, let $v(m, z)$ represent the value attained by the government (or sovereign, or borrower) at income state z and owing m to the monopolist. The lender similarly attains a value $h(m, z)$.

At the beginning of period t, borrower and lender negotiate over the terms of the loan. Payment of the full amount m extinguishes any debts and serves as a natural threat point. We use a simple Nash bargaining framework and set θ as the lender's bargaining power. The outcome of this negotiation is a transfer x and a new loan size m' which solve

$$\max_{x,m'} \mathcal{L}(x, m, m', z)^{\theta} \times \mathcal{B}(x, m, m', z)^{1-\theta} \tag{1}$$

where $\mathcal{L}$ and $\mathcal{B}$ represent the lender and borrower's surplus functions. It will be useful to keep track of the implicit price of the loan φ satisfying $x = \varphi m' - m$ or $\varphi = \frac{x+m}{m'}$ and its interest rate $r = \frac{m'}{x+m} - 1$

After negotiations are concluded and transfers settled, consumption takes place. The lender has an endowment of a and must finance the transfer x, so $c_L = a - x$. Conversely, the borrower receives the transfer so $c = y(z) + x$. Assuming risk neutral preferences for the lender,

$$\begin{aligned}\mathcal{L}(x, m, m', z) &= a - x + \beta_L \mathbb{E}\left[h(m', z') \mid z\right] - \left(a + m + \beta_L \mathbb{E}\left[h(0, z') \mid z\right]\right) \\ &= -x - m + \beta_L \mathbb{E}\left[h(m', z') - h(0, z') \mid z\right]\end{aligned}$$

and similarly

$$\mathcal{B}(x, m, m', z) = u(y(z) + x) - u(y(z) - m) + \beta \mathbb{E}\left[v(m', z') - v(0, z')\right]$$

Notice that the choice of m' only involves continuation values v and h, while the choice of x only involves flow payoffs. Given a choice of m', the first-order condition for x is

$$\mathcal{B}(x, m, m', z)\theta = \mathcal{L}(x, m, m', z)u'(y(z) + x)(1 - \theta)$$

Finally, given the solution $x(m, z)$, $m'(m, z)$ to (1), the value functions satisfy

$$\begin{aligned}v(m, z) &= u(y(z) + x(m, z)) + \beta \mathbb{E}\left[v(m'(m, z), z') \mid z\right] \\ h(m, z) &= a - x(m, z) + \beta_L \mathbb{E}\left[h(m'(m, z), z') \mid z\right]\end{aligned} \tag{2}$$

2.1 Equilibrium with bilateral loans only

We solve the model with bilateral loans only at a parametrization that illustrates the forces at play. We choose $\theta = 0.5$ so the surplus is split equally between borrower and lender; we also set $\beta = \beta_L$ to isolate consumption smoothing and bargaining from the initial indebtedness that would result if the borrower was relatively impatient, which in sovereign debt models tends to be the relevant case.

Figure 1 summarizes the terms of the new loan for each level of income z and initial loan size m. Unsurprisingly, the borrower economy delevers when high-income states and receives positive transfers in low-income ones. The monopolist makes intense use of the interest rate to extract surplus. When both debt and income are low, the monopolist offers subsidized and even negative rates. The benefit of incurring this cost is to induce high levels of debt, which eventually make the borrower's threat point more costly to exercise. Once the loan size is large, repaying it in full becomes difficult and the monoplist is able to charge much higher interest rates, even going above 10% in the higher income states.

