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Dealing with Systemic Sovereign Debt Crises: Fiscal Consolidation, Bail-ins or Official Transfers?

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Abstract

The paper presents a tractable model to understand how international financial institutions (IFIs) should deal with the sovereign debt crisis of a systemic country, in which case private creditors' bail-ins entail international spillovers. Besides lending to the country up to its borrowing capacity, IFIs face the difficult issue of how to address the remaining financing needs with a combination of fiscal consolidation, bail-ins and possibly official transfers. To maximize social welfare, IFIs should differentiate the policy mix depending on the strength of spillovers. In particular, stronger spillovers call for smaller bail-ins and greater fiscal consolidation. Furthermore, to avoid requiring excessive fiscal consolidation, IFIs should provide highly systemic countries with official transfers. To limit the moral hazard consequences of transfers, it is important that IFIs operate under a predetermined crisis-resolution framework that ensures commitment.

JEL Classification Numbers: F33, F34, F4

Keywords: Sovereign default, fiscal consolidation, debt restructuring, bail-ins, transfers, moral hazard.

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Contents

1 Introduction

The recent euro-area crisis has triggered an animated debate on how to deal with the sovereign debt crisis of a systemic country. In particular, the crisis has brought to the forefront the risk that a debt restructuring that imposes losses on private creditors, i.e. a bail-in, may spread large systemic spillovers to the rest of the international community. For example, in the case of Greece, Ireland, and Portugal, there were fears that a restructuring of sovereign bonds could have caused widespread financial turmoil, by possibly destabilizing the European banking sector and triggering runs on other sovereign debt markets.[1]

The risk of international spillovers stemming from bail-ins is likely to reappear in future crises. As the world becomes more financially integrated and countries' balance sheets continue to grow, the potential for sovereign crises to destabilize the international community will remain a very concrete possibility. On the one hand, this calls for stronger and more sophisticated prudential regulation that can limit the possible spillovers associated with debt restructuring. On the other, it poses major new challenges for those international financial institutions (IFIs) that are tasked to resolve sovereign debt crises, among which for example the International Monetary Fund and the European Stability Mechanism. In particular, it raises crucial questions about how to update their crisis-resolution frameworks. The purpose of this paper is to address the latter issue by developing a tractable model that can transparently characterize the trade-offs faced by IFIs and solve for their optimal intervention strategy. In doing so, we assume that IFIs aim to maximize social welfare, defined as the aggregate welfare of the country, its creditors, and the international community at large.

The model considers a country that faces financing needs potentially larger than its borrowing capacity. In this case, under the laissez-faire equilibrium the model features a disruptive default involving the inefficient liquidation of capital and a decline in output. This is because of two forms of market failures that notoriously hinder the resolution of sovereign debt crises: the inability of the country to commit to fiscal consolidation and the lack of coordination among creditors in accepting an orderly debt restructuring. In the context of the model, IFIs are able to improve upon the laissez-faire equilibrium because they can use program conditionality to ensure that the country implements fiscal consolidation,

[1] Emblematic of these concerns was the decision by the International Monetary Fund (IMF) in 2010 to amend its lending framework by introducing the so called "systemic exemption". If a country requires "exceptional access" to Fund resources, the IMF can lend only if public debt is assessed to be sustainable with high probability. If this is not the case, IMF financing should be contingent on a debt restructuring operation that restores sustainability with high probability. The "systemic exemption" was introduced to waive the latter requirement in cases where debt is sustainable, but not with high probability, and debt restructuring entails "a high risk of international systemic spillovers". The exemption was invoked in dealing with the sovereign debt crises of Greece, Ireland, and Portugal.

and can coordinate creditors to negotiate an orderly debt restructuring.[2] In doing so, IFIs should lend to the country up to its borrowing capacity. Furthermore, IFIs face the difficult decision of how to address any remaining financing need through a combination of three possible tools: fiscal consolidation by the country; a bail-in operation that involves the restructuring of sovereign debt held by private creditors; or official transfers from the international community, for example through the restructuring of debt held by the official sector or concessional financing.[3] The main purpose of the paper is to solve for the optimal combination of these financing tools by considering not only their ex-post costs during a crisis, but also their ex-ante moral hazard effects on countries' behavior.

Let us first consider the optimal policy mix to address the financing needs of a non-systemic country, for which bail-ins do not entail international spillovers. In this case, besides lending to the country up to its borrowing capacity, IFIs should use only fiscal consolidation and bail-ins. In particular, they should choose the combination that minimizes the ex-post costs of covering the country's financing needs in excess of its borrowing capacity, without worrying about the ex-ante effects on countries' behavior. This is because – to the extent that creditors price the expected losses from debt restructuring into higher ex-ante borrowing costs – bail-ins do not generate moral hazard: imprudent behavior that increases the likelihood of a future debt restructuring is penalized through an increase in sovereign spreads.[4] Official transfers should instead be avoided because they do generate severe moral hazard since they are not priced into countries' ex-ante borrowing rates. Note that resolving a non-systemic crisis poses relatively limited requirements on the operational frameworks of IFIs. In particular, IFIs can operate effectively even if they are unable to provide transfers and have no commitment ability, i.e. they narrowly focus on minimizing the ex-post costs of resolving the crisis.

Dealing with the sovereign debt crisis of a systemic country, in which case bail-ins impose negative externalities on the international community, raises significant new challenges. A first implication is that bail-ins should be used to a lesser extent since they are more socially harmful due to the associated spillovers. If IFIs are prevented from providing transfers, any reduction in bail-ins would need to be offset entirely through an increase in fiscal consolidation. In this case, systemic countries might be required to endure an excessive amount of consolidation to spare the international community from the systemic

[2] As later discussed in the literature review, IFIs can also play a more traditional role as liquidity providers to avoid self-fulfilling runs. We dispense from this aspect since it is already well understood and equally applies to both non-systemic and systemic countries.

[3] In the case of concessional financing, the transfer component is given by the difference between the concessional and actuarially-fair financing terms. Note that the conventional notion of bail-outs tends to incorporate both non-concessional financing as well as official transfers. We keep these concepts distinct in the paper since only official transfers generate severe moral hazard.

[4] As clearly explained once analyzing the model implications, bail-ins involves a form of moral hazard in the case of systemic countries, since creditors do not price the spillover costs into sovereign borrowing rates.

consequences of bail-ins.

When dealing with systemic countries, it may thus become efficient to compensate the reduction in bail-ins not only through greater fiscal consolidation, but also with official transfers. As previously mentioned, it is important to consider that transfers can generate severe moral hazard effects since the costs sustained by the international community are not priced into sovereign spreads. In particular, the expectation of transfers induces countries to behave ex-ante less prudently than socially optimal. This raises a time-consistency problem for IFIs that would want to pledge ex-ante not to provide transfers, but actually use them ex-post. Therefore, the net benefits from transfers crucially depend on the extent to which IFIs can be endowed with commitment, i.e. they can operate under a binding framework that constrains their actions during a crisis to limit ex-ante moral hazard.

The model allows us to analyze the implications of official transfers under alternative assumptions about commitment. If IFIs have no commitment at all, they would exclusively focus on minimizing the ex-post costs of a crisis with no concern for the ex-ante moral hazard consequences. IFIs would thus rely on transfers to avoid any bail-ins whenever they are associated with spillover effects. The resulting severe moral hazard effects could greatly reduce social welfare, possibly leading to an inferior outcome than if IFIs are prevented from using transfers at all. At the opposite extreme, we could consider the case in which IFIs have full commitment including the ability to use ex-ante conditionality, i.e. to credibly deny assistance to countries that have not behaved prudently enough. This approach would in principle eliminate the moral hazard concerns associated with official transfers and allow IFIs to only focus on minimizing the ex-post costs of a crisis. As in the case with no commitment, IFIs would then use transfers to entirely avoid bail-ins whenever they entail spillovers.

The use of strict ex-ante conditionality is, however, problematic since it is politically difficult to punish countries confronting a crisis because of their alleged past mis-behavior.[5] We thus focus on the optimal solution assuming that IFIs can commit to a given crisis-resolution framework, but cannot impose ex-ante conditionality. We see this as a realistic characterization of the operational constraints of IFIs. Furthermore, this is a particularly interesting case to analyze since it requires IFIs to optimally balance the desire to reduce the ex-post costs of the crisis with the need to limit the ex-ante moral hazard effects. This tension closely captures the lively debate about the euro-area debt crisis, where some commentators emphasize the ex-post costs from fiscal consolidation and the contagion risks from bail-ins in 2010, while others point out the moral hazard consequences of official transfers.

[5] A politically compelling argument against ex-ante conditionality is that, at times of crises, voters often elect new governments that condemn previous policies and ask not to be penalized for the errors of their predecessors.

The optimal framework involves a restrained use of transfers that should be provided only to highly systemic countries in order to limit bail-ins without requiring excessive fiscal consolidation. Nonetheless, to contain moral hazard, the provision of transfers should still be complemented with greater fiscal consolidation demands than for countries not receiving transfers: systemic countries would thus behave prudently by knowing that transfers during a crisis will be coupled with more stringent requests for fiscal consolidation. A welcome feature of this framework is that it could ensure similar expected welfare across systemic and non-systemic countries: the benefits from transfers could indeed be roughly compensated by the losses from greater consolidation. This should facilitate support across countries and limit pressures to modify the framework in times of crises.

Summing up, the paper suggests that to properly deal with the sovereign crises of systemic countries, IFIs should tailor their crisis-resolution policies on the strength of spillovers. In particular, IFIs should reduce the extent of bail-ins in more systemic countries due to the associated spillover effects and demand greater fiscal consolidation. However, to avoid imposing excessive fiscal consolidation, IFIs should also provide highly systemic countries with transfers. In doing so, it is crucial that IFIs operate under commitment by following a pre-determined crisis resolution framework that limits discretion in times of crisis. Otherwise, IFIs would have an incentive to over-provide transfers, thus generating excessive moral hazard.

The paper is organized as follows. After reviewing the related literature, we describe the structure of the model in Section 2. We characterize the laissez-faire equilibrium in Section 3 and consider the role of IFIs and their implications for welfare in Section 4. We conclude in Section 5 by summarizing the key insights of the analysis and discussing a few issues for future research.

Literature review. The academic literature has rationalized the role of IFIs, and the IMF in particular, in several ways. One approach is to consider IFIs as international lenders of last resort to address liquidity crises. As in the case of individual banks (Diamond and Dybvig, 1983), sovereign countries may also suffer from self-fulfilling runs due to coordination problems among private creditors (Calvo, 1988; Detragiache, 1996; Cole and Kehoe, 2000). These liquidity crises can arise even if countries are fundamentally solvent, forcing unnecessary sharp fiscal adjustments and possibly disruptive defaults. If endowed with sufficient financial resources (Jeanne and Wyplosz, 2003), IFIs can avoid these effects, as well as prevent runs in the first place, by simply extending official financing to solvent countries (Sachs, 1995; Fischer, 1999; Rochet and Vives, 2004; Jeanne and Zettelmeyer, 2005*b*). Our model can easily incorporate a role for IFIs as pure liquidity providers since it assumes lack of coordination among private creditors. However, we leave this aspect aside since it applies

equally to systemic and non-systemic countries. We instead emphasize two other important functions played by IFIs that have received less attention in the literature and require a different approach depending on the extent of spillovers associated with bail-ins.

