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Sovereign Debt Crisis: Coordination, Bargaining and Moral Hazard*

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Abstract

We study the interaction between (a) inefficiencies in the post-default debtor-creditor bargaining game and (b) ex ante debtor moral hazard and excessive lending in sovereign debt markets. Conditional on default, self-fulfilling debt crisis driven by creditor coordination failure exists and crisis risk is inefficiently high. Strengthening collective action clauses (CACs) has an ambiguous impact on crisis risk. Even with ex ante debtor moral hazard, crisis risk remains inefficiently high. Moreover, even without debtor moral hazard, excessive lending by creditors generates, endogenously, positive default probability. We establish the case for a formal sovereign bankruptcy procedure to complement the role of CACs.

Keywords: Sovereign Debt, Bargaining, Coordination, Moral Hazard, Collective Action Clauses.

JEL Classifications: C72, C78, D82, F34

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1 Introduction

Following Mexico's debt moratorium in 1982, there was a large-scale write-down under the Brady Plan and the market's response was to switch from bank finance to arms-length bond-finance (Eichengreen and Portes, 1995). Typically, emerging markets issue New York bonds, which require the unanimous consent of all creditors to change any financial terms[1]. This requirement makes these sovereign debt contracts difficult to restructure (Roubini and Setser, 2003) thus substantially reducing the perceived risk of restructuring (Cline, 1984; Buchheit, 1999). However, a rash of emerging market liquidity crises during the 1990s demonstrated that sovereign bonds, nevertheless, carry substantial default risk.

The official response, particularly in the form of extremely large financial bailouts, ran the risk of encouraging overborrowing as creditors, anticipating automatic bailouts, ceased to monitor debtors[2]. To reign back a seemingly unending series of bailouts, two principal mechanisms were considered: (a) an official Sovereign Debt Restructuring Mechanism (SDRM), based on Chapter 11 of the US bankruptcy code (Krueger, 2001) and (b) the market-driven adoption of CACs in debt contracts as in the nineteenth century London capital market (Buchheit, 1999, Ghosal and Miller, 2003). The former proved unpopular, both with large borrowers fearing for their reputation, and with the US, the largest lender: so CACs have been strongly promoted as a viable, market-driven, alternative (Taylor, 2002), with Mexico taking a lead in early 2003.

Why does sovereign debt crisis occur? Is the risk of a sovereign debt crisis inefficiently high? What are the effects of strengthening CACs? Are CACs indeed a panacea for the problems of emerging market finance? Is there a case for a formal sovereign debt bankruptcy procedure? To answer these questions, in this paper, we develop a model that studies the interaction between bargaining, coordination, and structural adjustment on one hand, with ex ante sovereign debtor moral hazard and endogenous entry into the market for sovereign debt, on the other.

We study sovereign debt financing in an open economy with a fully liberalised capital account. A sovereign embarks on a two-period project bond-financed by a group of private creditors. The bond contracts promise a stream of returns over two periods to these private creditors. In addition, we assume that, if the project continues to maturity, the sovereign debtor obtains a non-contractible

[1] The financial terms are narrowly defined as payment dates and principal of the bond contract.

[2] The failure to bailout Russia in 1998 came as a shock to investors and sovereign risk premium rose to double figures.

payoff, i.e. payoff which cannot be attached by creditors in settlement of their claims[3]. We begin our analysis at the point where, following an exogenous and unanticipated shock[4], the sovereign debtor is unable to fulfil the terms of the debt contract in the first period when payment is due to a group of private creditors. An example of such a shock could be a devaluation when sovereign debt is denominated in dollars. This leads to a technical default, making the debt callable and exposing the sovereign to the risk of a debt crisis. Conditional on default, each private creditor receives a noisy, privately observed signal of the future net worth of the project. In addition, the debtor obtains privately observed information about her non-contractible benefit if the project continues to the next period.

We consider two versions of the model which are distinguished by whether or not, conditional on default at $t = 1$, the sovereign debtor can credibly commit to transfer some of her non-contractible payoffs to the creditors. If the sovereign debtor cannot make such a credible commitment, there is no bargaining. Each private creditor decides whether or not to accelerate[5] her claim. When the proportion of creditors who choose to accelerate their claims exceeds a critical threshold, the project is terminated. With bargaining, the debtor makes an offer, a transfer of her non-contractible continuation payoff to private creditors. When the proportion of creditors who choose to reject the debtor's offer exceeds a critical threshold, the project is terminated. In both cases, we say that a sovereign debt crisis occurs when, relative to a first-best benchmark, there is inefficient project termination.

