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. In particular, we solve for the optimal combination between fiscal consolidation, bail-ins, and official transfers to restore debt sustainability. For non-systemic countries, only fiscal consolidation and bail-ins should be used, based on an ex-post assessment of their relative costs. Systemic crises raise significant new challenges. First, to limit bail-ins without requiring excessive fiscal consolidation, IFIs should provide highly systemic countries with official transfers. Second, to contain the moral hazard consequences of systemic bail-ins and official transfers, IFIs should operate under commitment by following a predetermined crisis-resolution framework that considers also the ex-ante costs of each financing tool.

JEL Codes: F33, F34, F4

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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 debt crises to destabilize the international community will remain a very concrete possibility. This calls for decisive policy action along two main fronts. First, there is a need to put in place measures that can contain the risk of spillovers associated with bail-ins. These may include higher capital requirements against sovereign debt and the ample provision of international liquidity at times of crises. Second, the presence of spillovers 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 to maximize social welfare.

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 that involves an inefficient liquidation of capital and an output decline. 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". Previously, if a country required "exceptional access" to Fund resources, the IMF could lend only if public debt was assessed to be sustainable with high probability. If this was not the case, IMF financing had to be contingent on a debt restructuring operation that restored debt 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 the case 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 needs 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 – absent spillovers and 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. Official transfers should instead be avoided because they do generate moral hazard since they are not priced into 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, as currently the case for the IMF, and have no commitment, 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. In particular, it requires strengthening the operational frameworks of IFIs along two key dimensions. First, IFIs should be given the ability to provide systemic countries with official transfers. To understand this point, note that the presence of systemic spillovers calls for reducing the use of bail-ins since they are more socially harmful. If IFIs are prevented from providing transfers, any reduction in bail-ins would have to be offset entirely through an

[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] Note that we refrain from using the notion of bail-outs since it is generally associated with both non-concessional financing and official transfers. For example, IMF programs are often referred to as bail-outs, even though they may only involve actuarially fair lending. In this paper, it is crucial to carefully differentiate between the concepts of non-concessional financing and official transfers since only the latter generate moral hazard.

increase in fiscal consolidation by the crisis country. This may imply requiring systemic countries to endure an excessive amount of fiscal consolidation to spare the international community from the systemic consequences of bail-ins. To prevent this outcome, IFIs should be able to partially compensate the reduction in bail-ins through official transfers.

Second, to contain the moral hazard consequences of systemic bail-ins and official transfers, it is crucial that IFIs operate under a predetermined crisis resolution framework that ensures commitment. In the model, countries can control the probability of experiencing a debt crisis by behaving ex-ante more or less prudently. Moral hazard arises when a certain crisis-resolution approach induces countries to behave less prudently than socially optimal. This occurs both with bail-ins, if they are associated with spillovers, and with official transfers. Regarding bail-ins, note that lenders do not price into sovereign bonds the spillover costs that third parties would suffer in case of a debt restructuring. Therefore, countries neglect these costs when deciding how prudently to behave. Similarly, countries neglect the costs sustained by the international community to finance official transfers. The presence of moral hazard raises a time-consistency problem. For example, IFIs would want to pledge ex-ante not to provide official transfers, but actually use them ex-post. Therefore, the net benefits from bail-ins and official transfers crucially depend on the extent to which IFIs can operate under commitment and thus properly take into account the costs of each financing tool from an ex-ante perspective.

The model allows us to analyze the implications of bail-ins and official transfers under alternative assumptions about commitment. If IFIs have no commitment, they would exclusively focus on minimizing the ex-post costs of a crisis with no concern for ex-ante moral hazard. In this case, we show that IFIs would use official transfers to avoid any bail-ins whenever they are associated with spillover effects. The resulting moral hazard effects can reduce social welfare significantly, possibly even below the level under the laissez-faire equilibrium. At the opposite extreme, we could consider the case in which IFIs have commitment as well as the ability to use ex-ante conditionality, i.e. to credibly deny assistance to countries that have not behaved prudently enough. This approach would eliminate any moral hazard concerns and allow IFIs to focus only 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.

However, the use of strict ex-ante conditionality is problematic for various reasons. First, it may require IFIs to deny assistance to a country that misbehaved in the past even if this triggers a disruptive default that involves larger costs not only for the country, but also for the creditors and the international community. Second, compliance with ex-ante conditionalities requires a complex and impractical assessment of past government policies. Third, if compliance is assessed in on a continuous basis, IFIs might be reluctant to declare

a violation of ex-ante conditionality because this decision may precipitate a crisis. Therefore, we focus on the optimal solution assuming that IFIs can commit to a crisis-resolution framework that is contingent only on the country's financial shortfall at the time of a crisis and the extent of spillovers, without imposing ex-ante conditionality. As we shall see, this framework requires a milder form of commitment relative to the adoption of ex-ante conditionalities. In particular, IFIs have to commit to limit bail-ins and official transfers, which is in line with the ex-post interests of the creditors and the international community. Furthermore, the commitment solution without ex-ante conditionalities is particularly interesting 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 have emphasized the ex-post costs of fiscal consolidation and the contagion risks from bail-ins in 2010, while others have pointed out the moral hazard consequences of official transfers.

The optimal framework involves a restrained use of bail-ins and official transfers. In particular, transfers 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 be complemented with greater fiscal consolidation requirements than for non-systemic countries. This ensures that systemic countries behave more prudently by knowing that official 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 to adopt a similar framework and limit pressures to modify it in times of crisis, thus strengthening commitment.

Summing up, the paper suggests that to properly deal with the sovereign crises of systemic countries, IFIs should strengthen their operational frameworks along two dimensions. First, they should be able to provide highly systemic countries with official transfers. Otherwise, they would have to require systemic countries to endure excessive fiscal consolidation in order to spare the international community from the spillovers associated with bail-ins. Second, to properly manage the moral hazard effects of systemic bail-ins and official transfers, it is imperative that IFIs operate under commitment by following a predetermined crisis resolution framework that limits discretion in times of crisis.