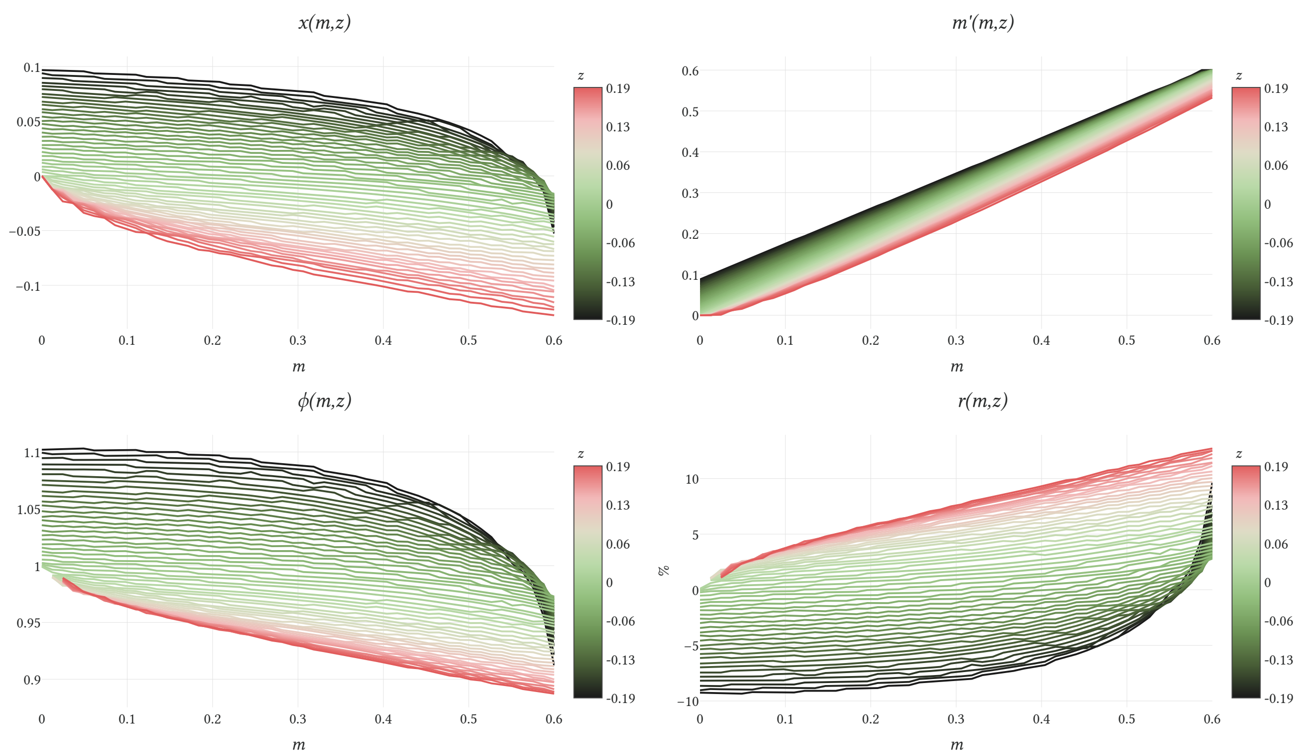

FIGURE 1: MONOPOLIST'S TERMS WITH $\theta = 0.5$

Figure 2 shows the value functions v and h for borrower and lender. As indebtedness m increases, the borrower's threat point becomes less credible, which allows the lender to charge higher interest rates and create more surplus. This effect creates convexity in the lender's profits and, hence, in the value function h.

Convexity in the lender's value function implies endogenously risk-loving behavior. This explains why, even though its 'true' preferences are risk-neutral, the lender gambles with the borrower: it subsidizes the loan to induce high indebtedness, which only creates profits if the borrower's income takes a long time to revert. If it

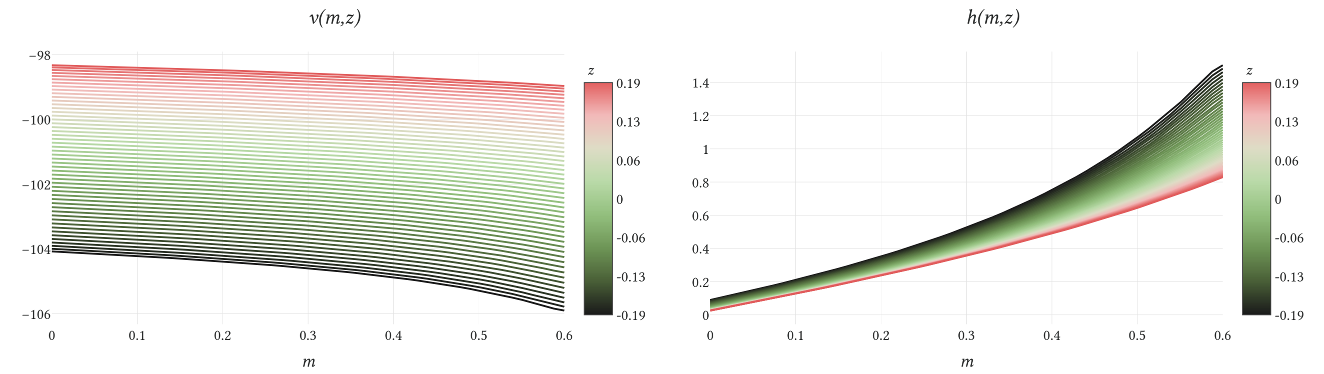

FIGURE 2: VALUE FUNCTIONS, $\theta = 0.5$

instead reverts quickly, the loan can be repaid before the monopolist has had an opportunity to raise rates and collect profits.

Figure 3 shows a simulation path, which further clarifies the lender's strategy. The swap is subsidized on the way up and, once debt has accumulated, the interest rate can increase to extract profits from the borrower. The borrower government anticipates these dynamics: the relationship between the initial subsidy and the (expected) high rates later on is disciplined by an implicit participation constraint.