Our results are as follows. Without bargaining, the existence of self-fulfilling symmetric Bayesian equilibrium thresholds, driven by creditor coordination failure, is a distinct possibility. So, relative to the first-best benchmark, there is an excessive probability of project termination. Strengthening CACs facilitates creditor coordination. With bargaining, we show that an extreme form of coordi-

[3] An example of such non-contractible payoffs is when for instance the funds borrowed by the sovereign are used to finance a publicly operated infrastructure project. If the infrastructure project succeeds, the government enjoys the prospect of higher tax revenue as more domestic and foreign firms invest and employment is generated. Although no private creditor can attach the future tax revenues generated by the infrastructure project, the sovereign debtor may be able to credibly commit to transfer some of the tax revenue to private creditors.

[4] Later in the paper, we extend the model to endogenise the probability of default and allow creditors to anticipate default with the correct probability.

[5] Acceleration clauses are designed to limit the ability of a minority of bondholders in disrupting the restructuring process by enforcing their claims after default and prior to a restructuring agreement. These provisions consist of two parts: (i) a vote by 25 percent of outstanding principal is needed to accelerate their claims and vote of more than 50 percent is required to de-accelerate these claims (IMF, 2002).

nation failure always exists: it is always a Bayesian equilibrium for the debtor to make a zero offer and for all creditors to reject the debtor's offer. The existence of self-fulfilling Bayesian equilibrium thresholds driven by creditor coordination failure is a robust possibility. As before, there is an excessive probability of project termination relative to the first-best benchmark. The key to our analysis is the debtor's incentives to bargain: taking as given the creditor's threshold strategies, the debtor faces a trade-off as increasing her offer increases probability of project continuation but decreases the amount she keeps for herself if the project does continue to the next period. We show that, in general, strengthening CACs has an ambiguous impact on Bayesian equilibrium thresholds. Taking as given the debtor's offer, while strengthening CACs makes it more difficult for creditors to ensure early termination, it, at the same time, reduces the debtor incentives to bargain. The net effect, in equilibrium, is ambiguous. It follows that strengthening CACs could push the set of Bayesian equilibrium thresholds away from the first-best termination probability. However, we also derive a sufficient condition which ensures that strengthening CACs has an unambiguous impact in lowering crisis risk. Even when strengthening CACs has a positive impact on lowering crisis risk, we show that the first-best threshold is never achieved.

We, then, extend the model to examine the debtor incentives, conditional on default, to undertake costly, imperfectly observed (by private creditors) structural adjustment effort[6]. In this context, the structural adjustment effort could correspond to the policy to run a fiscal surplus or the measures to contain inflation or reduce public debts. When strengthening CACs lower crisis risk, it has a positive impact on the debtor incentives to undertake structural adjustment effort; however, in general, the impact of strengthening CACs on crisis risk is ambiguous.

Next, we extend the model to analyse ex ante debtor moral hazard. We assume that the debtor can undertake good or bad effort ex ante. We assume that good effort lowers the probability of default. In this context, good effort could correspond to a situation where money is borrowed and used to promote R&D in the export sector and bad effort could correspond to transferring borrowed money to local elites who are, then, free to put it in tax havens overseas[7]. We show that a positive risk of early project termination, conditional on default, is needed to solve the debtor's ex ante incentives. However, the risk of early

[6] Later in the paper, the structural adjustment effort is described as effort exerted by the sovereign debtor, which affects the distribution over the future net worth of the project.

[7] Refer to Ghosal and Miller (2003) for more examples on ex ante debtor moral hazard and for other relevant results.

project termination generated in the post-default bargaining game is inefficiently high, relative to a second-best benchmark. Moreover, we find that there may be a conflict in providing the debtor with appropriate ex ante incentives and undertake, conditional on default, high structural adjustment effort. What is the effect of strengthening CACs on the debtor incentive? When strengthening CACs lowers crisis risk, it will have an adverse effect on the debtor ex ante incentive, therefore, it may be able to price debtor moral hazard efficiently. However, in general, the impact of strengthening CACs on crisis risk is ambiguous[8].

Next, even without ex ante debtor moral hazard, we show that excessive entry by creditors endogenously generates a positive probability of default in the market for sovereign debt. We do this by deriving a lower bound on the number of creditors participating in the market for sovereign debt. A key feature of our analysis is that, as more creditors enter the market, the interest rate charged for sovereign debt adjusts upwards to compensate for any additional default risk. In this sense, adjustments in the interest rate compensate each creditor for the dilution of her individual claim on the debtor. Nevertheless, any increase in the probability of default is inefficient in our model as, conditional on default, there is inefficient project termination. Therefore, there is excessive entry by creditors even without IMF bailouts.