First, IFIs can help countries commit to a given set of policies. A crucial characteristic of sovereign debt markets is that countries cannot commit to repay their obligations (Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008; Mendoza and Yue, 2012; Dovis, 2014). Since sovereign contracts are difficult to enforce in legal courts, the risk of repudiation can severely curtail market access when the country's fundamentals are weak. Our model captures this aspect by assuming that countries cannot commit to undertake fiscal consolidation. As we will see, this implies that if the country's financing needs are sufficiently large, the laissez-faire equilibrium features credit rationing and capital liquidation. As already mentioned in Sachs (1984) and Claessens and Diwan (1990) and formalized more recently in Jeanne, Ostry and Zettelmeyer (2008), IFIs can improve upon the laissez-faire allocation by using program conditionality. For example, the IMF has developed over time a lending technology, involving trenched disbursements and frequent program reviews, that constrains the country to follow a given set of policies. In doing so, IFIs can provide the country with commitment and improve market access. An important constraint, that we incorporate in the model, is that IFIs should increase the country's welfare relative to the laissez-faire equilibrium, otherwise the country would simply abandon the program.

Second, IFIs can facilitate coordination among creditors. An important feature of sovereign debt markets is the lack of an international bankruptcy regime. Despite the growing use of collective action clauses, coordination problems across creditors can thus severely complicate a bail-in operation, for example through free-riding incentives and hold-outs (Wright, 2005; Pitchford and Wright, 2012). IFIs can play an important role in alleviating these problems. They are indeed well-placed to reach out to creditors and induce them to accept an orderly debt restructuring. For example, IFIs may require debt restructuring as a pre-condition for a program that would improve the country's ability to repay at least part of the debt. As in the case of program conditionality, the model takes into account that IFIs can induce creditors to accept a bail-in only if they are better off than under the laissez-faire equilibrium.

The literature on the role of IFIs has also witnessed a lively debate on the moral hazard consequences of policy intervention. Some have argued that by lowering the costs of sovereign crises, IFIs reduce countries' incentives to behave prudently leading to a higher incidence of crises (Barro, 1998; Calomiris, 1998; Meltzer Commission, 2000). Others have pointed out that, by avoiding self-fulfilling crises, IFIs may actually strengthen the incentives to follow good policies (Morris and Shin, 2006; Cordella and Yeyati, 2005; Corsetti, Guimaraes and Roubini, 2006). Finally, Jeanne and Zettelmeyer (2005*a*) have shown that

even if IFIs lead to less prudent policies, this could be the socially efficient outcome of a better technology to resolve crises. Our model captures the moral hazard implications of different financing tools by considering the effects on the country's ex-ante prudential behavior and, more specifically, on possible deviations from the socially efficient level.

2 A model of systemic sovereign debt crises

2.1 Model structure

We consider a three period model, $t \in \{0, 1, 2\}$, that features a country, its private creditors, and the international community. For the sake of simplicity, we assume that agents do not discount the future and that the world risk-free rate r^* is equal to zero. At time 0, the country invests an exogenous level of capital k which produces Ak units of output at time 2, with $A > 1$. Capital can be liquidated in period 1 in which case it returns χk output units where $\chi < 1$. The country finances investment by issuing one-period government bonds at time 0 and pledging a repayment equal to $k(1 + r)$ in time 1, where r is the interest rate. For notational convenience, we define $R = 1 + r$.

At time 1, the country confronts a random primary fiscal deficit d which is distributed as follows

$$d = \begin{cases} 0 & \text{with probability } p \\ D & \text{with probability } (1 - p) \end{cases}$$

where D is a random variable distributed between 0 and $\bar{D} > 0$ with CDF denoted with $\Phi(\bullet)$. We refer to p as the probability of the "non-crisis state" and to $(1 - p)$ as the probability of the "crisis state" since the country confronts a primary fiscal deficit.

Following Jeanne, Ostry and Zettelmeyer (2008), we let the country control the probability of the crisis state by acting ex-ante more or less prudently. As explained later on, this allows us to analyze the moral hazard implications of different policy instruments. In particular, we assume that the country can exercise a crisis-prevention effort e that entails a convex utility cost $z(e)$, but increases the probability p of the non-crisis state

$$\frac{\partial p}{\partial e} > 0$$

This effort captures how prudently the country's authorities manage fiscal accounts and macroeconomic policies. Since lenders can largely monitor government policies by reviewing legislative decisions, macroeconomic data, and the reports of various international institutions, we treat the crisis-prevention effort as observable.

Turning to the decisions at time 1, the country has to rollover the debt Rk and finance

the primary deficit d. We consider two possible scenarios depending on whether or not the country is able to cover its financing needs. We first describe the model in case financing needs are met so that production continues until time 2. We then consider the alternative scenario where the country is unable to cover its financing needs and creditors trigger the full liquidation of capital. We avoid describing the model under partial capital liquidation since it is not an equilibrium.

2.2 Financing needs are met and production continues

Financing needs can be covered in several ways. First, the country can issue new bonds b against time-2 production Ak. The model does not feature any uncertainty between time 1 and time 2. Therefore, contingent on avoiding capital liquidation, the country can issue bonds b at the risk-free rate (equal to zero by assumption) subject to the following limit:

$$b \leq Ak \tag{1}$$

Second, the country can undertake a fiscal consolidation of size f. We assume that fiscal adjustment entails a utility cost $h(f)$ for the country which is assumed to be convex to reflect, for example, curvature in the utility function of domestic agents or non-linearities in the contractionary effects of fiscal consolidation. To enhance tractability, we use the following functional form

$$h(f) = f + \alpha f^2/2$$

where $\alpha > 0$ is a parameter that controls the marginal cost of fiscal consolidation.

Third, private creditors may agree to a bail-in i that provides the country with some debt relief without triggering capital liquidation. These operations, even if they are accepted by creditors without litigation, entail a broad range of costs, ranging from administrative and legal fees during the negotiation process to distress in domestic financial markets that limits access to finance and depresses output. We capture these costs by assuming that any transfers from creditors to the country through debt restructuring involves a partial loss of resources. More specifically, we assume that an haircut $(1 + \xi)i$ on creditors is associated with a net debt relief for the country equal to i, where the parameter $\xi \geq 0$ controls the efficiency losses associated with debt restructuring.[6]

Furthermore, we allow for the possibility that a bail-in operation may impose negative spillovers to the rest of the international community. This could happen through two main channels. First, there could be a mechanical balance-sheet channel. For example, if banks

[6]Note that the model places no restrictions on whether the costs ξ are paid by the country or the creditors. These costs simply capture the notion that debt restructuring entails some efficiency losses that do not allow for a costless redistribution of resources from the creditors to the country.

holding government bonds do not have sufficient capital buffers, they might be unable to absorb the losses from debt restructuring and become insolvent, possibly triggering a destabilizing chain of bankruptcies in the financial sector. Second, bail-ins may spread panic in financial markets and possibly lead to runs on the sovereign debt of other countries. We do not take a stand on the particular form of spillovers, but simply assume that each unit i of bail-in is associated with a cost to the international community equal to λi, where $\lambda \geq 0$ controls the intensity of the spillovers. We refer to countries as non-systemic or systemic depending on whether λ is respectively zero or positive.

Finally, we consider the possibility that the international community may provide the country with *o*fficial transfers o. In the real world, transfers are generally implemented through either the restructuring of sovereign debt held by official creditors or lending at concessional rates, with the transfer component being given by the difference between the actuarially-fair and concessional terms. Differently from bail-ins, official transfers do not entail negative spillovers. This is because rather than imposing losses on private lenders, official transfers are financed by the public balance sheets of various countries. However, transfers still entail efficiency losses similar to those from bail-ins, since they also often involve complicated negotiations and lingering uncertainty. To keep the focus of the analysis on the role of transfers in preventing spillovers, we assume equal efficiency losses for bail-ins and transfers. Therefore, a transfer of $(1 + \xi)o$ resources by the international community provides the country with net funds equal to o. As discussed later on, the advantage of transfers over bail-ins in avoiding spillovers has to be traded off with the moral hazard consequences.

Summing up, at time 1 the country's total financing needs $Rk + d$ can be covered with new borrowing b, fiscal consolidation f, the bail-in i of private creditors, or official transfers o from the international community. These considerations are captured in the following financing constraint

$$b + f + i + o = Rk + d \tag{2}$$

The main purpose of the paper is to solve for the financing mix that maximizes social welfare and analyze how it varies with the size of systemic spillovers. If the financing constraint is satisfied, production can continue and, at time 2, the country consumes output net of debt repayments

$$c = Ak - b$$

2.3 Financing needs are not met and capital is liquidated

We now turn to the case in which financing needs are not met. Under particular conditions that we will characterize subsequently, the country is unable to cover its financing needs

$Rk + d$ in which case the country defaults and creditors demand the liquidation of capital. This reduces output to χk that we assume creditors can claim through litigation. A default is likely to involve higher efficiency losses that those under an orderly debt restructuring, as described in the previous section. However, for the sake of simplicity, we assume that default entails the same efficiency losses ξ. Therefore, as creditors are forcefully bailed-in and suffer losses equal to $(1 + \xi)(R - \chi)k$, the country receives debt relief i equal to $(R - \chi)k$. As in the case without liquidation, the bail-in of private creditors has the potential to generate international spillovers equal to λi. Since liquidation prevents production at time 2 the country is unable to issue bonds at time 1, $b = 0$, and has to close its primary deficit entirely through fiscal consolidation, so that $f = d$. Consumption at time 2 is zero, $c = 0$.

We interpret this scenario as a disruptive default which prevents the country from borrowing internationally and generates a substantive contraction in output, from time-2 production Ak to time-1 liquidation value χk. As we will see, even though liquidation is socially inefficient, it could arise in the laissez-faire equilibrium under fairly common forms of market failures.

The model timeline is summarized in Figure 1.

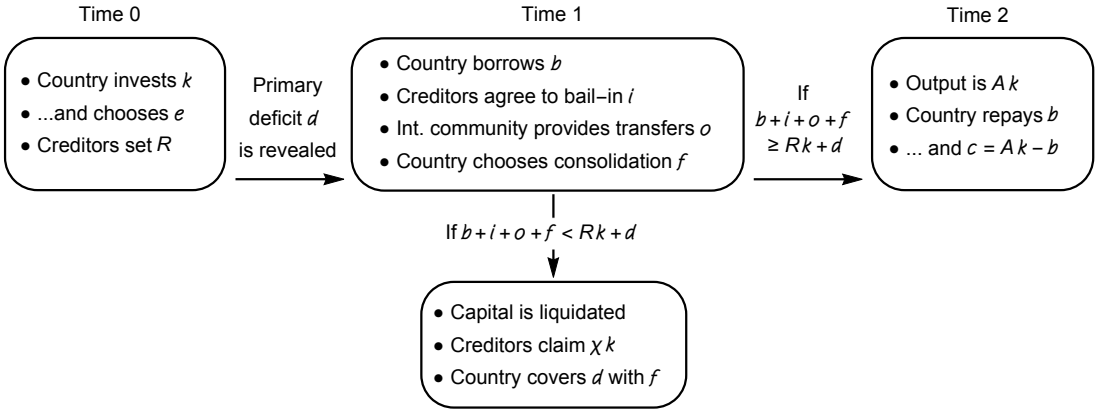

Figure 1: Model timeline.