FIGURE 3: SIMULATED PATH, $\theta = 0.5$

Figure 11 in the Appendix, which simulates a model with $\theta = 0$, shows that when the borrower holds all the bargaining power, it is able to borrow at rate β_L^{-1} at all times. Because rates do not go up once the loan is large, they cannot be negative when it is still small. This effectively recovers an income fluctuations problem at the risk-free rate without default.

3. Model with defaultable debt and swaps

In this section we present the full version of our model, in which the borrowing government has access to the monopolist as well as a competitive fringe of lenders. Default on the debt b held by competitive lenders is possible, subject to standard output costs of default. However, for the same reasons as before, bilateral loans m cannot be defaulted on.

A period takes place as follows.

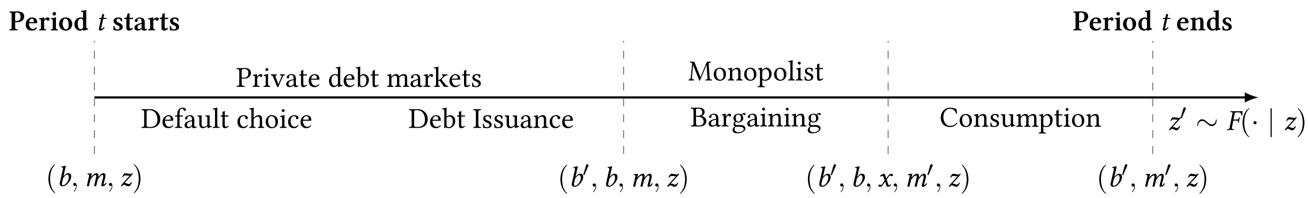

Figure 4: Timeline of events while not in default

At the start of t, the government owes m to the monopolist, b to the fringe, and observes the exogenous state z. Additionally, the economy can be in default ($\zeta = 1$) or in repayment ($\zeta = 0$). Let $v(b, m, z)$ and $h(b, m, z)$ represent the government's and the monopolist's value functions in case of repayment, and similarly $v_D(m, z)$ and $h_D(m, z)$ in case of default.

Private markets In the morning of t, first, the government decides default for the current period if it is in repayment.

$$v(b, m, z) = \max\left\{v_R(b, m, z) + \varepsilon_R, v_D(m, z) + \varepsilon_D\right\} \tag{3}$$

where the ε's follow a Type 1 Extreme Value distribution, yielding closed forms for $v(b, m, z)$ and the (ex-post) default probability $\mathcal{P}(b, m, z)$

$$\begin{aligned} v(b, m, z) &= \chi \log\left(\exp(v_D(m, z)/\chi) + \exp(v_R(b, m, z)/\chi)\right) \\ \mathcal{P}(b, m, z) &= \frac{\exp(v_D(m, z)/\chi)}{\exp(v_D(m, z)/\chi) + \exp(v_R(b, m, z)/\chi)} \end{aligned}$$

If it is not in default, the government issues new debt b' to the fringe of lenders understanding the value of entering negotiations with the monopolist having issued debt b'

$$v_R(b, m, z) = \max_{b'} w_R(b', b, m, z) \tag{4}$$

The price faced by the borrower government reflects its lenders' expectations of repayment, discounted with a risk-neutral kernel

$$q(b', b, m, z) = \frac{1}{1+r}\mathbb{E}\left[(1 - 1_{\mathcal{D}}(b', m'(b', b, m, z), z'))\left(\kappa + (1-\rho)q(b'', b', m'(b', b, m, z), z')\right) \mid z\right] \tag{5}$$

where $1_{\mathcal{D}}(b, m, z)$ denotes the government's default policy (as perceived by lenders), $b'' = b'(b', m'(b', b, m, z), z')$ is the expected debt issuance in the following period and $m'(b', b, m, z)$ is the expected result of negotiations with the monopolist, to happen in the afternoon.

Bilateral loan In the afternoon of t, the government meets with the monopolist to negotiate the loan m. As before, the outcome of their negotiation is a transfer x and new loan size m' which solve the following Nash bargaining problem

$$\max_{m',x} \mathcal{L}_R(b', x, m, m', z)^{\theta} \; \mathcal{B}_R(b', b, x, m, m', z)^{1-\theta}$$
$$\text{or} \tag{6}$$
$$\max_{m',x} \mathcal{L}_D(x, m, m', z)^{\theta} \; \mathcal{B}_D(x, m, m', z)^{1-\theta}$$