We show that some policy interventions that occur conditional on default, like strengthening CACs, have limited efficacy. IMF bailouts could push the probability of project termination towards its efficient level and therefore, have a positive impact on the debtor's incentives to undertake higher structural adjustment effort. However, in doing so, it could have an adverse impact on the ex ante debtor incentives and, by encouraging excessive entry, unless the first-best is achieved in the post-default bargaining game, inefficient risk will still persist in the market for sovereign debt. Nevertheless, we argue that our analysis suggests a role for an appropriately designed formal sovereign bankruptcy procedure like the SDRM (see, for instance, Krueger, 2002) which incorporates both ex ante and ex post elements. An example of such a procedure which addresses the issues raised in our analysis is explicitly worked out.

Related literature Kletzer (2004), building on the analysis of Kletzer and Wright (2000) (see also Bulow and Rogoff, 1989), studies the model of debtor-creditor bargaining where strengthening CACs eliminates the inefficiency of creditor holdout. As noted above, we obtain completely different results. A

[8] Strengthening CACs will have a positive impact if the debtor's offer is increasing in the CACs critical threshold; however, if this is not the case, then it might have a perverse impact on the debtor's incentive to bargain in the post-default bargaining game thus it is not necessarily able to price debtor moral hazard, which is in contrast to Eichengreen et al. (2003).

key difference with our analysis is that, in Kletzer and Wright (2000), a high probability of disagreement has a high impact on the debtor willingness to pay. In related work, Eichengreen et al. (2003) predict that CACs will be able to price ex ante debtor moral hazard by lowering borrowing cost for creditworthy issuer but increasing borrowing cost for less creditworthy issuer. Again, their analysis relies on the result that CACs eliminate inefficiency associated with creditor holdout. In contrast, we show that strengthening CACs prices debtor moral hazard only when, conditional on default, it is associated with a lower of crisis risk.

Tirole (2003), by adopting, a “dual-and-common agency” perspective, provides a rationale for “debt finance, short maturities, and foreign currency denomination of liabilities”[9] as it makes the sovereign debtor more accountable but his formal analysis takes as exogenous both the probability of default and the probability of a debt crisis, conditional on default, and ignores issues arising from post-default bargaining and endogenous entry in the market for sovereign debt. In contrast, in our analysis, the maturity structure and currency denomination of sovereign debt are taken as given while both the probability of default and the probability of a debt crisis, conditional on default, are made endogenous via bargaining, endogenous entry into the market for sovereign debt and ex ante debtor moral hazard.

The reason for excessive lending in our model is different from Tirole (2002) where overlending occurs only when no creditor can verify that the borrower does not dilute her claim by issuing new securities to other investors. In contrast, in our model, ex ante adjustments in the interest rate compensate each creditor for the dilution of her individual claim and for any increase in the probability of default. Nevertheless, lending is inefficiently high as, conditional on default, there is inefficiently high crisis risk.

Our results are consistent with empirical studies of the effects of CACs. Using data for both primary and secondary market yields, Becker et al. (2003) report that the use of CACs in a bond issue did not increase the cost of borrowing for that particular bond. Richards and Gugiatti (2003) find that CACs do not have a significant impact on bond pricing in the secondary market. Our model predicts that strengthening CACs will reduce borrowing costs for issuer with high credit rating only when it lowers crisis risk conditional on default. Even without debtor moral hazard, we show that strengthening CACs does not eliminate the inefficiency associated with the positive crisis risk. Our analysis

[9] As cited in Tirole (2003, p. 5), the ‘original sin’ is intially referred to by Eichengreen and Hausmann (1999) as “the practice of borrowing short and in foreign currency”.

of the efficacy of various policy interventions is related to Rodrik (1998) who suggests that, when financing development by issuing bonds exposes the country to excessive crises, the unrestricted use of such debt instruments should be limited.

Finally, the existence of self-fulfilling symmetric Bayesian equilibrium thresholds, driven by creditor coordination failure, with and without bargaining, contrasts with the unique Bayesian equilibrium threshold result obtained elsewhere in the literature in similar contexts involving coordination games with asymmetric information (Carlsson and van Damme, 1993; Morris and Shin, 1998).

The remainder of the paper is structured as follows. In Section 2, we study post-default debtor-creditor interaction. In Section 3, we show how the probability of default is endogenised. Section 4 is devoted to policy issues while section 5 concludes. Some technical material is contained in the appendix.

2 Post-default debtor-creditor interaction

We develop a model of bond finance which emphasises the connections between creditor coordination, bargaining incentives and sovereign debt crisis. We begin by studying the case without bargaining. We, then, extend the analysis to allow for debtor-creditor bargaining.

2.1 The model

We state the model when conditional on default, at $t = 1$, there is bargaining between the sovereign debtor and private creditors. The case without bargaining is not stated explicitly as it is a special case of the more general model.