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 in Section 4. Section 5 concludes 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). 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 a country's financing needs are sufficiently large, the laissez-faire equilibrium features credit rationing and capital liquidation. As already pointed out by 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, to ensures compliance with a given set of policies. In doing so, IFIs provide countries with commitment and improve market access. An important constraint, that we incorporate in the model, is that IFIs should increase a country's welfare relative to the laissez-faire equilibrium, otherwise the country would not subscribe to 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 among creditors can still 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 a country's ability to repay at least part of the debt. As in the case of program conditionality for the country, 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 (Cordella and Yeyati, 2005; Corsetti, Guimaraes and Roubini, 2006; Morris and Shin, 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 crisis-resolution technology. 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 prob-

ability 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, possibly with assistance from IFIs. 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. Fiscal adjustment entails a utility cost $h(f)$ that satisfies two properties. First, we assume that $\lim_{f \to 0} h'(f) = 0$ so that the country can endure a little amount of consolidation with minimal utility losses. This captures the fact that, when confronting moderate fiscal imbalances, countries use fiscal consolidation rather than calling for a debt restructuring or seeking the assistance of IFIs. Second, we assume that the marginal cost of consolidation is increasing in the size of fiscal adjustment $h'(f) \geq 0$ 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 will use this simple functional form

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

where $\alpha > 0$ controls the marginal cost of fiscal consolidation.

Third, private creditors may agree to a bail-in that provides the country with some debt relief i 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 a 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.[4]

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 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 throughout 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 official 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 systemic spillovers. This is because rather than imposing concentrated losses on private lenders that can trigger bankruptcy chains, official transfers are financed by the public balance sheets of various countries.[5] 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

[4]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.

[5]Similar considerations apply in the case of banking crises, where public funds are often used to avoid the collapse of systemic financial institutions.

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 continues into period 2 where 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 unilaterally defaults at time 1 and creditors demand the liquidation of capital. This reduces output to χk that is claimed by creditors through litigation. A default is likely to involve higher efficiency losses that those under an orderly bail-in described in the previous section. However, for the sake of simplicity, we assume that default entails the same efficiency losses ξ. Therefore, as creditors 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 losses suffered by private creditors have 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 contraction in output, from time-2 production Ak to time-1 liquidation value χk. Note that liquidation is socially inefficient, since it reduces output without preventing any of the losses associated with bail-ins and fiscal consolidation. Nonetheless, we will show that it can arise in the laissez-faire equilibrium under common forms of market failures that affect sovereign debt markets.

The model timeline is summarized in Figure 1.

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 both an ex-ante and ex-post standpoint, i.e. from the perspective of time

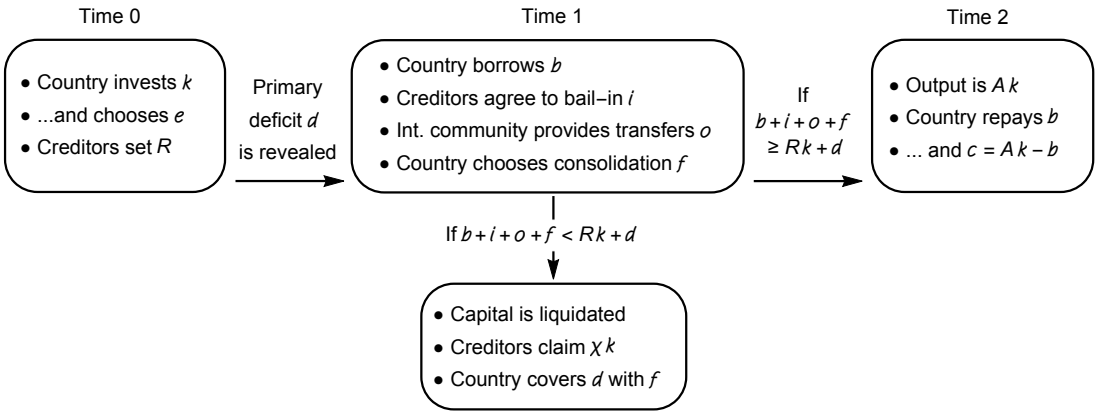

Figure 1: Model timeline.

0 and time 1. 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 lenders, they finance the capital investment k at time 0 and receive the country's pledged repayment Rk net of the losses from debt restructuring $(1+\xi)i$ at time 1.[6] Under the assumption of risk neutrality, their ex-post and ex-ante welfare are

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

We 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.

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

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

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

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 aggregate utility of the country and the international community.[7]

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 prevent liquidation.[8] This is 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) 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. Therefore, after raising b, the country faces two

[7] The analysis could be easily extended by introducing different welfare weights for the country and the international community. The implications are, however, rather straightforward. For example a larger Pareto weight on the international community increases the socially-efficient level of fiscal consolidation that the country should endure.

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

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

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

Before characterizing the laissez-fare equilibrium, we need to specify one last aspect of the model that regards the scope for state contingency in the interest rate R. As shown in Appendix A.1, if we assume that R can be made contingent on the exact realization of the primary deficit d, the country can choose a schedule that avoids any need for fiscal consolidation or bail-ins. More specifically, the country would issue bonds that require lower repayments, possibly even negative, in case of large primary deficits, thus avoiding liquidation and the need for any intervention by IFIs.[9]

To proceed with the analysis, we thus have to limit the degree of state contingency in R, at least within the crisis state. We do so in the most conservative manner, by assuming that the interest rate can still be contingent on the crisis versus non-crisis states of the economy, but not on the exact realization of the primary deficit D within the crisis state. This can reflect the fact that creditors can observe whether countries are dealing or not with a crisis situation, but domestic authorities can conceal the exact financing needs confronted during a crisis. The interest rate is thus given by

$$R = \begin{cases} \underline{R} + \pi & \text{if } d = 0 \\ \underline{R} & \text{if } d = D \end{cases} \tag{6}$$

where $\underline{R}$ is the crisis interest rate and $\pi > 0$ is the premium that investors charge in the non-crisis state to ensure break-even in expectation according to equation (3). This formulation has also the advantage of dramatically enhancing the tractability of the model and is essential to obtain closed-form solutions, since the interest rate in the crisis-state

[9] Note that, since the schedule for R needs to satisfy lenders' break-even condition (3), state-contingency in R can avoid liquidation only if 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, liquidation may occur even under a fully state-contingent R requiring IFIs to intervene as analyzes in the following section.

does not vary with the extent of bail-ins and the crisis-prevention effort. Appendix C shows that the key results of the model extend to the case in which we entirely eliminate state contingency in sovereign contracts by assuming a constant interest rate across both the non-crisis and crisis states.