As before the monopolist's surplus is

$$\begin{aligned}
\mathcal{L}_R(b', x, m, m', z) &= -x - m + \beta_L \mathbb{E}\left[h(b', m', z') - h(b', 0, z') \mid z\right] \\
\mathcal{L}_D(x, m, m', z) &= -x - m + \beta_L \mathbb{E}\left[\psi\left(h(0, m', z') - h(0, 0, z')\right) + (1-\psi)\left(h_D(m', z') - h_D(0, z')\right) \mid z\right]
\end{aligned}$$

while the borrower's surplus is

$$\begin{aligned}
\mathcal{B}_R(b', b, x, m, m', z) &= u(y(z) + P(b', b, m, z) + x) - u(y(z) + P(b', b, m, z) - m) + \\
&\quad + \beta \mathbb{E}\left[v(b', m', z') - v(b', 0, z') \mid z\right] \\
\mathcal{B}_D(x, m, m', z) &= u(y_D(z) + x) - u(y_D(z) - m) + \\
&\quad + \beta \mathbb{E}\left[\psi\left(v(0, m', z') - v(0, 0, z')\right) + (1-\psi)\left(v_D(m', z') - v_D(0, z')\right) \mid z\right]
\end{aligned}$$

where the function $y_D(z) = y(z) - \xi(z)$ is output in default and P summarizes net transfers from lenders. We assume long-term debt in the form of standard geometrically-decaying coupons which yield $P(b', b, m, z) = q(b', m, z)(b' - (1-\rho)b) - \kappa b$. In default, opportunities to reaccess markets arrive with probability ψ.[1] The bargaining problems yield new terms for the bilateral loan $x_R(b', b, m, z)$, $m'_R(b', b, m, z)$ and $x_D(m, z)$, $m'_D(m, z)$ in default and repayment.

After the negotiation is done and transfers settled, consumption takes place, which also determines the expected value of beginning negotiations

$$\begin{aligned}
c_{\zeta}(b', b, m, z) &= y(z) + P(b', b, m, z) + x_{\zeta}(b', b, m, z) \\
w_R(b', b, m, z) &= u(c_R(b', b, m, z)) + \beta \mathbb{E}\left[v\left(b', m'_R(b', b, m, z), z'\right) \mid z\right] \\
w_D(m, z) = v_D(m, z) &= u(c_D(m, z)) + \beta \mathbb{E}\left[\psi v\left(0, m'_D(m, z), z'\right) + (1-\psi) v_D\left(m'_D(m, z), z'\right) \mid z\right]
\end{aligned} \tag{7}$$

and the monopolist's value functions

$$\begin{aligned}
h(b, m, z) &= \mathcal{P}(b, m, z) h_D(m, z) + (1 - \mathcal{P}(b, m, z)) h_R(b'(b, m, z), b, m, z) \\
h_R(b', b, m, z) &= a - x_R(b', b, m, z) + \beta_L \mathbb{E}\left[h(b', m'_R(b', b, m, z), z') \mid z\right] \\
h_D(m, z) &= a - x_D(m, z) + \beta_L \mathbb{E}\left[\psi h(0, m'_D(m, z), z') + (1-\psi) h_D(m'_D(m, z), z') \mid z\right]
\end{aligned} \tag{8}$$

4. Quantitative results

We parametrize our model at a quarterly frequency following standard strategies in the sovereign default literature (most parameters taken from the calibration to the 2001 Argentina default in Roch and Roldán, 2023). Table 1 summarizes our parametrization.

[1] As debt resets to zero, a government will always take the opportunity to exit the default.

Table 1: Baseline parameter values

	Parameter	Value
Sovereign's discount factor	β	0.9852
Sovereign's risk aversion	γ	2
Preference shock scale parameter	χ	0.025
Lender's bargaining power	θ	0.5
Risk-free interest rate	r	0.01
Duration of debt	ρ	0.05
Income autocorrelation coefficient	ρ_z	0.9484
Standard deviation of y_t	σ_z	0.02
Reentry probability	ψ	0.0385
Default cost: linear	d_0	-0.24
Default cost: quadratic	d_1	0.3

When both debt with private competitive lenders and swaps with the monopolist are available, they are clearly substitutes. For instance, Figure 5 shows that the default probability (which only affects private debt) is increasing in both types of indebtedness, fixing income at its mean.