2.4 Welfare definitions and equilibrium interest rate

We now turn to the definitions of welfare for the country, the creditors, and the international community from the perspectives of both time 0 and time 1, that we refer to as ex-ante and ex-post welfare. The country benefits from time-2 consumption c, but faces the utility costs $z(e)$ and $h(f)$ associated with the crisis-prevention effort at time 0 and fiscal consolidation

at time 1. Therefore, the country's ex-post and ex-ante welfare are given respectively by

$$\begin{aligned} U_1^C &= c - h(f) \\ U_0^C &= -z(e) + \mathbb{E}_0\left[U_1^C\right] \end{aligned}$$

where $\mathbb{E}_0$ is the expectation operator conditional on time 0.

Regarding creditors, they finance at time 0 the capital investment k and receive at time 1 the country's pledged repayment Rk net of the losses from debt restructuring $(1+\xi)i$.[7] Under the assumption of risk neutrality, their ex-post and ex-ante welfare are

$$\begin{aligned} U_1^L &= Rk - (1+\xi)i \\ U_0^L &= -k + \mathbb{E}_0\left[U_1^L\right] \end{aligned}$$

where the superscript L is mnemonic for lenders. We also assume that creditors act competitively, so that they lend to the country as long as the expected net return is equal to the zero risk-free rate, i.e. $U_0^L = 0$. The interest rate R has thus to compensate creditors for the expected losses from bail-ins according to the following break-even condition

$$\mathbb{E}_0\left[Rk - (1+\xi)i\right] = k \tag{3}$$

Note that creditors are ex-ante indifferent about the extent to which future financing needs are dealt with bail-ins since they can offset the expected losses by charging a higher lending rate.

Turning to the international community, its welfare is negatively affected by the spillovers λi from bail-ins and the costs $(1+\xi)o$ incurred to provide transfers to the country. The international community's ex-post and ex-ante welfare are thus given by

$$\begin{aligned} U_1^I &= -\left(\lambda i + (1+\xi)o\right) \\ U_0^I &= \mathbb{E}_0\left[U_1^I\right] \end{aligned}$$

Finally, by equally weighting the welfare of all agents, we define social welfare as the aggregate utility of the country, the creditors, and the international community

$$U_t^S = U_t^C + U_t^L + U_t^I$$

Note that since the break-even condition for the interest rate (3) ensures that creditors' ex-ante welfare is zero, social welfare from the perspective of time 0 is simply given by the

[7] The model also features lenders at time 1 that can either be private creditors or IFIs. Since these lenders are always repaid, their welfare is always zero and can thus be omitted from the analysis.

aggregate utility of the country and the international community.

3 Laissez-faire equilibrium

In this section we solve for the laissez-faire equilibrium of the model under two simple forms of market frictions that notoriously impair the resolution of sovereign debt crises. First, we assume that coordination problems prevent creditors from agreeing to an orderly bail-in that would provide the country with debt relief and allow production to continue.[8] This is is meant to capture the collective action problems that severely complicate debt restructuring operations, for example through free riding problems or pernicious holdouts (Wright, 2005; Pitchford and Wright, 2012).

Second, we take into account the repudiation risk that characterizes sovereign debt markets (Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008; Mendoza and Yue, 2012; Dovis, 2014) by assuming that the country cannot commit to undertake fiscal consolidation and repay creditors. The idea is that the country can try to borrow at time 1 by promising to implement fiscal consolidation. However, after issuing debt, it may prefer to use these resources to cover its primary fiscal needs and then trigger default. We incorporate this aspect into the model by assuming that the country chooses fiscal consolidation f after issuing bonds b, but before repaying Rk. After raising b, the country thus faces two options. One the one hand, it can exercise enough fiscal consolidation (if needed) to cover its total financing needs, setting $f = \max\{d + Rk - b, 0\}$, and repay creditors. Production can then continue, allowing the country to consume $Ak - b$ in period 2. In this case, the country's welfare from the perspective of time 1 is given by:

$$U_1^C = -h(\max\{d + Rk - b, 0\}) + Ak - b \qquad \text{if financing needs are met} \tag{4}$$

On the other hand, the country can use the newly issued bonds b to cover the primary deficit, limiting fiscal consolidation to any residual gap $f = \max\{d - b, 0\}$. In turn, creditors trigger the liquidation of capital leading to zero consumption at time 2. Country's utility is then equal to

$$U_1^C = -h(\max\{d - b, 0\}) \qquad \text{if financing needs are not met} \tag{5}$$

We start by solving the model under the assumption of complete financial markets, i.e. in case the country can finance investment at time 0 with state-contingent bonds whose return R can be made fully contingent on the realization of the primary deficit d. This allows us to characterize the first best equilibrium. We then limit the degree of state contingency in

[8] For example, this is the case if creditors are atomistic and can liquidate their investment with a sequential service constraint.

the interest rate R and show that the laissez-faire equilibrium can involve credit rationing and capital liquidation. We present the results in concise and intuitive terms, referring the reader to Appendix A for a formal derivation.

3.1 Complete financial markets

Let us assume that R can be made fully contingent on the realization of the primary deficit d. This requires that creditors can costlessly observe the primary deficit and have access to an enforcement mechanism. Needless to say, these assumptions poorly capture the reality of sovereign markets, but allow us to briefly characterize the first best equilibrium of the model as a useful benchmark.

The country can take advantage of state contingency in R to insure against the realizations of the primary deficit. This involves choosing a schedule for R that satisfies the financing constraint (2) and the borrowing limit (1) without the need for fiscal consolidation.[9] Therefore, the interest rate R has to decline in relation to the primary deficit d to ensure that financing needs never exceed the country's borrowing capacity

$$d + Rk \leq Ak \tag{6}$$

Turning to the crisis-prevention effort, the country chooses e to maximize its own ex-ante utility. Taking into account that the country covers its total financing needs by borrowing alone and that in the absence of bail-ins creditors' break-even condition (3) implies $\mathbb{E}_0[R] = 1$, we can write the ex-ante utility of the country as

$$U_0^C = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0[D] \tag{7}$$

where $\underline{\mathbb{E}}_0[\bullet]$ is the expectation operator conditional on the crisis state, i.e. on $d = D$. The country thus chooses the level of effort at which its marginal utility cost is equal to the marginal benefit from reducing the expected primary deficit

$$z'(e) = p'(e)\underline{\mathbb{E}}_0[D] \tag{8}$$

where z' and p' are the first derivatives with respect to e.

Note that since the equilibrium does not involve bail-ins or official transfers, the international community does not suffer any losses. Creditors' ex-ante welfare is also zero given

[9] Note that, since the schedule for R needs to also satisfy lenders' break-even condition (3), state-contingency in R can avoid fiscal consolidation in so far as the net return from production is at least as high as the expected primary deficit, i.e. $A(k-1) \geq \mathbb{E}_0[d]$. If this is not the case, fiscal consolidation would be required in some instances, leading to the risk of liquidation that we analyze in the following section.

the break-even interest rate condition. Therefore, from an ex-ante perspective, social and country's welfare coincide, i.e. $U_0^S = U_0^C$. This implies that the country's choice of the crisis-prevention effort in (8) is socially efficient and the equilibrium achieves the first best allocation. Under complete financial markets, IFIs have thus no role to play.

3.2 Incomplete financial markets

We now consider the laissez-fare equilibrium once we limit the degree of state contingency in debt contracts. To preserve tractability, we assume that the interest rate can still be contingent on the crisis versus non-crisis states of the economy, but not on the exact value of the primary deficit D within the crisis state. This captures, for example, a situation where the country can abscond from creditors the exact financing needs confronted during a crisis. More specifically, we assume that lenders demand an exogenous interest rate $\underline{R}$ in the crisis state and charge a premium $\pi > 0$ in the non-crisis state to ensure break-even in expectation

$$R = \begin{cases} \underline{R} + \pi & \text{if } d = 0 \\ \underline{R} & \text{if } d = D \end{cases} \tag{9}$$

This specification still allows for partial insurance against the primary deficit since the country faces lower interest payments in the crisis state. Nonetheless, it is sufficient to highlight the implications of the model once we depart from complete markets. Appendix C shows that the key results remain valid if we entirely eliminate state contingency in sovereign contracts by assuming a constant interest rate across both the non-crisis and crisis states.

To streamline the analysis, we assume that in the non-crisis state, where the fiscal deficit is equal to zero, the country can rollover debt with borrowing alone:

$$(\underline{R} + \pi)k \leq Ak \tag{10}$$

This assumption allows us to focus on the solution of the model under the crisis state where the country confronts a non-zero primary deficit. The premium π, that has to ensure creditors' break-even, can then be written as

$$p\pi k = (1-p)\underline{\mathbb{E}}_0[(1+\xi)i] + (1-\underline{R})k \tag{11}$$

This expression shows that π has to compensate creditors for the expected losses from bail-ins in the crisis-state as well as any deviation of the interest rate $\underline{R}$ from the zero risk-free rate.

We proceed by characterizing the laissez-faire equilibrium at time 1 since it is important

to assess whether the crisis-resolution policies proposed by IFIs are compatible with the participation of both the country and the creditors. The solution of the crisis-prevention effort at time 0 is instead presented in Appendix A.2. We first observe that if the primary deficit D is sufficiently small, the country's financing needs can be covered entirely with new borrowing. Taking into account the borrowing limit (1), this is possible as long as the primary deficit does not exceed

$$D_1 = (A - \underline{R})k \tag{12}$$

If $D > D_1$, financing needs can no longer be covered through borrowing alone. Here is where the country's inability to commit to fiscal consolidation comes into play. Creditors take into account that, after issuing debt b, the country undertakes fiscal consolidation only if the utility from preventing liquidation as defined in equation (4) is at least as large as the utility under liquidation in equation (5). Note that at the maximum borrowing level $b = Ak$, the country has no incentive to prevent liquidation since time-2 consumption is zero even if production continues. In this case the country confronts a debt overhang problem, where any benefit from fiscal consolidation would accrue to creditors through higher debt repayments as analyzed for example in Krugman (1988) and Borensztein (1990).

Therefore, once the primary deficit exceeds D_1, creditors have to restrain lending b below Ak in an attempt to elicit fiscal consolidation to cover the financing needs $f = \underline{R}k + D - b$. In fact, as shown in Appendix A, b has to fall below $\underline{R}k$, thus requiring the country to undertake a fiscal adjustment greater than its primary deficit in order to benefit from positive future consumption. The laissez-faire equilibrium can prevent liquidation through credit rationing as long as the primary deficit does not exceed the following threshold

$$D_2 = \max\left\{D_1, \frac{(A - \underline{R})k}{\alpha \underline{R}k} - \frac{\underline{R}k}{2}\right\} \tag{13}$$

Note that if the utility cost of consolidation α and the interest rate $\underline{R}$ are sufficiently high relative to productivity A, the D_2 threshold is equal to D_1. This implies that creditors are unable to elicit consolidation despite credit rationing and therefore the laissez-faire equilibrium features the loss of market access and capital liquidation as soon as the primary deficit exceeds D_1. On the contrary, if productivity is high enough relative to α and $\underline{R}$, there is a region $D_1 < D \leq D_2$ where liquidation can still be avoided by appropriately restricting credit supply to the country.