We focus the analysis on the crisis state by assuming that in the non-crisis state the country can rollover debt with borrowing alone:

$$(\underline{R} + \pi)k \leq Ak \tag{7}$$

Regarding the crisis state, 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

$$D_1 = (A - \underline{R})k \tag{8}$$

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 classic debt overhang problem, where any benefit from fiscal consolidation would accrue to creditors through higher debt repayments (Krugman, 1988; Borensztein, 1990). Therefore, once the primary deficit exceeds D_1, creditors have to ration credit b below Ak in an attempt to elicit fiscal consolidation to cover the financing needs $f = \underline{R}k + D - b$. As shown in Appendix A.2, creditors can prevent liquidation through credit rationing as long as the primary deficit does not exceed the following threshold

$$D_2 = \max\left\{D_1, \frac{(A - \underline{R})k}{\alpha \underline{R}k} - \frac{\underline{R}k}{2}\right\} \tag{9}$$

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 and we summarize the laissez-faire solution in the following proposition:

Proposition 3.1 (Laissez-faire equilibrium) *In the crisis state, under the laissez-fare equilibrium: (i) if the primary deficit is sufficiently low, $D \leq D_1$, the country covers its financing needs through borrowing alone; (ii) if $D_1 < D \leq D_2$, creditors ration lending, $b < Ak$, and the country exercises fiscal consolidation to cover the remaining financing needs; (iii) if $D > D_2$, the country is unable to borrow and uses fiscal consolidation to only cover the primary deficit, while creditors trigger capital liquidation.*

Proof. See discussion above and Appendix A.2. ■

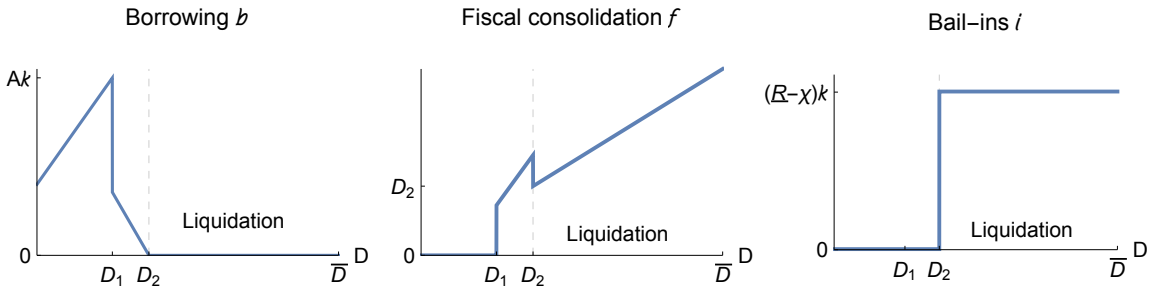

Figure 2: Laissez-faire equilibrium.

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 IFIs may provide official transfers financed by 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 possible 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.

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

$$U_1^S = Ak - \left(D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right) \tag{10}$$

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 (3) to substitute out the interest premium π, we can express social welfare from an ex-ante perspective as

$$U_0^S = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right] \tag{11}$$

where $\underline{\mathbb{E}}_0[\bullet]$ is the expectation operator conditional on the crisis state, i.e. on $d = D$. The crisis-prevention effort e^S that maximizes ex-ante social welfare is then simply given by

$$z'(e^S) = p'(e^S)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi + \lambda)i + \xi o\right] \tag{12}$$

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

$$U_0^C = -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \tag{13}$$

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:

$$z'(e^C) = p'(e^C)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \tag{14}$$

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.[10] Using these functional forms, we can express the difference between the socially-efficient and country-preferred level of effort as

$$e^S - e^C = \frac{\nu}{\beta} \cdot \underline{\mathbb{E}}_0\left[\lambda i + (1+\xi)o\right] \tag{15}$$

This difference reflects the moral hazard costs associated with bail-ins and official transfers. We observe that in the absence of spillovers, bail-ins do not generate moral hazard since the losses faced by creditors are priced into a higher interest premium π and are thus internalized by the country.[11] Bail-ins generate instead moral hazard in the case of systemic countries, since neither the country nor the creditors internalize the spillover costs suffered by third parties. This is the case also for official transfers since the country neglects the costs faced by the international community to finance them.

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 in which case she would only focus on minimizing the ex-post costs of the crisis, neglecting the implications for ex-ante moral hazard. The planner would thus solve:

$$\begin{aligned} \max_{b,f,i\geq 0,o\geq 0} \quad & Ak - \left(D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right) \\ & \text{subject to} \\ & b + f + i + o = \underline{R}k + D \\ & b \leq Ak \end{aligned} \tag{16}$$

[10] 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.

[11] 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.

We will later show that the planner's solution satisfies the participation constraints of both the country and the creditors, since they are ex-post better off than under laissez faire.

At the opposite extreme, we could assume that the planner has commitment as well as the ability to credibly use ex-ante conditionality. In particular, 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 several reasons. First and most important, should a country deviate from the socially-efficient effort, it becomes extremely difficult to deny assistance during a crisis because such a decision would impose losses on all parties: the country would suffer an output contraction; the creditors would experience larger losses because of capital liquidation; and these larger losses would impose stronger spillovers on the international community. Therefore, all parties would put pressure on IFIs to provide assistance ex-post despite the violation of ex-ante conditionalities. Second, different 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. Third, if ex-ante conditionalities are evaluated on a regular basis, IFIs can be reluctant to declare a country to be not compliant because of the risk to trigger a crisis.