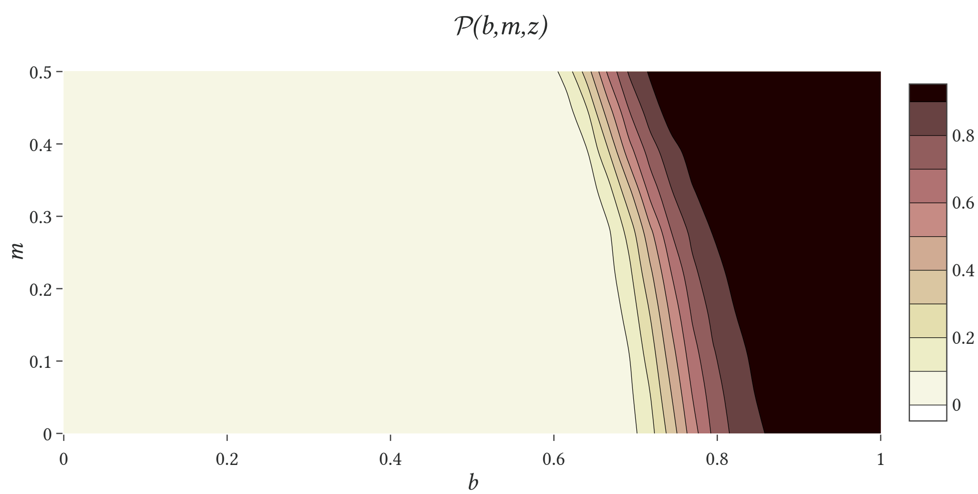

Figure 5: Default probability

Figure 6 compares an economy with access to swaps but with current level $m = 0$, on the left, to an economy in which the swap is not available, on the right. It shows that the availability of swaps exacerbates sovereign risk by raising the option value of default: the economy with access to swaps defaults at lower levels of debt (or higher levels of income) than the one without them.

Moreover, since the monopolist keeps a share of the surplus generated by the swap, the borrower economy is reluctant to borrow from it. Figure 7 shows simulations paths for identical economies with and without access to bilateral loans. Even when bilateral loans are available, most of the borrowing takes place in private markets.