A sovereign debtor is embarking on a bond-financed project which lasts for two periods. There are n identical private creditors, investing b each in the project. The promised return for each private creditor is r in period 1 and $(1 + r)$ in period 2. So long as the cash flow in period 1 exceeds nrb and cash flow in period 2 is greater than $(1 + r)nb$, all is well and the project will run to completion. We assume that, in addition, the sovereign debtor obtains a gross non-contractible payoff, Ω, if project continues to maturity. For later reference, we note that, at $t = 1$, all payoffs realised at $t = 2$ are measured in period $t = 1$ units. Assume that an exogenous and unanticipated shock lowers the sovereign's capacity to pay in the first period the amount that is due to the bondholders under their contracts. The failure to fulfil the terms of the debt contract constitutes technical default, i.e. making the debts callable at $t = 1$.

Conditional on default at $t = 1$, per capita, the project's future net worth is equal to $P = \gamma(1 + r)b$, where $0 \leq \gamma \leq 1$. We assume that the debtor's non-contractible payoff can take one of two values i.e. $\Omega \in \{\underline{\Omega}, \overline{\Omega}\}$. The prior probability distribution over γ is given by some continuous probability density function $f(.)$ (with $F(.)$ being the associated cumulative probability distribution) while the prior probability over $\{\underline{\Omega}, \overline{\Omega}\}$ is given by $\{q, 1 - q\}$. We assume that the two distributions are independent. We assume that there is incomplete information on (γ, Ω): while the sovereign debtor knows the true value of (γ, Ω), each private creditor receives a privately observed signal, $\sigma^i \in \{\gamma - \varepsilon, \gamma + \varepsilon\}$, of the true value of γ where $\varepsilon > 0$ but small. Conditional on (γ, Ω), for each i, σ^i are iid over $\{\gamma - \varepsilon, \gamma + \varepsilon\}$ according to the distribution $\{\frac{1}{2}, \frac{1}{2}\}$. Moreover, conditional on (γ, Ω), the distributions $\{\frac{1}{2}, \frac{1}{2}\}$ and $\{q, 1 - q\}$ are independently generated.

Conditional on default at $t = 1$, the debtor makes an offer, a transfer, denoted by Γ, of her per capita non-contractible continuation payoff, Ω, if the project continues to the following period. Simultaneously, each creditor decides whether or not to accept the debtor's offer. Built into the debt contract is a critical threshold, m, $\frac{1}{n} \leq m \leq 1$, such that if the proportion of creditors who reject the debtor's offer exceeds the critical threshold, m, the project is terminated. When $m = \frac{1}{n}$, this is equivalent to requiring unanimity amongst creditors for the debtor's offer to be accepted. In general, increasing m is equivalent to strengthening CACs. Once the project is terminated, the creditors enter into an asset grab race where creditors who choose to quit have a payoff advantage because either they pay a lower legal cost or they are able to claim a higher proportion of the liquidation value of the project.

We assume that any offer made by the debtor to creditors is divided equally between creditors[10] and therefore the per capita offer made to each creditor is $\tau = \frac{\Gamma}{n}$. Since the debtor's offer takes the form of per capita transfer, we can restate the debtor's non-contractible continuation payoff Ω in per capita terms as well. Let $\omega = \frac{\Omega}{n}$. Stated in per capita terms, the debtor's non-contractible continuation payoff is ω with $\omega \in \{\underline{\omega}, \overline{\omega}\}$.

Formally, a strategy for the debtor is a per capita offer denoted by the map $\theta : [0, 1] \times \{\underline{\omega}, \overline{\omega}\} \rightarrow [0, 1]$, where $\theta(\omega, \gamma)$ is a proportion of her per capita continuation payoff she commits to transfer to creditors if the project continues to $t = 2$. Therefore, the per capita transfer $\tau(\omega, \gamma) = \theta(\omega, \gamma)\omega$. Label an individual creditor by i, where $i = 1, ..., n$. Conditional on γ, each creditor

[10] All the creditors are ex ante symmetric and, therefore, we are implicitly invoking the doctrine of pari passu.

chooses a map $a^i(\gamma) : \{\gamma - \varepsilon, \gamma + \varepsilon\} \rightarrow \{Accept, \mathrm{Re}\,ject\}$ and a strategy is the collection $\{a^i(\gamma) : \gamma \in [0,1]\}$. For a strategy profile $a = (a^1, ..., a^n)$, conditional on γ, let $R_a(\gamma) = \{i : a^i(\gamma) = R\}$. Conditional on γ and a, in order to determine creditor i's payoff, there are two cases to consider:

Case 1, $\#R_a(\gamma) \geq mn$: If $a^i(\gamma) = R$, the payoff to creditor i is $G = \alpha(1+r)b - L'$, while if $a^i(\gamma) = A$, the payoff to creditor i is $L = \beta(1+r)b - L''$ where (a) α, β denote the liquidation payoffs (expressed as a proportion of $(1+r)b$) to creditors with $0 < \alpha < 1$, $0 < \beta < 1$ and $\alpha > \beta$[11] and (b) L', L'' denote the privately borne legal cost of entering into the asset grab race with $L'' > L'$.