For these reasons, we focus the analysis on the planner's solution under commitment but without ex-ante conditionalities. In other words, we solve for the optimal crisis-resolution framework that is contingent only on the country's financing needs at the time of a crisis and the size of spillovers, but not on the crisis-prevention effort e. In this case, the planner chooses the policy mix that maximizes social welfare from an ex-ante perspective taking into account the country's choice of the crisis-prevention effort:

$$\begin{aligned} \max_{e,b,f,i\geq 0,o\geq 0} \quad & -z(e) + (A-1)k - (1-p)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + (\xi+\lambda)i + \xi o\right] \\ & \text{subject to} \\ & b + f + i + o = \underline{R}k + D \\ & b \leq Ak \\ & z'(e) = p'(e)\underline{\mathbb{E}}_0\left[D + \alpha f^2/2 + \xi i - o\right] \end{aligned} \tag{17}$$

As we shall see, this problem requires IFIs to commit to limit the use of bail-ins and official transfers and thus raise the extent of fiscal consolidation. This is a much lighter form of com-

mitment than the one required to support ex-ante conditionalities. As previously discussed, for ex-ante conditionalities to be credible, IFIs should stand ready to deny assistance even when this aggravates a crisis and imposes greater costs not only on the country, but also on the creditors and the international community. On the contrary, limiting bail-ins and official transfers is in line with the ex-post interests of the creditors and the international community. The commitment solution without ex-ante conditionalities is also particularly interesting from an analytical perspective, since it involves a delicate balance between minimizing the ex-post costs of resolving the crisis and containing the ex-ante moral hazard effects.

We begin by solving the planner's problem in the absence of official transfers, characterizing the solution with and without commitment. This reflects the current operational frameworks of IFIs that are generally prevented from providing transfers. We then solve the planner's problem allowing for transfers, but in the absence of commitment. This scenario captures the risks of incomplete reforms that would give IFIs the ability to provide transfers without constraining them to operate under a predetermined crisis-resolution framework. Finally, we consider the optimal crisis-resolution framework with both transfers and commitment. We present the results in concise and intuitive terms, referring the reader to Appendix B for a formal derivation.

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, $o = 0$. We begin by considering the problem without commitment in which case the planner solves problem (16) to maximize social welfare from an ex-post perspective without considering the ex-ante consequences on moral hazard.

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 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

$$MC^{f}_{\text{ex-post}} = \alpha f \tag{18}$$

$$MC^{i}_{\text{ex-post}} = \xi + \lambda \tag{19}$$

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 we assumed $\lim_{f\to 0} h'(f) = 0$ so that 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.[12] This is consistent with the fact that countries use fiscal consolidation rather than debt restructuring to deal with moderate fiscal imbalances. The model also features 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:

$$\bar{f}_{\not{O},\not{C}} = \frac{MC^{i}_{\text{ex-post}}}{\alpha} = \frac{\xi + \lambda}{\alpha} \tag{20}$$

where the subscripts $\not{O}$ and $\not{C}$ denote respectively the solution with no official transfers and no commitment. 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 as in problem (17), taking into account not only the ex-post costs of resolving the crisis, but also the ex-ante moral hazard effects. The planner allows again the country to issue bonds up to its borrowing limit Ak. Regarding the mix between fiscal consolidation and bail-ins to cover the remaining financing needs, the planner now considers their social marginal costs from an ex-ante perspective taking into account the moral hazard implications. As shown in Appendix B, the marginal costs from an ex-ante perspective are given by

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

$$MC^{i}_{\text{ex-ante}} = \xi + \lambda + \lambda \cdot \left(\frac{1 - p^{C}}{1 - p^{S}} - 1 \right) \tag{22}$$

where p^S and p^C denote the probability of the non-crisis state under the crisis prevention

[12] In the context of the model, we could obtain similar predictions by assuming that bail-ins involve a fixed cost.

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 (18). Indeed, fiscal consolidation does not generate moral hazard since the associated costs are entirely borne by the country. This is true also for bail-ins in the 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 in deciding on the crisis-prevention effort the country neglects the spillover costs 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 state 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 ex-ante more costly raises the upper bound on fiscal consolidation to

$$\bar{f}_{\varnothing,\mathrm{C}} = \frac{MC^i_{\text{ex-ante}}}{\alpha} \tag{23}$$

where the subscript C denotes the solution with commitment.

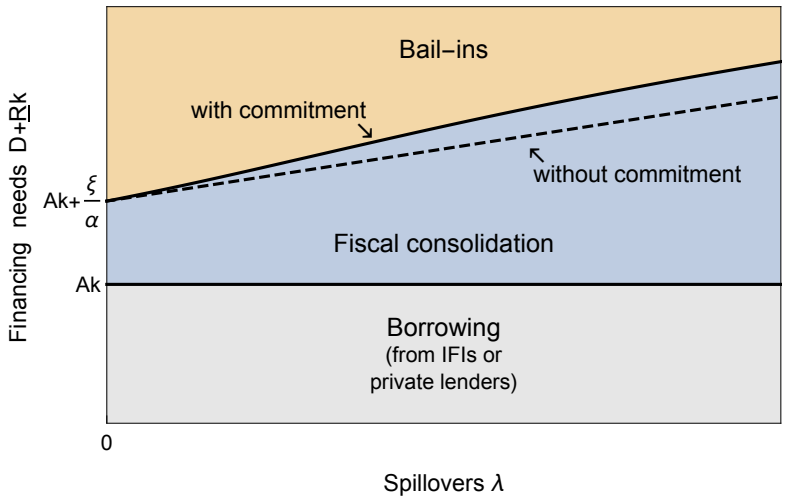

Figure 3: Planner's solution without official transfers

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. Fur-

thermore, 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. We summarize the planner's solution without official transfers in the following proposition

Proposition 4.1 (Planner's solution without official transfers) *The planner's solution without official transfers involves the country borrowing up to its maximum capacity, $b = Ak$. Additional financing needs should be covered first with fiscal consolidation up to $\bar{f}_{\not\emptyset} \in \{\bar{f}_{\not\emptyset,\not\emptyset}, \bar{f}_{\not\emptyset,C}\}$ and then using bail-ins.The upper bound $\bar{f}_{\not\emptyset}$ is (i) increasing in the size of spillovers, $\partial \bar{f}_{\not\emptyset}/\partial\lambda > 0$ and (ii) higher if the planner operates under commitment relative to no commitment, $\bar{f}_{\not\emptyset,C} \geq \bar{f}_{\not\emptyset,\not\emptyset}$.*