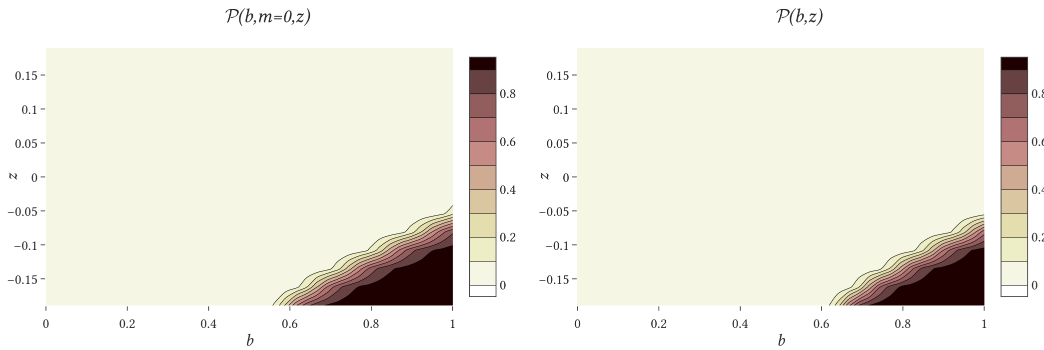

FIGURE 6: DEFAULT PROBABILITY AT $m = 0$ WITH (LEFT) AND WITHOUT (RIGHT) SWAPS

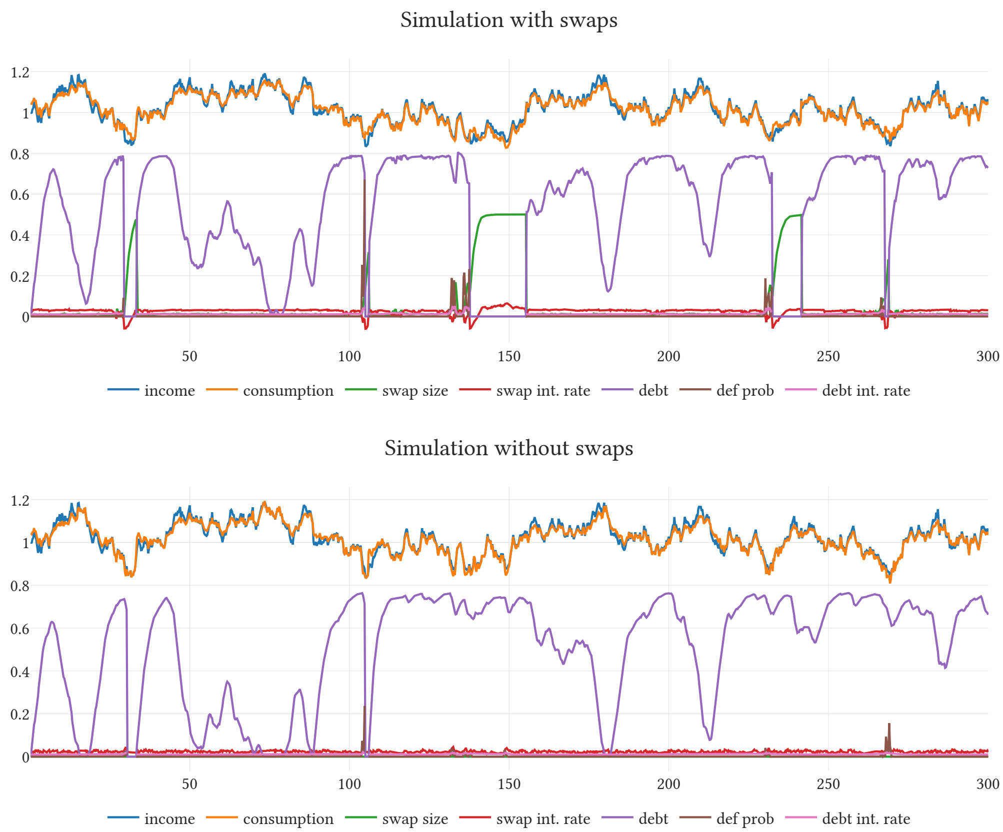

FIGURE 7: SIMULATED PATHS WITH AND WITHOUT SWAPS, $\theta = 0.5$

However, when default risk makes private borrowing more expensive (and when the costs associated with default become possible), the government resorts to borrowing from the monopolist in order to reduce private debt and hence contain spreads. Episodes of default are preceded by drawings from the swap in an effort to avoid or postpone default. The monopolist subsidizes accumulation of debt under the swap in these circumstances, expecting to increase rates when either income improves and the government pays down the debt and the swap, or the government defaults and its threat point becomes less credible. Finally, when the economy is actually in default, the monopolist resorts to its strategy from Section 2 of subsidizing debt accumulation to charge a high interest rate later. When the economy exits default, it uses its new debt capacity to convert the swap to private debt and avoid high interest payments.

Observation In the simulation above there are at least two distinct episodes ($\sim$140, $\sim$230) and in which the economy defaults when swaps are available but not when they are not. It is also clear from Figure 7 that the possibility of bilateral loans induces more issuance in private debt markets, as debt levels are higher in the simulation with swaps than without. The higher indebtedness is supported by (*i*) the possibility of drawing on the swap if or when debt payment becomes difficult, (*ii*) the higher value of default when swaps are available. Both of these have opposite effects on the default probability and hence on spreads, so borrowing costs do not play an obvious role.

The availability of bilateral loans affects the economy in two ways: on the one hand, they provide extra financing when default risk is present and makes borrowing in private markets costly. But they also provide funds in default, which raises the value of being excluded from private markets and consequently spreads. To disentangle these effects, we consider a variant of the model in which the loan size cannot be increased while the economy is excluded from private debt markets, in other words, a variant with the extra constraint that $m'_D(m, z) \leq m$.

4.1 Default probabilities and debt prices

Figure 8 shows ex-post default probabilities as a function of the debt level in private markets b, when the bilateral loan $m = 0$ and a certain level of income, as a function of the lender's bargaining power θ. Solid lines, corresponding to the version of the model with unrestricted bilateral loans in default, show that default is more likely when bilateral loans are available, for almost all debt levels (except for the case of all the bargaining power for the borrower). In contrast, the models in which no extra funds can be obtained from the monopolist while in default (marked Limited) all display a lower default probability.

Figure 8 highlights the negative impact of bilateral loans. When the monopolist can provide funds during default, it makes private debt repayment less attractive. The higher default probability translates into lower prices for debt, as shown in Figure 9. However, the figure also reveals that debt prices are lower in part of the state space even when the bilateral loan is limited. The fact that debt prices can be lower for the economy with Limited access to swaps than the one without any access while the one-period-ahead default probability is also lower means that the Limited economies accumulate more debt later on, which eventually results in a higher default probability which support the lower prices. In other words, the option of swaps, even when they are Limited, worsens overborrowing and the debt dilution problem.

These forces combine to produce welfare losses of bilateral loans. Figure 10 shows the government's value function as a function of debt b when the bilateral loan is 0. Except when the government holds all the bargaining power, the 'limited' version is preferred to the unrestricted one. However, except is the bargaining power is very large, the presence of swaps actually causes welfare losses for the government, because of the worsening in debt prices discussed above.

Figure 12 in the Appendix confirms this intuition about debt dilution. In particular, it shows that with short-