Finally, once $D > D_2$, the laissez-faire equilibrium necessarily involves capital liquidation. In this case, the country is unable to issue new bonds $b = 0$ and has to cover the primary deficit with fiscal consolidation alone $f = D$. As described in section 2.3, creditors suffer losses equal to $(1 + \xi)(\underline{R} - \chi)k$ providing the country with debt relief $(\underline{R} - \chi)k$. The

policy functions for lending b, fiscal consolidation f, and bail-ins i are plotted in Figure 2.

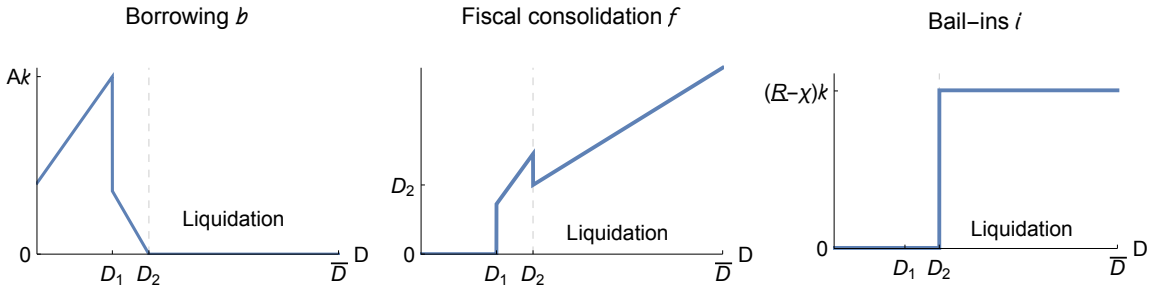

Figure 2: Laissez-faire equilibrium.

4 Crisis-resolution frameworks for IFIs

As we have seen, the laissez-faire equilibrium can entail credit rationing and costly defaults due to coordination problems among creditors and lack of commitment by the country. In this section, we consider the role of a social planner that can coordinate creditors to accept an orderly debt restructuring and provide the country with commitment to undertake fiscal consolidation. We think of the planner as broadly capturing the role of IFIs, among which for example the International Monetary Fund or the European Stability Mechanism, that can play an important role in shaping the resolution of a sovereign debt crisis. For example, IFIs can reach out to international creditors and require a debt restructuring as a pre-condition to provide official lending and monitor the country. Furthermore, as discussed in Claessens and Diwan (1990) and Jeanne, Ostry and Zettelmeyer (2008), they can use policy conditionality and trenched lending to ensure that the country follows a given fiscal consolidation plan. We also consider the possibility that the planner may mobilize official transfers from the international community.

Our main interest lies in solving for the crisis-resolution framework that maximizes social welfare. In particular, we will derive the optimal combination between fiscal consolidation, bail-ins and official transfers that should be used to cover financing needs in excess of the country's borrowing capacity. In making this decision, the planner has to trade off the benefits from reducing the ex-post costs of a crisis with the potential ex-ante moral hazard effects on the crisis-prevention effort. Furthermore, the planner's solution has to satisfy the participation constraint of both the country and the creditors, i.e. it needs to provide higher ex-post welfare than under the laissez-faire equilibrium. If not, the country or the creditors would refuse the crisis-resolution plan put forward by the planner. Note that we undertake the analysis assuming limited state contingency in debt contracts as in equation (9) and that the country can rollover debt in the non-crisis state according to equation (10). This

allows us to focus on the planner's intervention in the crisis state.

To maximize social welfare, the planner avoids liquidation since it involves an inefficient reduction in output from Ak to χk. Conditional on non-liquidation, we can derive simple expressions for the country's utility and social welfare that are helpful to show transparently the ex-post costs associated with each policy instrument and their ex-ante moral hazard consequences. By using the financing constraint (2) to substitute out borrowing b, we can rewrite ex-post social welfare as

$$U_1^S = Ak - \left(D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right) \tag{14}$$

This equation highlights the ex-post social costs associated with each policy instrument. Fiscal consolidation is socially costly because of the quadratic utility costs faced by the country; bail-ins and official transfers entail the efficiency costs ξ; furthermore, bail-ins generate the spillovers λ.

Similarly, by using lenders' break-even condition (11) to substitute out the interest premium π, we can express social welfare from an ex-ante perspective as

$$U_0^S = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right] \tag{15}$$

The crisis-prevention effort e^S that maximizes ex-ante social welfare is thus simply given by

$$z'(e^S) = p'(e^S)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right] \tag{16}$$

Regarding the country's utility, we can write ex-ante welfare as

$$U_0^C = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \tag{17}$$

This expression shows that the country internalizes the efficiency losses from bail-ins ξ since they are priced into the interest premium π. In other words, a greater reliance on bail-ins is paid by the country through higher ex-ante borrowing costs. However, the country does not internalize the possible spillovers from bail-ins λ. Furthermore, it considers official transfers as a net utility gain neglecting the costs $o(1+\xi)$ faced by the international community. The crisis-prevention effort that maximizes country's welfare e^C solves:

$$z'(e^C) = p'(e^C)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \tag{18}$$

To highlight the moral hazard costs that are associated with each financing instrument, we assume the following simple functional forms for the utility loss associated with the

crisis-prevention effort and the probability of the non-crisis state

$$\begin{aligned} z(e) &= \beta e^2/2 \\ p(e) &= \nu e \end{aligned}$$

where β and ν are positive parameters. Note that we assume that β is sufficiently high relative to ν to ensure that the probability of the non-crisis state p does not exceed one in equilibrium. Using these functional forms, we can express the difference between the socially-efficient and country-preferred level of effort as

$$e^S - e^C = \frac{\nu}{\beta} \cdot \underline{\mathbb{E}}_0 \left[\lambda i + (1+\xi)o\right] \tag{19}$$

This difference reflects the moral hazard costs that are associated with bail-ins and official transfers. We observe that bail-ins open up a wedge between e^S and e^C only if they generate spillovers to the international community. In the absence of spillovers, bail-ins do not entail moral hazard costs since the losses faced by creditors are priced into a higher interest premium π and are thus internalized by the country.[10] On the contrary, the costs faced by the international community to finance official transfers are entirely neglected by the country and are thus associated with severe moral hazard consequences.

The social planner's solution depends crucially on the assumption about commitment. On the one hand, we could assume that the planner has no commitment at all in which case she would only focus on minimizing the ex-post costs of the crisis, neglecting the ex-ante moral hazard effects. On the opposite extreme, the planner could be endowed with full commitment, including the ability to credibly use ex-ante conditionality by choosing a crisis-resolution framework contingent on the crisis-prevention effort e. In other words, the planner could threaten the country not to intervene during a crisis if the ex-ante effort deviates from the socially efficient level. If this threat is credible and sufficiently harsh to elicit the socially-efficient effort, moral hazard concerns would be entirely avoided. As a consequence, the planner would again choose the crisis-resolution framework that minimizes the ex-post costs of a crisis, exactly as under the solution without commitment.

However, the use of credible ex-ante conditionality is problematic because of two main reasons. First, should a country deviate from the socially-efficient effort, it becomes politically very difficult to deny assistance during a financial crisis. This would not only impose harsh costs on the country, but also entail large losses for creditors and the international

[10] Note that this is true since we assume that creditors can observe the crisis-prevention effort and thus price at the margin its impact on the probability of the crisis state. As mentioned in section 2.1, we think this is a reasonable assumption since lenders can largely monitor government policies by reviewing legislative decisions, macro data, and the reports of various international institutions.

community through default and possible spillover effects. Second, differently from the stylized setup of the model that features only one crisis-prevention effort, crises develop in the real world after a long series of policy choices. An efficient crisis-resolution framework would thus require a complex set of ex-ante conditionality that would be difficult to articulate and enforce. For these reasons, we will solve for optimal crisis-resolution framework under commitment that is not contingent on the crisis-prevention effort e. Without ex-ante conditionality, the planner faces a delicate balance between minimizing the ex-post costs of resolving the crisis and containing the ex-ante moral hazard effects.

To streamline the presentation and focus on the intuition, we describe in the next few sections only the key features of the planner's solution. A formal derivation of the results is presented in Appendix B. We begin the analysis by assuming that the planner cannot provide the country with transfers, characterizing the solution with and without commitment. We then solve the planner's problem allowing for transfers in the absence of commitment. Finally, we consider the case with both transfers and commitment.

4.1 Planner's solution without official transfers

In this section we solve for the crisis-resolution framework in case the planner is unable to mobilize transfers from the international community. We being by considering the problem without commitment in which case the planner maximizes social welfare from an ex-post perspective without considering the ex-ante consequences for moral hazard. Using the definition of ex-post social welfare in equation (14) and ruling out the possibility of transfers, the planner solves

$$\begin{aligned} \max_{b,f,i\geq 0} \quad & Ak - \left(D + \alpha f^2/2 + (\xi+\lambda)i\right) \\ & \text{subject to} \\ & b + f + i = \underline{R}k + D \\ & b \leq Ak \end{aligned} \tag{20}$$

We will later show that the planner' solution makes both the country and the creditors ex-post better off than under laissez faire, thus satisfying their participation constraints.

Note first that, since lending does not entail any social costs, the planner allows the country to issue bonds b up to its borrowing capacity Ak. Therefore, to the extent that the country is unable to borrow from private creditors – for example, because of the market failures analyzed in section 3.2 or a self-fulfilling run – IFIs should lend to the country themselves up to its borrowing capacity. If lending alone is unable to cover the country's financing needs, i.e. if the primary deficit is sufficiently large so that $D > D_1$, the planner

has to decide how to cover the remaining financing gap with fiscal consolidation or bail-ins. The planner chooses the least costly combination by comparing the ex-post social marginal costs (MC) of each instruments which are given respectively by

$$MC^{f}_{\text{ex-post}} = \alpha f \tag{21}$$

$$MC^{i}_{\text{ex-post}} = \xi + \lambda \tag{22}$$

where the superscript on MC denotes the financing instrument. The marginal social cost of fiscal consolidation is the marginal utility loss experienced by the country to sustain the consolidation adjustment net of the resources that fiscal consolidation generates, i.e. αf. The social marginal cost of bail-ins is given by the efficiency losses ξ plus the spillover effects λ.

Since a small amount of fiscal consolidation entails limited utility losses, fiscal consolidation should be the first policy tool to be used when the country faces financing needs in excess of its borrowing capacity. However, there is a well defined upper bound $\bar{f}$ that limits how much consolidation the country should endure. This is the level at which the marginal cost of consolidation reaches the efficiency losses associated with bail-ins:

$$\bar{f} = \frac{MC^{i}_{\text{ex-post}}}{\alpha} = \frac{\xi + \lambda}{\alpha}$$

Any remaining financing gap should be dealt exclusively with bail-ins. Note that the upper bound on fiscal consolidation increases with the size of spillovers λ. Therefore, a more systemic country is required to endure greater consolidation to limit the spillovers suffered by the rest of the international community. Albeit this is efficient from a social perspective, it clearly lowers the welfare of more systemic countries. We discuss these implications in section 4.4.