Case 2, $\#R_a(\gamma) < mn$: If $a^i(\gamma) = R$, the payoff to creditor i is $\gamma(1+r)b + \theta(\omega,\gamma)\omega - L'''$, while if $a^i(\gamma) = A$, the payoff to creditor i is $\gamma(1+r)b + \theta(\omega,\gamma)\omega$, where $L''' > 0$ denotes the privately borne legal cost for the individual creditor who unsuccessfully tries to terminate the project.

We study the Bayesian equilibria of the debtor-creditor bargaining game.

2.2 Creditor coordination without bargaining

In our computations, we find it convenient to work with normalised payoffs where all payoffs are divided by $(1+r)b$. For future reference, let $g = \frac{G}{(1+r)b}$, $l = \frac{L}{(1+r)b}$, $\eta = \frac{\omega}{(1+r)b}$, and $\varphi = \frac{L'''}{(1+r)b}$. Without bargaining, conditional on default, creditors independently decide whether to stay or quit after observing their private signal[12].

We begin by noting an extreme form of coordination failure between creditors: it is always a Bayesian equilibrium for all creditors to choose to quit irrespective of their signal. Next, we demonstrate that other, less extreme forms of coordination failure also exist. A threshold strategy of creditor i, specifies a $\overline{\gamma} \in [0, \hat{\gamma}]$ such that (i) if $\sigma^i > \overline{\gamma}$, creditor i stays, (ii) if $\sigma^i < \overline{\gamma}$, creditor i quits and (iii) if $\sigma^i = \overline{\gamma}$, creditor i stays with probability v and quits with probability $(1-v)$, where $0 \leq v \leq 1$. We show that there are other interior symmetric Bayesian equilibria in threshold strategies where $0 < \overline{\gamma} < 1$. Let $\overline{\gamma}$, where $0 < \overline{\gamma} < 1$, be an interior symmetric Bayesian equilibrium threshold. Suppose all other creditors are choosing a symmetric threshold strategy for some interior threshold $\overline{\gamma}$. For creditor i, conditional on observing $\sigma^i = \overline{\gamma}$, the probability

[11] The assumption that $\alpha > \beta$ and $L'' > L'$ can be justified as the first-mover advantage in the asset grab race which ensues when the debtor's offer is rejected.

[12] Note that, without bargaining, with a positive probability, there is a irrevocable decline in the future net worth of the project. Moreover, formally, some modifications to the game outlined in the previous section are necessary. The action set of each creditor is $\{Quit, Stay\}$ and in the expressions determining the payoffs for each individual creditor, τ, has to be set equal to zero.

that j other creditors choose to quit is denoted by $f(v,j)$[13].

Again, conditional on observing $\sigma^i = \overline{\gamma}$, if creditor i quits, her payoff is given by the expression $E_{Q,v,m} = [g \sum_{j=mn-1}^{n-1} f(v,j) + [\bar{\gamma} - \varphi] \sum_{j=0}^{n(m)} f(v,j)]$ while if she stays her payoff is given by the expression $E_{S,v,m} = [l \sum_{j=mn}^{n-1} f(v,j) + \bar{\gamma} \sum_{j=0}^{mn-1} f(v,j)]$, where $n(m) = \max\{0, mn-2\}$. At $\overline{\gamma}$, each creditor has to be indifferent between quitting and staying. It follows that any interior symmetric Bayesian equilibrium threshold, $\overline{\gamma}_m^v$, is determined by the expression

$$\overline{\gamma}_m^{*v} = [\frac{[g-l]}{f(v,mn-1)} \sum_{j=mn}^{n-1} f(v,j)] + g - [\frac{\varphi}{f(v,mn-1)} \sum_{j=0}^{n(m)} f(v,j)] \qquad (1)$$

Note that for $v' < v$, the probability distribution $\{f(v',j)\}_{j=0}^{n-1}$ first-order stochastically dominates $\{f(v,j)\}_{j=0}^{n-1}$. For $v' < v$, note that (a) when $\bar{\gamma} < g + \varphi$, $E_{Q,v',m}$ is greater than $E_{Q,v,m}$; when $\bar{\gamma} = g + \varphi$, $E_{Q,v',m}$ is equal to $E_{Q,v,m}$ and finally, when $\bar{\gamma} > g + \varphi$, $E_{Q,v',m}$ is less than $E_{Q,v,m}$ and (b) when $\bar{\gamma} < l$, $E_{S,v',m}$ is greater than $E_{S,v,m}$; when $\bar{\gamma} = l$, $E_{S,v',m}$ is equal to $E_{S,v,m}$ and $\bar{\gamma} > l$, $E_{S,v',m}$ is less than $E_{S,v,m}$. It follows that $\overline{\gamma}_m^{*v'} > \overline{\gamma}_m^{*v}$.