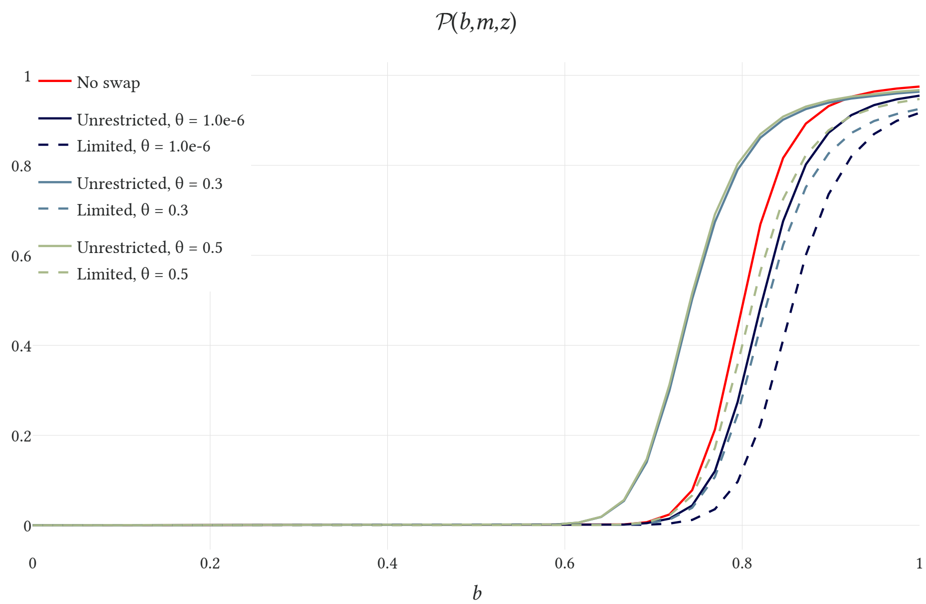

Figure 8: Default probability

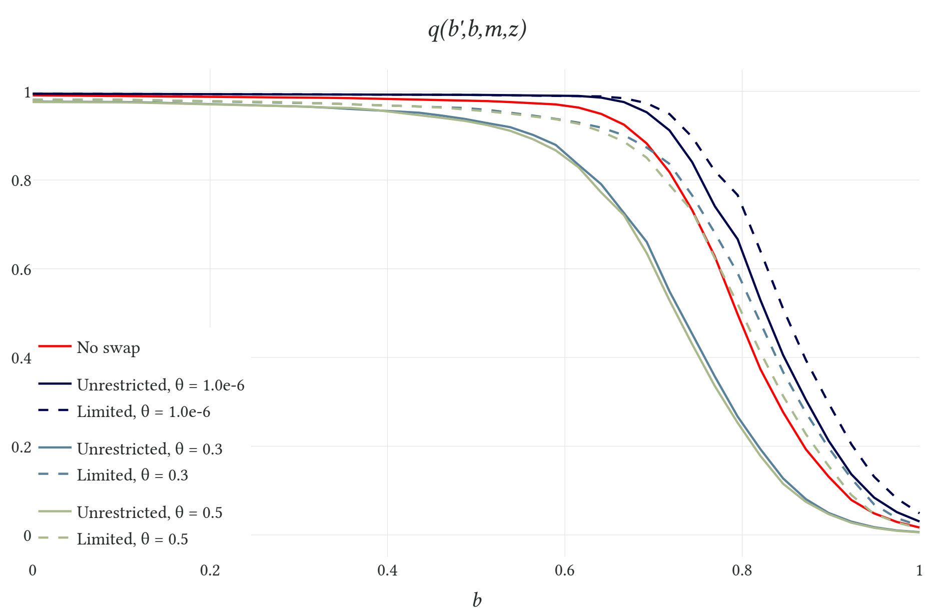

Figure 9: Debt prices

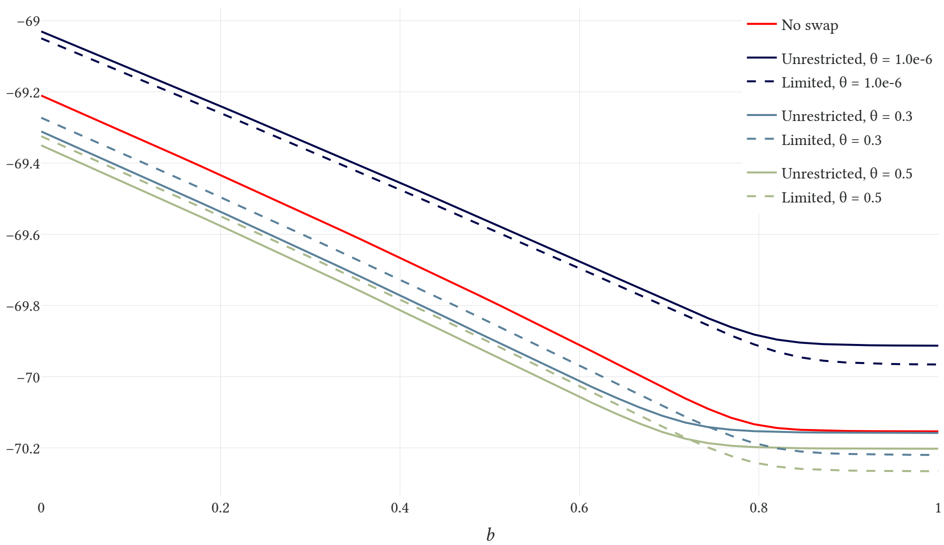

Figure 10: Value functions

term debt there are welfare gains for a larger range of values of the bargaining weight parameter. Furthermore, the "limited" version generates welfare losses with respect to the "unrestricted" one with short-term debt.