We now consider how the solution varies under commitment. In this case, the planner chooses the appropriate policy mix to maximize social welfare from an ex-ante perspective, taking into account not only the ex-post costs of resolving the crisis, but also the ex-ante moral hazard effects. Formally, the planner solves

$$\begin{aligned} \max_{e,b,f,i\geq 0} \quad & -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi+\lambda)i\right] \\ & \text{subject to} \\ & b + f + i = \underline{R}k + D \\ & b \leq Ak \\ & z'(e) = p'(e)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i\right] \end{aligned} \tag{23}$$

where the last constraint captures the country's choice of the crisis-prevention effort as in equation (18). The planner allows again the country to issue bonds up to its borrowing limit. Regarding how to cover the remaining financing needs with fiscal consolidation and bail-ins, the planner now considers their social marginal costs from an ex-ante perspective that takes into account the moral hazard implications. As shown in Appendix B, the marginal costs from an ex-ante perspective are given by

$$MC^{f}_{\text{ex-ante}} = \alpha f \tag{24}$$

$$MC^{i}_{\text{ex-ante}} = \xi + \lambda + \lambda \cdot \left(\frac{1 - p^{C}}{1 - p^{S}} - 1 \right) \tag{25}$$

where p^S and p^C denote the probability of the non-crisis state under the crisis prevention effort that is respectively socially efficient and chosen by the country. Note that the ex-ante social marginal cost of fiscal consolidation is equal to the ex-post cost in equation (21). Indeed, fiscal consolidation does not generate moral hazard since the country internalizes its costs when choosing the crisis-prevention effort. This is true also for bail-ins in case of non-systemic countries.

However, if the country is systemic, the ex-ante social marginal cost of bail-ins is higher than from an ex-post perspective. As previously discussed, this is because the country neglects systemic spillovers when deciding on the crisis-prevention effort since they are not priced into sovereign borrowing costs. The severity of moral hazard is captured by the percentage increase in the probability of the crisis under the effort chosen by the country relative to the socially efficient one, $(1-p^C)/(1-p^S)-1$. The fact that for systemic countries bail-ins are more ex-ante costly requires a higher upper bound on fiscal consolidation

$$\bar{f} = \frac{MC^{i}_{\text{ex-ante}}}{\alpha}$$

The planner's solution in the absence of official transfers, with and without commitment, is illustrated in Figure 3. The diagram shows on the horizontal axis the size of spillovers and on the vertical axis the country's financing needs. We observe that the planner lends to countries up to their borrowing capacity independently on whether they are systemic or not. The composition between fiscal consolidation and bail-ins to cover any remaining financing gap differs instead with the strength of spillover. In particular, stronger spillovers require limiting the extent of bail-ins, while increasing the contribution of fiscal consolidation. Furthermore, the upper bound on fiscal consolidation is higher if the planner has commitment and thus takes into account the ex-ante effects of spillovers on the crisis-prevention effort.

Finally, we note that the planner's solution satisfies the participation constraint of both the country and the creditors. This is illustrated in Figure 4 that compares the planner's

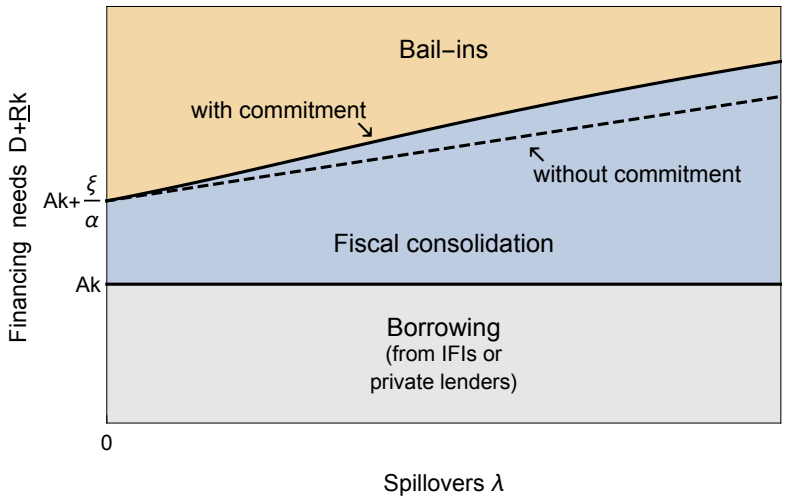

Figure 3: Planner's solution without official transfers

solution and the laissez-faire equilibrium. Note that we define

$$D_3 = D_1 + \bar{f}$$

as the primary deficit threshold above which bail-ins are used by the planner. This threshold is increasing in the strength of spillovers λ and is higher under commitment, possibly reaching the maximum primary deficit $\bar{D}$ in case bail-ins are entirely avoided. The left chart shows that, by preventing liquidation, the planner ensures that the country retains market access up to Ak. Therefore, fiscal consolidation has to cover at most the financing gap $D - D_1$ where, as defined in equation (12), D_1 is the maximum level of deficit that can be covered through borrowing alone. As shown in the middle chart, this makes the country better off than in the laissez-faire equilibrium where it would need to endure fiscal consolidation at least as large as D once $D > D_1$. Creditors are also better off under the planner's solution than in case of liquidation under laissez faire, at least as long as the maximum primary deficit $\bar{D}$ is not implausibly large. Under the planner's solution, creditors may at most suffer losses equal to $(1+\xi)(\bar{D} - D_3)$. As shown in the right chart, these are generally smaller than in case of liquidation, at least as long as $(A-\chi)k + \bar{f} > \bar{D}$, i.e. the sum of the output gain from avoiding liquidation and the upper bound on fiscal consolidation is larger than the maximum primary deficit.

4.2 Planner's solution with official transfers, but no commitment

We now consider the case in which the planner is able to provide the country with official transfers, but has no commitment. As in problem (20), the planner maximizes social welfare

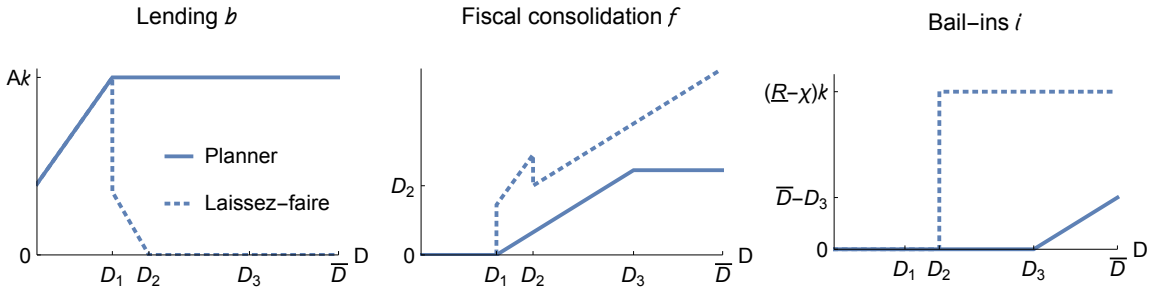

Figure 4: Laissez-faire versus planner's equilibrium without official transfers.

from an ex-post perspective, but can now also use transfers

$$\begin{aligned} \max_{b,f,i\geq 0,o\geq 0} \quad & Ak - \left(D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right) \\ & \text{subject to} \\ & b + f + i + o = \underline{R}k + D \\ & b \leq Ak \end{aligned} \tag{26}$$

The ex-post social marginal costs of fiscal consolidation and bail-ins are as defined in equations (21) and (22), while the marginal cost of transfers is

$$MC^o_{\text{ex-post}} \quad = \quad \xi \tag{27}$$

As usual, the planner allows the country to issue bonds up to its borrowing capacity. If this is not sufficient to cover the country's financing needs, i.e. $D > D_1$, the planner uses fiscal consolidation up to the level at which the marginal cost of consolidation reaches the lowest marginal cost between bail-ins and official transfers

$$\bar{f} \quad = \quad \frac{\min\left\{MC^i_{\text{ex-post}}, MC^o_{\text{ex-post}}\right\}}{\alpha}$$

If the country is not systemic, $\lambda = 0$, bail-ins and transfers entail the same marginal losses and the planner is thus ex-post indifferent between these two instruments. However, as soon as $\lambda > 0$, official transfers become ex-post less costly than bail-ins. Therefore, the planner keeps the upper bound on fiscal consolidation equal to $\bar{f} = \xi/\alpha$ and covers any additional financing gap through transfers alone. This solution is illustrated in Figure 5.

Compared to the planner's solution without transfers in Figure 3, both the country and the creditors are ex-post better off when $\lambda > 0$ since transfers are used to prevent any increase in fiscal consolidation and creditors' losses. This solution thus satisfies the country and creditors' participation constraints. However, it has the major drawback of

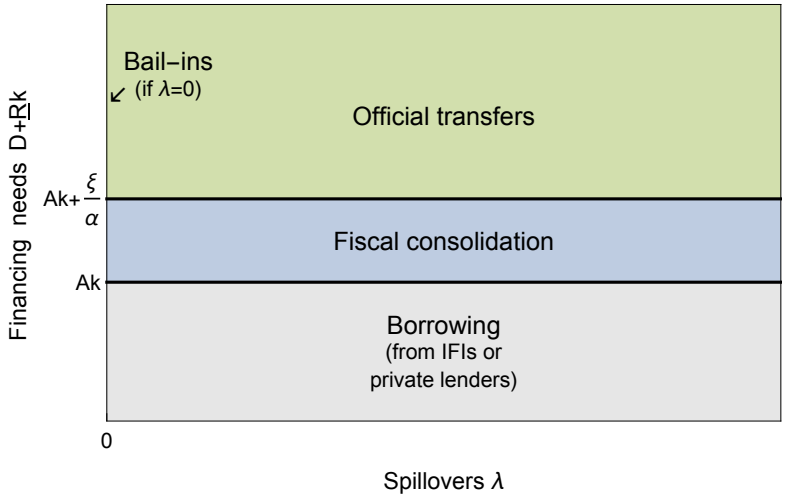

Figure 5: Planner's solution with official transfers, but no commitment

generating severe moral hazard effects. Without commitment, the planner neglects the ex-ante implications of her choices and relies excessively on official transfers. This opens up a considerable wedge between the socially-efficient and country-preferred level of crisis-prevention effort. As we shall see in section 4.4, this may even lead to lower ex-ante social welfare than if the planner is prevented from using transfers.

4.3 Planner's solution with official transfers and commitment

We finally turn to the case in which the planner has both commitment and the ability to use transfers. The planner maximizes social welfare from an ex-ante perspective by solving the following problem

$$\begin{aligned} \max_{e,b,f,i\geq 0,o\geq 0} \quad & -z(e)+(A-1)k-(1-p)\underline{\mathbb{E}}_0\left[D+\alpha f^2/2+(\xi+\lambda)i+\xi o\right] \\ & \text{subject to} \\ & b+f+i+o=\underline{R}k+D \\ & b\leq Ak \\ & z'(e)=p'(e)\underline{\mathbb{E}}_0\left[D+\alpha f^2/2+\xi i-o\right] \end{aligned} \tag{28}$$

The ex-ante social marginal costs of fiscal consolidation and bail-ins are as reported in equations (24) and (25). Regarding official transfers, their social marginal cost from an ex-ante perspective is given by

$$MC^o_{\text{ex-ante}} \quad = \quad \xi+(1+\xi)\cdot\left(\frac{1-p^C}{1-p^S}-1\right) \tag{29}$$

Transfers entail the ex-post efficiency losses ξ. Furthermore, they have severe moral hazard consequences since the country entirely neglects the costs $(1+\xi)$ faced by the international community. As in the case of spillovers from bail-ins, the moral hazard effects are captured by the percentage increase in the probability of the crisis under the country's effort relative to the socially efficient level, $(1-p^C)/(1-p^S)-1$.