Proof. See discussion above and Appendix B. ■

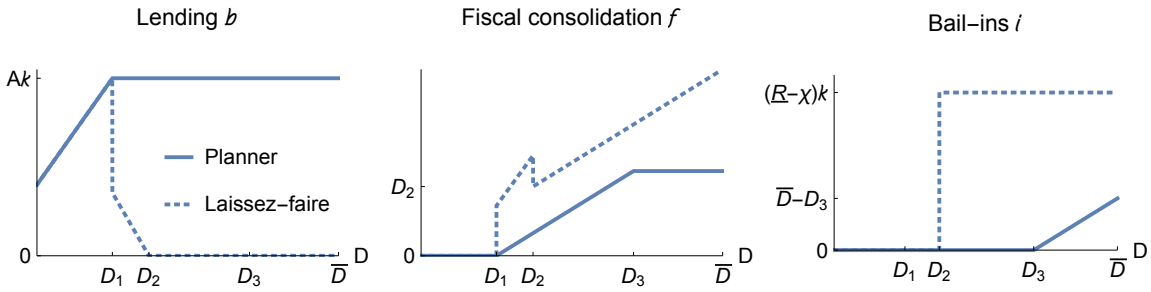

Figure 4: Laissez-faire versus planner's equilibrium without official transfers.

Finally, 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 solution and the laissez-faire equilibrium. Define

$$D_3 = D_1 + \bar{f}_{\not\emptyset}$$

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 residual financing gap $D - D_1$ where, as defined in equation (8), 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, where they may at most suffer losses equal to $(1 + \xi)(\bar{D} - D_3)$. As shown in the right chart, these are 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. The planner maximizes social welfare from an ex-post perspective according to problem (16). The ex-post social marginal costs of fiscal consolidation and bail-ins are as defined in equations (18) and (19), while the marginal cost of transfers is

$$MC^{o}_{\text{ex-post}} \quad = \quad \xi \tag{24}$$

The planner provides financing to the country up to its borrowing capacity. If this is not sufficient to cover the financing needs, i.e. if $D > D_1$, 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

$$\bar{f}_{\text{O},\mathscr{C}} \quad = \quad \frac{\min\left\{MC^{i}_{\text{ex-post}}, MC^{o}_{\text{ex-post}}\right\}}{\alpha} = \frac{\xi}{\alpha} \tag{25}$$

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 them. However, if $\lambda > 0$, official transfers become ex-post less costly than bail-ins. Therefore, the planner keeps the upper bound on fiscal consolidation equal to ξ/α and covers any additional financing gap through transfers alone. This solution is illustrated in Figure 5 and summarized in the following proposition

Proposition 4.2 (Planner's solution with official transfers but no commitment) *The planner's solution with official transfers but no commitment involves the country borrowing up to its maximum capacity, $b = Ak$. Additional financing needs should be covered first with fiscal consolidation up to $\bar{f}_{O,\mathscr{C}}$ and then using (i) either bail-ins or transfers if the country is not systemic $\lambda = 0$; (ii) only transfers if the country is systemic $\lambda > 0$.*

Proof. See discussion above and Appendix B. ■

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. Therefore, this solution also satisfies the country and creditors' participation constraints. However, it has the potential to generate severe moral hazard effects that, as we shall see in section 4.4, can even lead to lower ex-ante social welfare than under the laissez-faire equilibrium. This should serve as an important

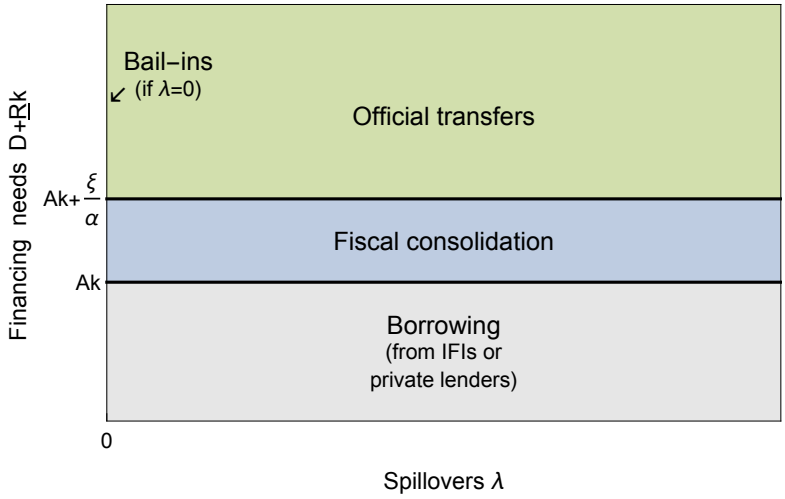

Figure 5: Planner's solution with official transfers, but no commitment

cautionary tale against allowing IFIs to provide official transfers, without constraining their operations within a predetermined crisis-resolution framework.

4.3 Planner's solution with official transfers and commitment

Finally, we 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 problem (17). The ex-ante social marginal costs of fiscal consolidation and bail-ins are as in equations (21) and (22). Regarding official transfers, their social marginal cost from an ex-ante perspective is given by

$$MC^{o}_{\text{ex-ante}} \quad = \quad \xi + (1+\xi) \cdot \left(\frac{1-p^{C}}{1-p^{S}} - 1 \right) \tag{26}$$

Transfers entail the ex-post efficiency losses ξ. Furthermore, they have potentially 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:

$$\bar{f}_{\text{O,C}} \quad = \quad \frac{\min\left\{MC^{i}_{\text{ex-ante}}, MC^{o}_{\text{ex-ante}}\right\}}{\alpha} \tag{27}$$

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

$$\bar{f}_{\text{O,C}} = \frac{MC^{i}_{\text{ex-ante}}}{\alpha} = \frac{\xi}{\alpha} \quad \text{if} \quad \lambda = 0$$

and any additional financing gap is covered exclusively through bail-ins. Note that this solution is identical to the one without transfers and commitment.[13] 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.