Let $\overline{\gamma}_m^{*S} = \overline{\gamma}_m^{*v=1}$. By computation, it follows that

$$\overline{\gamma}_m^{*S} = g + \frac{(g-l) \sum_{j=mn}^{n-1} f(1,j) - \varphi \sum_{j=0}^{n(m)} f(1,j)}{\left[\binom{n-1}{mn-1} \left(\frac{1}{2}\right)^n\right]}$$

If $\overline{\gamma}_m^{*S} < 1$, it follows that there exist interior symmetric self-fulfilling Bayesian equilibrium thresholds. Let $\overline{\gamma}_m^{*Q} = \min\left\{\overline{\gamma}_m^{v=0}, 1\right\}$. It follows that the set of symmetric self-fulfilling Bayesian equilibrium thresholds is given by $[\overline{\gamma}_m^{*S}, \overline{\gamma}_m^{*Q}] \cup \{1\}$. Note the specific nature of the coordination failure between creditors: given that each creditor is indifferent between quitting and staying, creditors are coordinating on different probabilities of quitting, resulting in multiple self-fulfilling Bayesian equilibrium thresholds.

For any value of n, $\left[\binom{n-1}{mn-1} \left(\frac{1}{2}\right)^n\right] < 1$ and $g - l > 0$. Therefore, if φ is small enough, $\overline{\gamma}_m^{*S} > g$. Note that when there is full information about γ, the

[13] The expression for $f(v,j)$ is given by $\left[\binom{n-1}{j} \left(\frac{1}{2}\right)^n\right] \upsilon^{n-1-j} + \left(\frac{1}{2}\right) \sum_{k=0}^{j-1} \left[\binom{n-1}{k} \left(\frac{1}{2}\right)^{n-1}\right] \binom{n-1-k}{j-k} (1-\upsilon)^{j-k} \upsilon^{n-1-j} + \left(\frac{1}{2}\right) \sum_{k=j+1}^{n-1} \left[\binom{n-1}{k} \left(\frac{1}{2}\right)^{n-1}\right] \binom{k}{j} (1-\upsilon)^j \upsilon^{k-j} + \left[\binom{n-1}{j} \left(\frac{1}{2}\right)^n\right] (1-\upsilon)^j$. To economise on notation, throughout the paper, we will assume that mn is an integer. When mn is a non-integer we will need to substitute the least upper bound of all the integers higher than mn for mn.

project should be terminated if and only if $\gamma \leq g$. It follows that, when φ is small enough ex ante, there is an inefficient risk of project termination.

What is the effect of strengthening the "acceleration clauses" in the bond contract? In the case when the set of interior symmetric Bayesian equilibrium thresholds does not exist, strengthening CACs has no impact on creditor coordination. Therefore, consider the case where, for some v, consider $\overline{\gamma}_m^{*v}$. For $m' > m$, note that (a) when $\gamma < g + \varphi$, $E_{Q,v,m'}$ is less than $E_{Q,v,m}$; when $\gamma = g + \varphi$, $E_{Q,v,m'}$ is equal to $E_{Q,v,m}$ and finally, when $\gamma > g + \varphi$, $E_{Q,v,m'}$ is greater than $E_{Q,v,m}$ and (b) when $\gamma < l$, $E_{S,v,m'}$ is less than $E_{S,v,m}$; when $\gamma = l$, $E_{S,v,m'}$ is equal to $E_{S,v,m}$ and $\gamma > l$, $E_{S,v,m'}$ is greater than $E_{S,v,m}$. It follows that $\bar{\gamma}_{m'}^{*v} < \bar{\gamma}_m^{*v}$. In this sense, strengthening CACs is an effective mechanism for coordinating the private creditors.