Once again, the planner's solution provides the country with financing up to its borrowing capacity. The remaining financing needs should be covered with fiscal consolidation up to the level at which its marginal costs reaches the lowest ex-ante marginal cost between bail-ins and transfers:

$$\bar{f} \quad = \quad \frac{\min\left\{MC^i_{\text{ex-ante}}, MC^o_{\text{ex-ante}}\right\}}{\alpha}$$

Let us first consider the optimal policy mix for a non-systemic country so that $\lambda = 0$. In this case, the marginal cost of bail-ins is strictly lower than the cost of transfers. This is because while both instruments involve the efficiency losses ξ, official transfers also entail negative moral hazard effects. The upper bound on fiscal consolidation is thus given by

$$\bar{f} = \frac{MC^i_{\text{ex-ante}}}{\alpha} = \frac{\xi}{\alpha} \quad \text{if} \quad \lambda = 0$$

and any additional financing gap is covered exclusively through bail-ins. Note that this solution is identical to the one without transfers and commitment.[11] Therefore, in the case of non-systemic countries, IFIs are able to adopt the appropriate crisis-resolution policy mix even without being able to provide transfers or being constrained to act under a predetermined crisis-resolution framework.

We now consider how the optimal policy mix varies in case the country is systemic, i.e. $\lambda > 0$. Since spillovers increase the marginal social cost associated with bail-ins, it is optimal to reduce their use. In turn, any reduction in bail-ins has to be compensated through either greater fiscal consolidation or official transfers. The appropriate policy mix is found by comparing the ex-ante social marginal costs of each instrument and differentiating countries depending on the strength of the spillovers λ.

If spillovers are sufficiently small, $\lambda < \lambda_1$, bail-ins remains less socially costly than transfers given the smaller moral hazard consequences. In this case, the upper bound on consolidation is pinned down by the marginal cost of bail-ins

$$\bar{f} = \frac{MC^i_{\text{ex-ante}}}{\alpha} \qquad \text{if } \lambda < \lambda_1 \text{ so that } MC^i_{\text{ex-ante}} < MC^o_{\text{ex-ante}}$$

[11] This solution can also be supported if the planner can use transfers, but has no commitment. The planner is indeed indifferent between bail-ins and transfers from an ex-post perspective since their social marginal costs in (22) and (27) are identical if $\lambda = 0$.

and any additional financing gap is covered through bail-ins only. Note that this upper bound is increasing in λ, so that more systemic countries should endure greater fiscal consolidation.

As spillovers become stronger, $\lambda_1 \leq \lambda \leq \lambda_2$, the marginal cost of bail-ins reaches the marginal cost of official transfers. The reduction in bail-ins should then be offset not only with an increase in fiscal consolidation, but also with the provision of transfers. The optimal policy mix involves an upper bound on fiscal consolidation and a relative contribution of bail-ins and transfers that equates the marginal costs of all three instruments. This implies

$$\bar{f} = \frac{MC^{i}_{\text{ex-ante}}}{\alpha} = \frac{MC^{o}_{\text{ex-ante}}}{\alpha} \qquad \text{if } \lambda_1 \leq \lambda \leq \lambda_2 \text{ so that } MC^{i}_{\text{ex-ante}} = MC^{o}_{\text{ex-ante}}$$

Finally, if the spillover effects are particularly strong, $\lambda > \lambda_2$, the marginal cost of bail-ins exceeds the marginal cost of transfers. In this case, the country is so highly systemic that bail-ins should be entirely avoided. In turn, the upper bound on fiscal consolidation is pinned down by the level at which its marginal cost reaches the ex-ante marginal losses from transfers

$$\bar{f} = \frac{MC^{o}_{\text{ex-ante}}}{\alpha} \qquad \text{if } \lambda > \lambda_2 \text{ so that } MC^{i}_{\text{ex-ante}} > MC^{o}_{\text{ex-ante}}$$

Any additional financing need should be covered with transfers only.

The model implications about the optimal crisis-resolution framework with transfers and commitment are illustrated in Figure 6. IFIs should provide financing to countries up to their borrowing capacity independently on whether they are systemic or not. We also note that the solution for non-systemic countries is identical to the one without official transfers and without commitment in Figure 3. In both cases, fiscal consolidation is used up to the upper bound ξ/α and any remaining financing shortfall is covered exclusively with bail-ins. In this respect, resolving non-systemic crises places relatively limited demands on IFIs since they can operate effectively even without commitment and the ability to provide transfers.

Dealing with systemic countries is considerably more challenging. First, to maximize social welfare, IFIs should differentiate their policy approach depending on the strength of the spillovers associated with bail-ins. In the context of the model, using a uniform treatment across countries – as it is often advocated on the grounds of fairness and political feasibility – would be socially inefficient. Second, IFIs should be able to provide systemic countries with transfers in order to reduce bail-ins and their associated spillover effects. Without the ability to use transfers, IFIs would end up placing undue burden on the country by compensating the reduction in bail-ins entirely through higher fiscal consolidation, as illustrated in Figure 3. Third, IFIs should be endowed with commitment in order to provide transfers only to particularly systemic countries, while requiring them to endure some

additional fiscal consolidation relative to less systemic countries to contain moral hazard. If IFIs are able to provide transfers but have no commitment, they would end up being too lenient with systemic countries and entirely replace bail-ins with transfers, as shown in Figure 5. This would have severe moral hazard implications and potentially reduce ex-ante social welfare as illustrated in the next section.

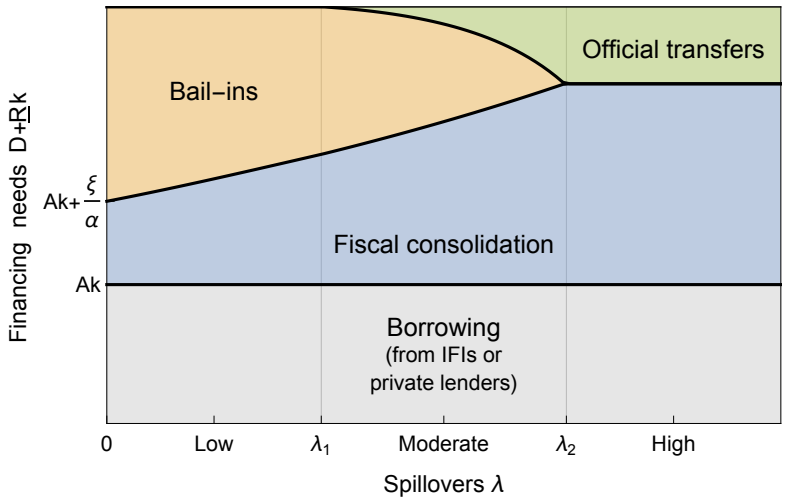

Figure 6: Planner's solution with commitment and official transfers.

We also note that the planner's solution with commitment and transfers satisfies the participation constraints. Thanks to the provision of transfers, the ex-post welfare of the country and the creditors is at least as large as in the solution without transfers that, as shown in Figure 4, was already individually rational.

4.4 Welfare implications of alternative crisis-resolution frameworks

In this section, we consider the implications of the crisis-resolution frameworks previously described for the ex-ante welfare of the society as a whole and the country. Figure 7 illustrates the effects on ex-ante social welfare. Three interesting aspects stand out. First, we observe that in the absence of spillovers, $\lambda = 0$, the planner's solution achieves the maximum welfare even without transfers and commitment. Therefore, IFIs can effectively address the sovereign debt crisis of a non-systemic country by simply focusing on minimizing ex-post costs and without being able to provide transfers.

Second, if IFIs have no commitment, allowing them to use transfers can be counter-productive. The shaded area shows the possible range of welfare under the solution with transfers but no commitment. This depends on the severity of the moral hazard effects that, as shown in equation (19), are proportional to the ratio ν/β. We see that, with the exception of highly systemic countries, ex-ante social welfare is lower relative to the solu-

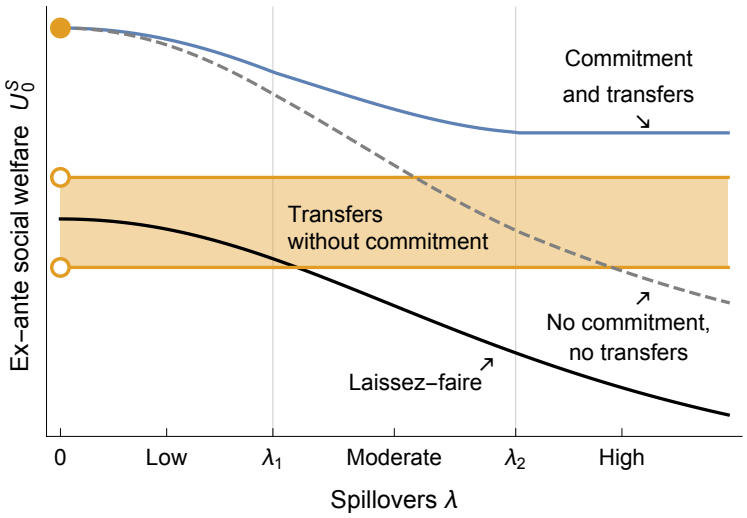

Figure 7: Ex-ante social welfare under alternative frameworks.

tion without transfers. In fact, giving IFIs the ability to provide countries with transfers despite lack of commitment may reduce welfare even below the laissez-faire equilibrium. As illustrated in Figure 5, this is because IFIs would use transfers to avoid any increase in fiscal consolidation and bail-ins, even if spillovers are small, and thus generate severe moral hazard costs.

Third, even under the optimal solution with transfers and commitment, social welfare is declining in the size of spillovers since they require limiting bail-ins and use more costly policy tools, i.e. greater fiscal consolidation and transfers. Social welfare reaches a lower bound in the case of highly systemic countries, $\lambda \geq \lambda_2$, for which it is socially efficient to entirely avoid bail-ins. The decline in social welfare associated with handling systemic crises calls for policy measures that can possibly reduce the risk of systemic spillovers or contain their effects. For example, regulation could force banks to hold greater capital buffers against the debt holdings of systemic countries to better absorb possible losses from debt restructuring.

The model provides also interesting insights about the implications of alternative crisis-resolution frameworks for the ex-ante welfare of the country, as illustrated in Figure 8. First, we note that the country is strictly better off under any of the planner's solutions than in the laissez-faire equilibrium. This is true even under the harshest crisis-resolution framework for the country, i.e. the one with commitment but no transfers. As shown in Figure 3, in this case more systemic countries have to endure greater fiscal consolidation to limit bail-ins. However, they still have to undertake less consolidation than under the laissez-faire equilibrium since, as illustrated in Figure 4, IFIs provide them with financing up to their borrowing capacity.