Consider now 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

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

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 through 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

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

[13] 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 (19) and (24) are identical if $\lambda = 0$.

Finally, if spillovers 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

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

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.

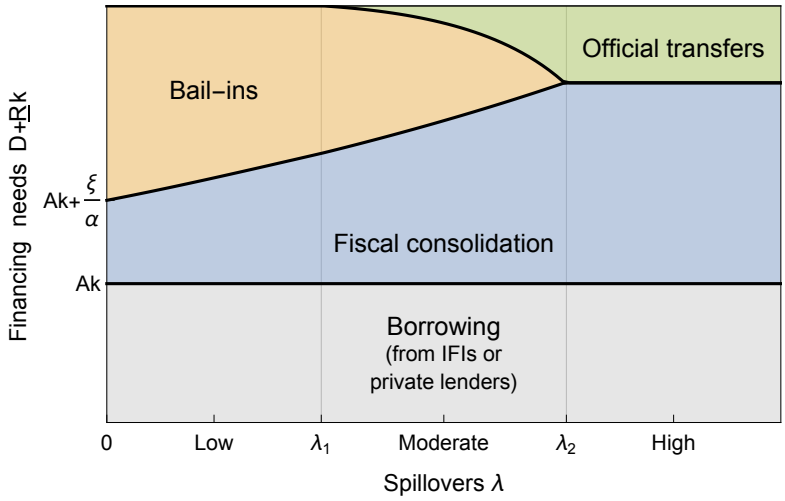

Figure 6: Planner's solution with commitment and official transfers.

Dealing with systemic countries is considerably more challenging. In particular, it is crucial to update the operational frameworks of IFIs along two aspects. First, 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. Second, IFIs should be endowed with commitment in order to provide transfers only to particularly systemic countries and in

moderate amount. 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. We summarize the planner's solution with official transfers and commitment in the following proposition

Proposition 4.3 (Planner's solution with official transfers and commitment) *The planner's solution with official transfers and commitment involves the country borrowing up to its maximum capacity, $b = Ak$. Additional financing needs should be covered first with fiscal consolidation up to $\bar{f}_{O,C}$ and then using (i) only bail-ins if $\lambda < \lambda_1$; (ii) a proportion of bail-ins and official transfers that ensure their marginal costs are equalized if $\lambda_1 \leq \lambda \leq \lambda_2$; (iii) only transfers if $\lambda > \lambda_2$.*

Proof. See discussion above and Appendix B. ■

Finally, note that the planner's solution with commitment and transfers satisfies the participation constraints of the country and the creditors. Indeed, since transfers limit the need for fiscal consolidaiton and bail-ins, the country and the creditors are ex-post better off than under the solution without transfers that already satisfies the participation constraints.

4.4 Welfare implications of alternative crisis-resolution frameworks

In this section, we consider the implications of the planner's solutions for the ex-ante welfare of the society as a whole and the country. Regarding the effects on ex-ante social welfare, three interesting aspects stand out

Corollary 4.4 (Implications for ex-ante social welfare) *(i) Absent spillovers $\lambda = 0$, IFIs can achieve the maximum ex-ante social welfare even without official transfers and commitment. (ii) If IFIs can provide transfers but have no commitment, ex-ante social welfare can decline below the laissez-faire equilibrium. (iii) Even if IFIs can use transfers and have commitment, ex-ante social welfare is declining in the size of spillovers.*

Proof. See discussion below. ■

The above considerations are illustrated in Figure 7. First, we observe that in the absence of spillovers, , the planner's solution achieves the maximum welfare even without transfers and commitment. This is because, as we have seen, the planner's solution without transfers and commitment is indeed identical to the one with transfers and commitment if $\lambda = 0$. Therefore, IFIs can effectively address the sovereign debt crisis of a non-systemic country by simply focusing on minimizing the ex-post costs of the crisis and without providing transfers, in accordance with the current operational frameworks.

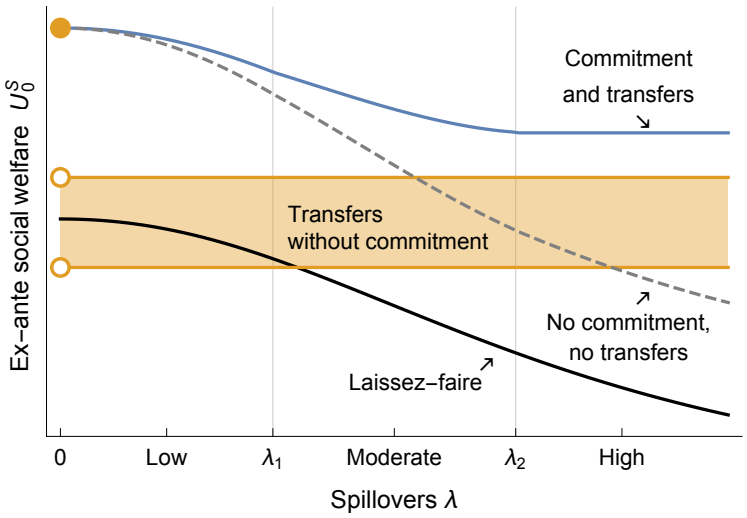

Figure 7: Ex-ante social welfare under alternative frameworks.

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 (15), 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 solution 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. To see this, consider the case of a positive but infinitesimally small λ, so that we can ignore the spillover and moral hazard costs of bail-ins. Absent commitment, IFIs would use transfers to prevent any bail-ins or higher fiscal consolidation. If the ratio ν/β is sufficiently high, the resulting moral hazard costs can outweigh the losses from the liquidation of capital under laissez-faire. These considerations should serve as an important warning against incomplete reforms that may authorize IFIs to provide transfers without disciplining their use through predetermined rules.