We summarise the above discussion as the following proposition:

Proposition 1 *In the creditor coordination game without bargaining, the existence of self-fulfilling symmetric Bayesian equilibrium thresholds is a robust possibility. So, relative to the first-best benchmark, there is an excessive probability of project termination. Strengthening CACs facilitates creditor coordination.*

2.3 Creditor coordination with bargaining

We begin by noting an extreme form of coordination failure between creditors and the debtor: it is always a Bayesian equilibrium for the debtor to make a zero offer and for all creditors to reject the debtor's offer. Indeed, if all other creditors are rejecting the debtor's offer, it is a strict best response for each individual creditor to do so and further, given the creditor's strategies, it is a best response for the debtor to make a zero offer. Actually, more dramatic forms of coordination failure occur with bargaining: it is always a Bayesian equilibrium for the debtor to make some strictly positive offer and for all creditors to reject the debtor's offer. Indeed, if all other creditors are rejecting the debtor's offer, it is a strict best response for each individual creditor to do so and further, given the creditor's strategies, as the project is terminated with probability one, any offer the debtor makes yields her a zero payoff.

Next, we show that other less extreme forms of coordination failure exist in the bargaining game. We focus on Bayesian equilibria where creditors use symmetric threshold strategies. We study how a Bayesian equilibrium threshold is determined by the best responses of creditors and the debtor.

Fix $\theta(.,.)$, a strategy of the debtor. We begin by finding the best response of creditors in symmetric, interior threshold strategies. Suppose all other creditors are choosing a symmetric threshold strategy for some interior threshold $\overline{\gamma}$. For creditor i, conditional on observing $\sigma^i = \overline{\gamma}$, the probability that j other creditors choose to reject the debtor's offer is still given by $f(v,j)$. Conditional on observing a signal $\sigma^i = \overline{\gamma}$, given the debtor's strategy $\theta(.,.)$, let τ^e denote the expected transfer if the project continues to the next period where

$$\begin{aligned}\tau^e &= \frac{1}{2}[q'\underline{\eta} + (1-q')\overline{\eta}][q'\{\theta((1+r)b\underline{\eta}, \overline{\gamma}+\varepsilon) + \theta((1+r)b\underline{\eta}, \overline{\gamma}-\varepsilon)\} \\ &\quad +(1-q')\{\theta((1+r)b\overline{\eta}, \overline{\gamma}+\varepsilon) + \theta((1+r)b\overline{\eta}, \overline{\gamma}-\varepsilon)\}]\end{aligned}$$

Conditional on $\sigma^i = \overline{\gamma}$ and $\theta(.,.)$, by computation, it follows that creditor i's payoff from rejecting the debtor's offer is given by the expression $E_{R,v,m} = [g \sum_{j=mn-1}^{n-1} f(v,j) + [\gamma+\tau^e-\varphi] \sum_{j=0}^{n(m)} f(v,j)]$ while creditor i's payoff from accepting the debtor's offer is given by the expression $E_{A,v,m} = [l \sum_{j=mn}^{n-1} f(v,j) + [\gamma + \tau^e] \sum_{j=0}^{mn-1} f(v,j)]$. At $\overline{\gamma}$, each creditor has to be indifferent between rejecting and accepting the offer and therefore, an interior symmetric best response in threshold strategies, $\overline{\gamma}_m^v$, is given by the expression

$$\overline{\gamma}_m^v = [\frac{[g-l]}{f(v,mn-1)} \sum_{j=mn}^{n-1} f(v,j)] + g - \tau^e - [\frac{\varphi}{f(v,mn-1)} \sum_{j=0}^{n(m)} f(v,j)].$$

Given that creditors choose this symmetric strategy, note that as $\overline{\gamma}_m^v$ is decreasing in τ^e, it is also decreasing in the numbers $\theta((1+r)b\underline{\eta}, \overline{\gamma}_m^v + \varepsilon), \theta((1+r)b\underline{\eta}, \overline{\gamma}_m^v - \varepsilon), \theta((1+r)b\overline{\eta}, \overline{\gamma}_m^v + \varepsilon)$ and $\theta((1+r)b\overline{\eta}, \overline{\gamma}_m^v - \varepsilon)$. It follows that the probability of project continuation conditional on γ is dependent on the region that γ belongs to: (i) if $\gamma < \overline{\gamma}_m^v - \varepsilon$ (Region A), the probability of project continuation is 0; (ii) if $\gamma = \overline{\gamma}_m^v - \varepsilon$ (Region B) or $\overline{\gamma}_m^v - \varepsilon < \gamma < \overline{\gamma}_m^v + \varepsilon$ (Region C), the probability of project continuation is equal to $[1 - (\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}]$ and (iii) if $\gamma \geq \overline{\gamma}_m^v + \varepsilon$ (Region D), the probability of project continuation is equal to 1. As the probability of project continuation is decreasing in $\overline{\gamma}_m^v$, and which in turn is decreasing in $\theta((1+r)b\eta, \gamma)$, the probability of project continuation conditional on γ is increasing in $\theta((1+r)b\eta, \gamma)$. Note that the debtor faces a trade-off: increasing $\theta(.,.)$ increases the probability of project continuation but decreases the amount she keeps for herself if the project does continue to $t = 2$. Given the creditors are using the threshold strategy, where the threshold is $\overline{\gamma}_m^v \leq \hat{\gamma}$, for the purposes of our argument, we only need to compute the debtor's best response when either $\gamma = \overline{\gamma}_m^v + \varepsilon$ or $\gamma = \overline{\gamma}_m^v - \varepsilon$. Note that when $\gamma = \overline{\gamma}_m^v + \varepsilon$ we are in Region D, where by assumption, the project continues with probability one and therefore for each value of η the debtor makes a per capita transfer of zero. When $\gamma = \overline{\gamma}_m^v - \varepsilon$, we are in Region B. In this case, for each η, the per capita transfer the debtor will make will be such that the debtor goes from Region B to Region D. In Region B or C, the debtor will always make a zero transfer because the continuation probability is the same. In going from Region B to Region D, the debtor gives up some of her non-contractible continuation payoff but ensure that the project continues with probability 1 to $t = 2$. Therefore, the debtor's best response must satisfy the equation