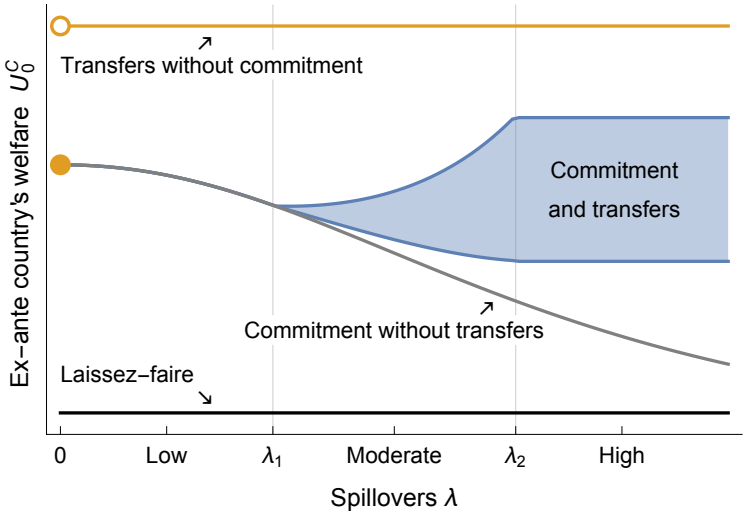

Figure 8: Ex-ante country's welfare under alternative frameworks.

Second, while under the planner's solution with transfers and commitment social welfare is monotonically declining in the size of spillovers λ, this is no longer necessarily the case at the level of individual countries as shown by the shaded area. This depends on whether the reduction in bail-ins for systemic countries is compensated mostly through greater fiscal consolidation or with transfers that respectively hurt and benefit the country. In turn, this decision hinges on the strength of moral hazard associated with transfers that as shown in equation (19) is proportional to the ratio ν/β. If moral hazard effects are severe, it is social efficient to replace bail-ins mostly through greater fiscal consolidation, thus reducing the welfare of more systemic countries. If instead moral hazard effects are limited, bail-ins should be replaced with a larger proportion of transfers, thus making highly systemic countries possibly better off than non-systemic ones.

Third, by differentiating the policy mix according to the size of spillovers, the planner's solution produces differences in countries' expected welfare. This may raise concerns about lack of evenhandedness across countries, making it difficult for IFIs to adopt such a framework. In this regard, it is important to emphasize that, as just discussed, it is actually not obvious whether systemic countries are worse or better off under the framework with transfers and commitment. Systemic countries benefit from transfers, but have also to endure greater fiscal consolidation. Expected welfare may thus not differ much across countries. Nonetheless, if there is a need to equalize welfare, imposing the same crisis-resolution framework irrespective of the size of spillovers is socially inefficient. A more effective response could be to design a compensating system of ex-ante taxes and subsidies across countries. For example, to the extent that systemic countries are better off, they could be asked to

contribute ex-ante to a pool of funds that will be later used to finance transfers.[12] We leave the design of such a scheme for future research.

5 Conclusion

In this paper we have developed a tractable model to understand how IFIs should handle systemic sovereign debt crises to maximize social welfare. In addition to providing countries with financing up to their borrowing capacity, IFIs confront difficult decisions about how to address the remaining financing needs using a combination between fiscal consolidation, bail-ins, and possibly official transfers. The model allows solving for the socially efficient policy mix by considering both the ex-post costs and the ex-ante moral hazard effects of each financing tool.

In the case of non-systemic countries, where bail-ins impose losses on creditors but do not spread systemic spillovers, we showed that IFIs can efficiently resolve a crisis even without official transfers and commitment. Besides proving official lending up to the country's borrowing capacity, the optimal policy mix simply involves minimizing the ex-post costs of the crisis by using the least socially costly combination between fiscal consolidation and bail-ins. To the extent that creditors price the expected losses from bail-ins into the country's ex-ante borrowing costs, the resolution of non-systemic crises entails no moral hazard costs.

Dealing with the sovereign crisis of a systemic country raises significant additional challenges. Since bail-ins entail systemic spillovers, it becomes socially efficient to reduce their use. In particular, to efficiently resolve systemic crises, IFIs should improve their crisis-resolution frameworks along three dimensions. First, to maximize social welfare, they should differentiate their policy approach depending on whether they are dealing with more and less systemic countries. Second, to limit bail-ins and the associated spillovers, IFIs should provide systemic countries with official transfers. Otherwise, the reduction in bail-ins may need to be offset through an excessive amount of fiscal consolidation. Third, to contain the moral hazard effects arising from official transfers, IFIs should have commitment and operate under a pre-determined crisis-resolution framework. This is to ensure that transfers are used only when systemic spillovers are particularly large and are complemented with somewhat stricter fiscal consolidation demands relative to countries not receiving transfers. Without commitment, IFIs would rely excessively on official transfers and generate severe moral hazard.

The model implications can inform the ongoing discussion about reforming the IMF

[12] A tax scheme that equalizes expected welfare may also be helpful to avoid perverse incentives for countries to become more systemic, for example by issuing more foreign debt, in order to benefit from transfers in times of crisis.

lending framework, in particular with regard to the so called "systemic exemption".[13] This clause allows countries to obtain exceptional access to Fund financing, even when debt is not sustainable with high probability, if debt restructuring involves a "high risk of international systemic spillovers" (see also footnote 1). As described in IMF (2014), a key drawback of this exemption is that, by dispensing from debt restructuring, it may end up requiring excessive fiscal consolidation by the country. Consistent with this view, the model shows that, in dealing with systemic crises, IFIs should go beyond conventional lending and mobilize the international community to provide the country with official transfers, for example through financing at concessional terms or the restructuring of debt held by the official sector. At the same time, the model warns about the moral hazard consequences of this approach, pointing out that transfers should be used only in case of highly systemic countries.

The model raises interesting avenues for future research. First, even in the presence of transfers and commitment, the social costs of resolving a sovereign debt crisis are increasing in the size of potential spillovers. This calls for the design of measures that can prevent spillovers or mitigate their effects. Second, adopting a crisis-resolution framework that varies with the size of spillovers may entail differences in expected welfare across countries. The model suggests that these differences might not be particularly large, since systemic countries that benefit from transfers would have to also endure somewhat greater fiscal consolidation. Nonetheless to eliminate possible differences in ex-ante welfare, it would be interesting to consider a system of ex-ante taxes/subsidies across countries depending on how they will be treated during a crisis. For example, countries that benefit ex-post from transfers might be asked to pay for them ex-ante by financing a reserve fund.

[13] As described in IMF (2014), the IMF is also considering introducing a debt reprofiling option. Fernández and Martin (2014) provide support for this proposal by using a model with endogenous debt maturity.

Appendices

A Derivation of the laissez-faire equilibrium

A.1 Complete financial markets

We begin by characterizing the first best equilibrium of the model in case the return on sovereign bonds R can be made contingent on the exact realization of the primary deficit d. We then show that this allocation can be achieved under the laissez-faire equilibrium without requiring commitment by the country or coordination among creditors. The first best allocation maximizes ex-ante social welfare U_0^S subject to the borrowing limit (1), the financing constraint (2), and the interest break-even condition (3):

$$\begin{aligned}\max_{e,f,i\geq 0,o\geq 0,R} \quad & -z(e) + \mathbb{E}_0\left[Ak - b - h(f)\right] - k + \mathbb{E}_0\left[Rk - (1+\xi)i\right] - \mathbb{E}_0\left[\lambda i + (1+\xi)o\right] \\ & \text{subject to} \\ & b \leq Ak \\ & b + f + i + o = Rk + d \\ & \mathbb{E}_0\left[Rk - (1+\xi)i\right] = k\end{aligned}$$

We use the financing constraint to substitute b out of the problem and the break-even condition to substitute Rk from the definition of social welfare. The problem can thus be expressed more compactly as

$$\begin{aligned}\max_{e,f,i\geq 0,o\geq 0,R} \quad & -z(e) + (A-1)k - \mathbb{E}_0\left[D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right] \\ & \text{subject to} \\ & Ak + f + i + o \geq Rk + d \\ & \mathbb{E}_0\left[Rk - (1+\xi)i\right] = k\end{aligned}$$

From this formulation of the problem, we can immediately observe that the interest rate R has no direct effect on social welfare, since it simply distributes resources between the country and the creditors. On the contrary, fiscal consolidation, bail-ins and official transfers entail social costs. Therefore, the first best equilibrium involves satisfying the financing constraint by exploiting state-contingency in the interest rate, thus setting

$$\begin{aligned}f = i = o = 0 \\ Ak \geq Rk + d\end{aligned}$$

In turn this solution is consistent with creditors' break-even condition $\mathbb{E}_0[Rk] = k$ as long as $A(k-1) \geq \mathbb{E}_0[d]$. Ex-ante social welfare can then be written as

$$U_0^S = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0[D]$$

and the first best provision of effort solves

$$z'(e) = p'(e)\underline{\mathbb{E}}_0[D]$$

We now show that this allocation is consistent with the laissez-faire equilibrium. First, we observe that since the first best allocation does not require bail-ins $i = 0$, it is compatible with lack of coordination by creditors. Second, since it does not require fiscal consolidation $f = 0$, it is also compatible with lack of commitment by the country. Third, since it does not require transfers $o = 0$ and does not trigger spillovers since $i = 0$, social welfare from an ex-ante perspective is identical to the country's welfare $U_0^C = U_0^S$. Therefore, by maximizing its own utility, the country chooses the crisis-prevention effort that is also socially optimal.

A.2 Incomplete financial markets

In this section, we solve for the laissez-faire equilibrium in case the interest rate R cannot be made contingent on the exact realization of the primary deficit D within the crisis state. In particular, we assume that the interest rate takes binary values as in equation (9) and that borrowing is sufficient to cover the country's financing needs in the non-crisis state as in equation (10). Focusing on the crisis state, note first that after issuing bonds b, the country undertakes fiscal consolidation to cover its financing needs only if it is weakly better-off than under default, i.e.

$$-h(\max\{D + \underline{R}k - b, 0\}) + Ak - b \geq -h(\max\{D - b, 0\})$$

This condition is clearly satisfied if the country's financing needs can be covered with borrowing alone which is the case as long as $D \leq (A - \underline{R})k = D_1$. If $D > D_1$, default is instead preferable for the country if $b = Ak$, since future income is pledged to creditors. This implies that if default is to be avoided, creditors must restrain credit supply by reducing b below D, thus forcing the country to endure fiscal consolidation also in the case of default. In turn, if $D > D_1$ and $b < D$, default can be averted only if

$$-h(D + \underline{R}k - b) + Ak - b \geq -h(D - b)$$

These conditions can be further manipulated to show that creditors can elicit fiscal consolidation $f = D + \underline{R}k - b$ and prevent default by setting

$$b = \frac{(A-R)k - \alpha(\underline{R}k)^2/2 - \alpha\underline{R}kD}{1 - \alpha\underline{R}k}$$

as long as

$$D \leq D_2 = \max\left\{D_1, \frac{(A-\underline{R})k}{\alpha\underline{R}k} - \frac{\underline{R}k}{2}\right\}$$

If $D > D_2$, the laissez-faire equilibrium involves no lending $b = 0$, fiscal consolidation to close the primary balance $f = D$, and creditors' losses equal to $(1+\xi)i$ with $i = (\underline{R} - \chi)k$.