Third, even under the optimal solution with transfers and commitment, social welfare is declining in the size of spillovers since they increase the cost of bail-ins. Social welfare reaches a lower bound in the case of highly systemic countries, $\lambda \geq \lambda_2$, for which it is preferable to avoid bail-ins entirely. The decline in social welfare associated with 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 sovereign debt of systemic countries to better absorb possible losses from bail-ins.

The model provides also interesting insights about the implications of alternative crisis-resolution frameworks for the ex-ante welfare of the country

Corollary 4.5 (Implications for the country's ex-ante welfare) *(i) A crisis country is better off under the assistance of IFIs than under laissez-faire. (ii) If IFIs provide official transfers under commitment, systemic countries are not necessarily better off than non-systemic countries. (iii) By using a different crisis-resolution approach depending on the strength of spillovers, IFIs generate differences in countries' ex-ante welfare.*

Proof. See discussion below. ■

These considerations are 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.

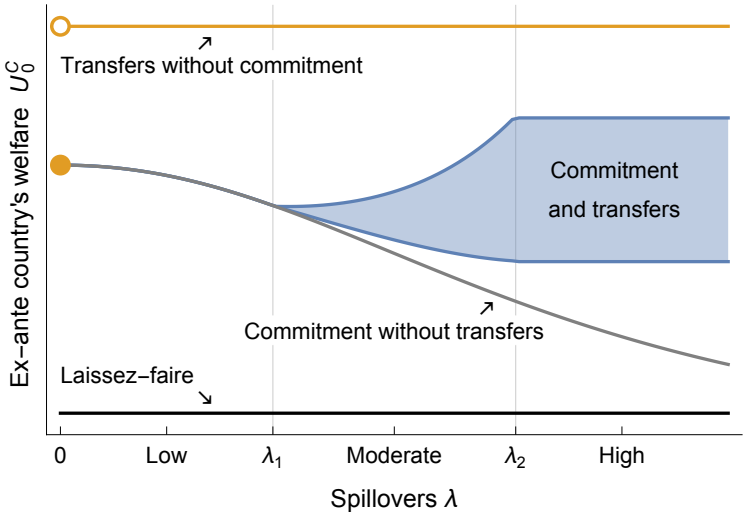

Figure 8: Ex-ante country's welfare under alternative frameworks.

Second, even if systemic countries receive official transfers from IFIs, they are not necessarily better off than non-systemic countries if IFIs operate under commitment. This depends on the extent to which the reduction in bail-ins for systemic countries is compensated through greater fiscal consolidation or with transfers that respectively hurt and benefit the country. In turn, this decision hinges on the strength of the moral hazard associated with transfers that as shown in equation (15) is proportional to the ratio ν/β. If moral hazard effects are severe, it is socially 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 under the framework with transfers and commitment, as just discussed, it is actually not obvious whether systemic countries are worse or better off. 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 would 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.

Finally, note that the fact that countries' expected welfare may differ depending on the extent of spillovers may raise concerns about strategic behavior. For example, countries may try to increase their systemic relevance in order to receive official transfers during a crisis. However, these effects are likely to be fairly limited. First, as we just discussed, it is not obvious that systemic countries are better off since under the commitment solution they would also have to endure greater fiscal consolidation. Second, countries can hardly change their systemic relevance. For example, a key factor that shapes the potential for systemic spillovers is the size of the country economy which is clearly difficult to alter. Furthermore, the extent of spillovers can largely depend on the state of the global economy rather than on an individual country's decisions: for example, the Greek sovereign debt crisis would have likely had much more limited systemic consequences if it occurred in a stronger international context.

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. Using the model, we have solved 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. In particular, it is crucial to update the operational frameworks of IFIs along two key dimensions. First, to limit bail-ins and the associated spillovers, IFIs should provide systemic countries with official transfers. Otherwise, the reduction in bail-ins would need to be offset entirely through fiscal consolidation, possibly placing an excessive burden on the crisis country. Second, to contain the moral hazard effects associated with systemic bail-ins and official transfers, IFIs should operate under commitment by following a predetermined crisis-resolution framework. This is important 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 lending framework, in particular with regard to the so called "systemic exemption".[14] 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 provide 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 particularly systemic countries and under a predetermined framework.

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 entail differences in expected welfare across countries. The model

[14] 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.

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.

Appendices

A Laissez-faire equilibrium

A.1 State contingent interest rate within the crisis state

In this section we first characterize the social planner's solution in case the interest rate R can be made contingent on the exact realization of the primary deficit d, even within the crisis state. 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 social planner 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):

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

Using the financing constraint to substitute out b and the break-even condition to substitute Rk from the definition of social welfare, the problem can be expressed more compactly as

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

This formulation of the problem shows 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 planner's solution 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. Finally, note that, since there is no need for official transfers $o = 0$ and there are no spillovers given the absence of bail-ins $\lambda i = 0$, the country's ex-ante welfare is identical to social welfare $U_0^C = U_0^S$. Therefore, by maximizing its own utility, the country chooses the socially optimal level of crisis-prevention effort.

A.2 Constant interest rate within the crisis state

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 (6) and that borrowing is sufficient to cover the country's financing needs in the non-crisis state asin equation (7). 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

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

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 fiscal 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. 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 using lenders' break-even equation (3), 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 and $\underline{\mathbb{E}}_0[\bullet]$ is the expectation operator conditional on the crisis state, i.e. on $d = D$. The crisis-prevention effort solves

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

B Planner's solution

B.1 Without commitment

By substituting out b, the Lagrangian of problem (16) 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, 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 (17) is

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

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 (15). The additional Kuhn Tucker conditions require:

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

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:

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

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 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 Planner's solution under a 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 (17) 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 (6), 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 derive analytical solutions.

The fact that the interest rate in the crisis state is affected by the crisis-prevention effort and the extent of 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.