5. Concluding remarks

Should drawn Central Bank swap lines be counted in public debt? We argue that swaps are a natural vehicle for sovereign borrowing when market access is limited, consistent with empirical observations over the past decade. Our model highlights the interaction between the terms of both types of debt and how the possibility of each affects the outside option (explicitly for bilateral loans and implicitly for private debt) of the other.

Our results suggest that having more sources of indebtedness can be detrimental for the borrowing government. The price of swaps can include large premia as a consequence of market power. Furthermore, while swaps could in some cases help a government fend off default, they also make it more likely by allowing borrowing during the exclusion period, effectively diminishing the output costs of default which, in most models, sustain sovereign borrowing in the first place.

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A. More results

Figure 11 shows that when the borrower holds all the bargaining power, the swap interest rate is constant at β_L^{-1}.

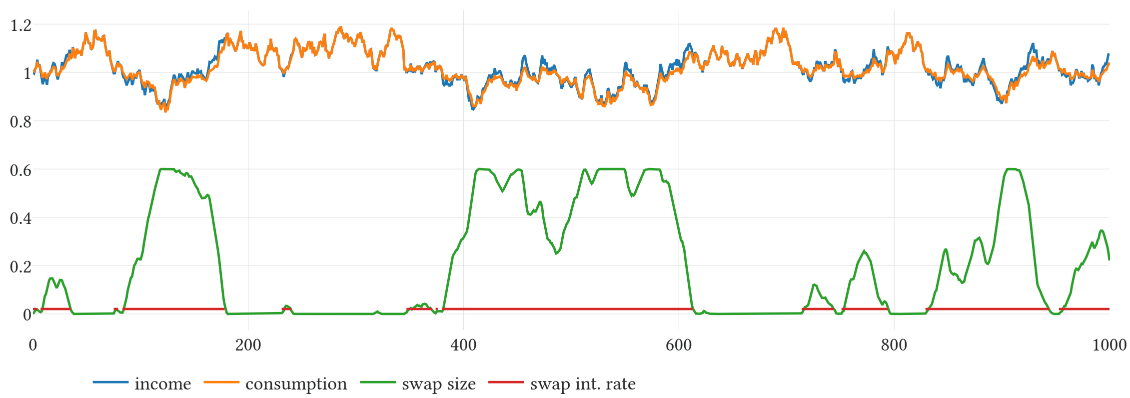

Figure 11: Simulated path, $\theta = 0$

Figure 12 shows that, (*i*) with short-term debt, allowing the swap to be drawn while in default provides welfare gains and (*ii*) there are welfare gains from the swap for a larger range of values of the bargaining weight, in particular for $\theta \leq 0.3$.

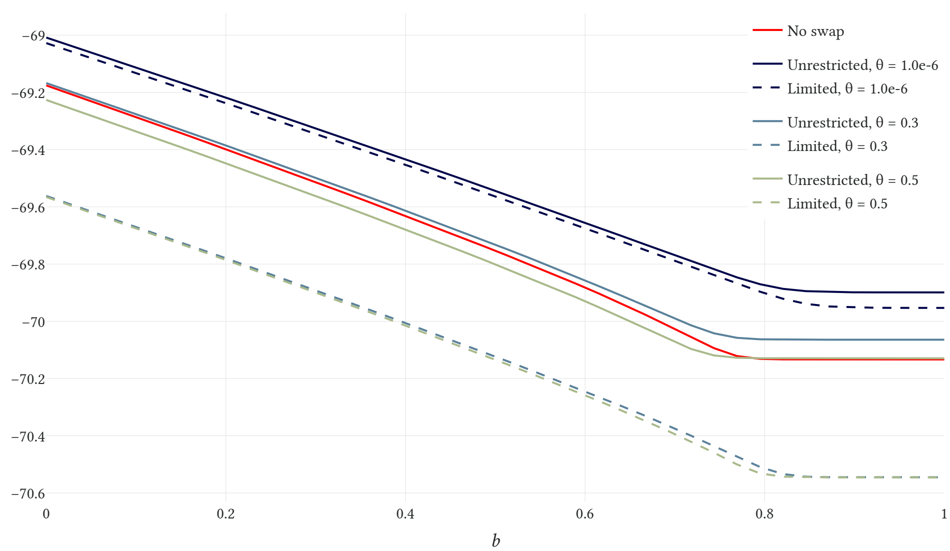

Figure 12: Value functions, short-term debt