We finally solve for the crisis-prevention effort at time 0. Given the time-1 equilibrium and substituting out the definition of the risk premium π from equation (11), the country's ex-ante utility can be written as

$$U_0^C = -z(e) + (A-1)k - (1-p)\left(\underline{\mathbb{E}}_0[D + \alpha f^2/2] + (1-\Phi(D_2))\left((A-\chi)k + \xi i\right)\right)$$

where $\Phi(\bullet)$ is the CDF of the primary deficit D. A comparison with the utility under complete financial markets in equation (7) reveals that the crisis state is now more costly for the country for three reasons. First, if $D > D_1$, the country has to endure fiscal adjustment to cover either its financing needs net of new borrowing if $D_1 < D \leq D_2$, or the primary deficit if $D > D_2$. Second, if $D > D_2$, capital is liquidated and output falls from Ak to χk. In addition, creditors price the expected losses from bail-ins into the ex-ante lending rates. This generates a reduction in country's welfare equal to the expected efficiency losses from bail-ins ξi. Faced with higher costs associated with the crisis state, the country finds it optimal to exercise greater crisis-prevention effort relative to the solution under complete financial markets by setting

$$z'(e) = p'(e)\left(\underline{\mathbb{E}}_0[D + \alpha f^2/2] + (1-\Phi(D_2))\left((A-\chi)k + \xi i\right)\right)$$

Note, however, that despite being higher than under complete financial markets, the prevention effort is less than socially efficient, since the country neglects the spillover costs λi borne by the international community.

B Derivation of the planner's solution

B.1 Without commitment

By substituting out b, the Lagrangian of problem (26) is

$$L = Ak - \left(D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right) + \mu_1 \left(Ak + f + i + o - \underline{R}k - D\right)$$

with Kuhn Tucker conditions

$$\begin{aligned}
&\frac{\partial L}{\partial f} = -\alpha f + \mu_1 = 0 \\
&\frac{\partial L}{\partial i} = -(\xi + \lambda) + \mu_1 \leq 0 \ , \ \ i \geq 0 \ , \ \ i \cdot \frac{\partial L}{\partial i} = 0 \\
&\frac{\partial L}{\partial o} = -\xi + \mu_1 \leq 0 \ , \ \ o \geq 0 \ , \ \ o \cdot \frac{\partial L}{\partial o} = 0 \\
&\frac{\partial L}{\partial \mu_1} = Ak + f + i + o - \underline{R}k - D \geq 0 \ , \ \ \mu_1 \geq 0 \ , \ \ \mu_1 \cdot \frac{\partial L}{\partial \mu_1} = 0
\end{aligned}$$

Fiscal consolidation, bail-ins and transfers all relax the consolidated financing constraint with a welfare gain equal to μ_1. However, they involve different costs leading to the following upper bound on fiscal consolidation:

$$\bar{f} = \frac{\xi}{\alpha}$$

The solution can thus be expressed as

$$\begin{aligned}
\text{If } D \leq (A - \underline{R})k = D_1 \quad &\Rightarrow \quad f = i = o = 0 \ , \ \ \mu_1 = 0 \\
\text{If } D_1 < D \leq D_1 + \bar{f} = D_3 \quad &\Rightarrow \quad f = D - D_1 \ , \ \ i = o = 0 \ , \ \ \mu_1 = \alpha f \\
\text{If } D > D_3 \quad &\Rightarrow \quad f = \bar{f} \ , \ \ i + o = D - D_3 \ , \ \ \mu_1 = \alpha f
\end{aligned}$$

Note that if $D > D_3$, the planner is indifferent between using bail-ins or transfers if $\lambda = 0$. If instead $\lambda > 0$, the solution involves $i = 0$ and $o = D - D_3$.

If the planner has no access to transfers as in problem (20), the solution is as above with the exception that $o = 0$. The upper bound on fiscal consolidation is thus:

$$\bar{f} = \frac{\xi + \lambda}{\alpha}$$

B.2 With commitment

By substituting out b, the Lagrangian of problem (28) is

$$\begin{aligned} L = & -z(e) + (A-1)k \\ & + (1-p)\underline{\mathbb{E}}_0\left[-\left(D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right) + \mu_1\left(Ak + f + i + o - \underline{R}k - D\right)\right] \\ & \qquad + \mu_2\left(-z'(e) + p'(e)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right]\right) \end{aligned}$$

Under the functional forms $z(e) = \beta e^2/2$ and $p(e) = \nu e$, the first order conditions for e and μ_2 are:

$$\begin{aligned} \frac{\partial L}{\partial e} &= -\beta e + \nu\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi+\lambda)i + o\right] - \beta\mu_2 = 0 \\ \frac{\partial L}{\partial \mu_2} &= -\beta e + \nu\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] = 0 \end{aligned}$$

By combining the above conditions we obtain:

$$\begin{aligned} \mu_2 &= \frac{\nu}{\beta}\underline{\mathbb{E}}_0\left[\lambda f + (1+\xi)i\right] \\ &= e^S - e^C \end{aligned}$$

where the last equality follows from equation (19). The additional Kuhn Tucker conditions require:

$$\begin{aligned} &\frac{\partial L}{\partial f} = -\alpha f(1 - p - \nu\mu_2) + \mu_1(1-p) = 0 \\ &\frac{\partial L}{\partial i} = -\xi(1-p-\nu\mu_2) - \lambda(1-p) + \mu_1(1-p) \leq 0\ ,\ \ i \geq 0\ ,\ \ i \cdot \frac{\partial L}{\partial i} = 0 \\ &\frac{\partial L}{\partial o} = -\xi(1-p) - \nu\mu_2 + \mu_1(1-p) \leq 0\ ,\ \ o \geq 0\ ,\ \ o \cdot \frac{\partial L}{\partial o} = 0 \\ &\frac{\partial L}{\partial \mu_1} = Ak + f + i + o - \underline{R}k - D \geq 0\ ,\ \ \mu_1 \geq 0\ ,\ \ \mu_1 \cdot \frac{\partial L}{\partial \mu_1} = 0 \end{aligned}$$

By combining $\partial L/\partial f = 0$, $\partial L/\partial i \leq 0$, and $\partial L/\partial o \leq 0$, we obtain the following upper bound on fiscal consolidation:

$$\bar{f} = \frac{\min\left\{\xi + \lambda + \lambda\cdot\left(\frac{1-p^C}{1-p^S} - 1\right), \xi + (1+\xi)\cdot\left(\frac{1-p^C}{1-p^S} - 1\right)\right\}}{\alpha}$$

where the first and second terms in the numerator represent the ex-ante social marginal

cost of bail-ins and transfers respectively. The solution can thus be expressed as

$$\begin{aligned} \text{If } D \leq (A - \underline{R})k = D_1 \quad &\Rightarrow \quad f = i = o = 0 \ , \ \ \mu_1 = 0 \\ \text{If } D_1 < D \leq D_1 + \bar{f} = D_3 \quad &\Rightarrow \quad f = D - D_1 \ , \ \ i = o = 0 \ , \ \ \mu_1 = \alpha f \\ \text{If } D > D_3 \quad &\Rightarrow \quad f = \bar{f} \ , \ \ i = \tau(D - D_3), o = (1-\tau)(D - D_3) \ , \ \ \mu_1 = \alpha f \end{aligned}$$

where $\tau \in [0, 1]$ represents the proportion of the financing gap in excess of the maximum fiscal consolidation that has to be covered with bail-ins rather than transfers. This proportion is pinned down by the following conditions:

$$\begin{aligned} \tau = 1 \quad \text{if} \quad \xi + \lambda + \lambda \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right) < \xi + (1 + \xi) \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right) \\ \tau = 0 \quad \text{if} \quad \xi + \lambda + \lambda \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right) > \xi + (1 + \xi) \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right) \end{aligned}$$

otherwise

$$\tau \in (0, 1) \text{ solves } \xi + \lambda + \lambda \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right) = \xi + (1 + \xi) \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right)$$

If the planner has no access to transfers, the solution to problem (23) follows the same considerations above. The upper bound on fiscal consolidation becomes

$$\bar{f} \quad = \quad \frac{\xi + \lambda + \lambda \cdot \left(\frac{1 - p^C}{1 - p^S} - 1 \right)}{\alpha}$$

and $\tau = 1$.

C Constant interest rate

In this Appendix we show that the key implications of the model for the optimal crisis-resolution framework remain valid if we eliminate any state contingency in bond contracts by keeping the interest rate R constant across both the crisis and non-crisis state. Under the assumption that the financing needs can be covered with borrowing alone in the non-crisis state, the planner's problem with transfers and commitment can be written analogously to

problem (28) as:

$$\begin{aligned}
\max_{e,b,f,i\geq 0,o\geq 0,R} \quad & -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right] \\
& \text{subject to} \\
& b + f + i + o = Rk + D \\
& b \leq Ak \\
& e = \arg\max_{\tilde{e}} -z(\tilde{e}) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \\
& pRk + (1-p)\underline{\mathbb{E}}_0\left[Rk - (1+\xi)i\right] = k
\end{aligned}$$

The last two constraints capture the fact that the crisis-prevention effort e is chosen by the country to maximize its own utility and that the interest rate R has to ensure creditors' break-even. The key difference with respect to the binary formulation of the interest rate in equation (9), is that the effort e and the extent of bail-ins i now affect the interest rate and thus the tightness of the financing constraint (2) also in the crisis state. This complicates considerably the first order conditions, making it impossible to obtain simple analytical solutions.

The fact that the interest rate in the crisis state is affected by effort and bail-ins has two main implications. First, bail-ins becomes more costly since, by increasing R also in the crisis state, they tighten the financing constraint. In turn, the planner's solution involves limiting the use of bail-ins and increasing the contribution of fiscal consolidation and transfers. This is illustrated in Figure 9. Second, the crisis-prevention effort becomes more valuable since it not only reduces the likelihood of a crisis, but relaxes the financing constraint in the crisis state by lowering the interest rate. Therefore, from both the country's and the social perspective, it becomes efficient to increase the effort level in proportion to the respective shadow cost of the financing constraint.

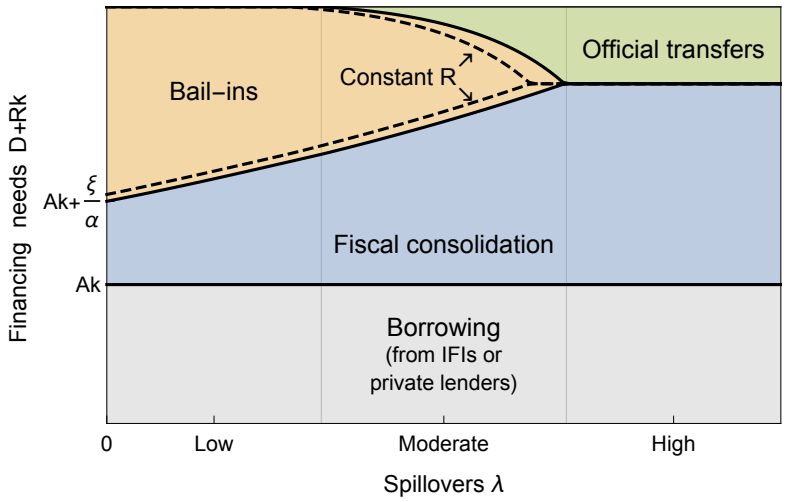

Figure 9: Planner's solution with constant interest rate R across states.

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