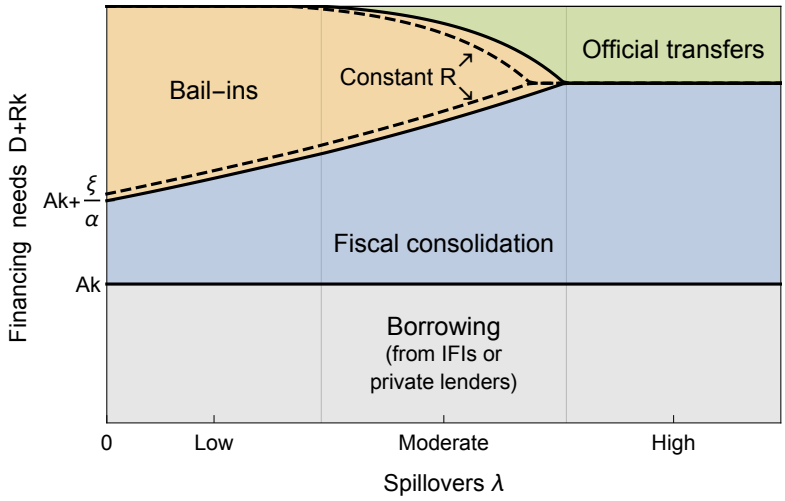

Figure 9: Planner's solution with constant interest rate R.

References

Aguiar, Mark, and Gita Gopinath. 2006. "Defaultable Debt, Interest Rates and the Current Account." *Journal of international Economics*, 69(1): 64–83.

Arellano, Cristina. 2008. "Default Risk and Income Fluctuations in Emerging Economies." *American Economic Review*, 98(3): 690–712.

Barro, Robert. 1998. "The IMF Doesn't Put Out Fires, It Starts Them." *Business Week*, December 7.

Borensztein, Eduardo. 1990. "Debt overhang, credit rationing and investment." *Journal of Development Economics*, 32(2).

Calomiris, Charles. 1998. "The IMF's Imprudent Role as Lender of Last Resort." *Cato Journal*, 17(3): 275–294.

Calvo, Guillermo A. 1988. "Servicing the Public Debt: The Role of Expectations." *The American Economic Review*, 78(4): 647–661.

Claessens, Stijn, and Ishac Diwan. 1990. "Investment Incentives: New Money, Debt Relief, and the Critical Role of Conditionality in the Debt Crisis." *The World Bank Economic Review*, 4(1): 21–41.

Cole, Harold L., and Timothy J. Kehoe. 2000. "Self-Fulfilling Debt Crises." *The Review of Economic Studies*, 67(1): 91–116.

Cordella, Tito, and Eduardo Levy Yeyati. 2005. "Country insurance." *IMF Staff Papers*, 52: 85–106.

Corsetti, Giancarlo, Bernardo Guimaraes, and Nouriel Roubini. 2006. "International Lending of Last Resort and Moral Hazard: A Model of IMF's Catalytic Finance." *Journal of Monetary Economics*, 53(3): 441–471.

Detragiache, Enrica. 1996. "Rational Liquidity Crises in the Sovereign Debt Market: In Search of a Theory." *IMF Staff Papers*, 43(3): 545–570.

Diamond, Douglas W., and Philip H. Dybvig. 1983. "Bank Runs, Deposit Insurance, and Liquidity." *The journal of political economy*, 91(3): 401–419.

Eaton, Jonathan, and Mark Gersovitz. 1981. "Debt with Potential Repudiation: Theoretical and Empirical Analysis." *Review of Economic Studies*, 48(2): 289–309.

Fernández, Raquel, and Alberto Martin. 2014. "The Long and Short of It: Sovereign Debt Crises and Debt Maturity." *NBER Working Paper No. 20786.*

Fischer, Stanley. 1999. "On the Need for an International Lender of Last Resort." *The Journal of Economic Perspectives*, 13(4): 85–104.

International Monetary Fund. 2014. "The Fund's Lending Framework and Sovereign Debt – Preliminary Considerations." *Staff Report for Consideration by the Executive Board.*

Jeanne, Olivier, and Charles Wyplosz. 2003. "The International Lender of Last Resort. How Large Is Large Enough?" In *Managing Currency Crises in Emerging Markets.* 89–124. University of Chicago Press.

Jeanne, Olivier, and Jeromin Zettelmeyer. 2005*a*. "The Mussa Theorem (and Other Results on IMF-Induced Moral Hazard)." *IMF Staff Papers*, 52(si): 64–84.

Jeanne, Olivier, and Jeromin Zettelmeyer. 2005*b*. "Original Sin, Balance Sheet Crises and the Roles of International Lending." In *Other Peoples Money.* , ed. B. Eichengreen and R. Hausmann, 95–121. Chicago: University of Chicago Press.

Jeanne, Olivier, Jonathan D. Ostry, and Jeromin Zettelmeyer. 2008. "A Theory of International Crisis Lending and IMF Conditionality." *IMF Working Papers No.08/236*, 1–33.

Krugman, Paul. 1988. "Financing vs. Forgiving a Debt Overhang." *Journal of Development Economics*, 29(3).

Meltzer Commission. 2000. "Report of the International Financial Institutions Advisory Commission."

Mendoza, Enrique G., and Vivian Z. Yue. 2012. "A General Equilibrium Model of Sovereign Default and Business Cycles." *The Quarterly Journal of Economics*, 127(2): 889–946.

Morris, Stephen, and Hyun Song Shin. 2006. "Catalytic finance: When does it work?" *Journal of international Economics*, 70(1): 161–177.

Pitchford, Rohan, and Mark L. J. Wright. 2012. "Holdouts in Sovereign Debt Restructuring: A Theory of Negotiation in a Weak Contractual Environment." *The Review of Economic Studies*, 79(2): 812–837.

Rochet, Jean-Charles, and Xavier Vives. 2004. "Coordination Failures and the Lender of Last Resort: Was Bagehot Right after All?" *Journal of the European Economic Association*, 2(6): 1116–1147.

Sachs, Jeffrey. 1984. *Theoretical Issues in International Borrowing.* International Finance Section, Department of Economics, Princeton University Princeton.

Sachs, Jeffrey. 1995. "Do We Need an International Lender of Last Resort?" Frank D. Graham Lecture, Princeton University.

Wright, Mark L. J. 2005. "Coordinating Creditors." *The American Economic Review*, 95(2): 388–392.