$$[1 - (\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}]\eta = (1 - \theta((1+r)b\eta, \overline{\gamma}_m^v - \varepsilon))\,\eta$$

It follows that, $\theta((1+r)b\eta, \overline{\gamma}_m^v - \varepsilon) = (\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}$. Therefore, for each η,

$$[\theta((1+r)b\eta, \overline{\gamma}_m^v + \varepsilon) + \theta((1+r)b\eta, \overline{\gamma}_m^v - \varepsilon)] = (\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}$$

and $\tau^e = (\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}$. It follows that the Bayesian equilibrium threshold, $\overline{\gamma}_m^{*v}$, is given by the expression

$$\overline{\gamma}_m^{*v} = g - \frac{1}{2}[q'\underline{\eta} + (1-q')\overline{\eta}]\left[(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}\right] + \frac{(g-l)\sum_{j=mn}^{n-1} f(v,j) - \varphi \sum_{j=0}^{n(m)} f(v,j)}{f(v, mn-1)}$$

Let $\hat{\gamma} = 1 - \eta$. If $\overline{\gamma}_m^{*v} \leq \hat{\gamma}$[14], the analysis is complete.

Suppose $\overline{\gamma}_m^{*A} \leq \hat{\gamma}$. Note that $(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k} < 1$. This implies that, at the Bayesian equilibrium, the debtor never offers to transfer her entire continuation payoff to the creditors. Further, multiple Bayesian equilibrium thresholds in the post-default bargaining game exist and are driven by the coordination failure between creditors. Moreover, τ^e does not depend on γ and therefore appears as an additive constant in the expressions for $E_{R,v,m}$ and $E_{A,v,m}$. It follows that the first-order stochastic dominance made in the preceding subsection still

[14] When $\gamma \leq \hat{\gamma}$ where $\hat{\gamma} + \eta = 1$, we are assuming that, without bargaining, with positive probability, there is an irrevocable decline in the future net worth of the project.

applies here and therefore it follows that $\overline{\gamma}_m^{*v}$ is decreasing in v. If $\overline{\gamma}_m^{*v=1} = \overline{\gamma}_m^{*A} < 1$, it follows that there exists a best response for each creditor in interior symmetric threshold strategies. Let $\overline{\gamma}_m^{*R} = \min\left\{\overline{\gamma}_m^{*v=0}, 1\right\}$. It follows that the set of symmetric self-fulfilling thresholds is given by $[\overline{\gamma}_m^{*A}, \overline{\gamma}_m^{*R}] \cup \{1\}$. When there is full information about γ, the project should be terminated if and only if $\gamma \leq g - [q'\underline{\eta} + (1-q')\overline{\eta}]$. Therefore, if φ is small enough, it follows by computation that, even the minimum Bayesian equilibrium threshold, $\overline{\gamma}_m^{*A} > g - [q'\underline{\eta} + (1-q')\overline{\eta}]$ and as before, there is always an excessive (relative to the first-best) probability of project termination.

Again suppose $\overline{\gamma}_m^{*A} \leq \hat{\gamma}$. What is the effect of strengthening CACs in the bond contract? Similar to the case without bargaining, when the set of interior symmetric Bayesian equilibrium thresholds does not exist, strengthening CACs has no impact on creditor coordination. When interior symmetric Bayesian equilibrium thresholds exist, evidently, the strength of CACs in the bond contract modelled in our paper as m should be chosen to minimise the distance between the set of Bayesian equilibrium threshold and the first-best termination probability. In our set-up, this is equivalent to choosing m to minimise the distance between $\overline{\gamma}_m^{*A}$ and $g - [q'\underline{\eta} + (1-q')\overline{\eta}]$. However, note that this does not necessarily imply that increasing m could push the set of Bayesian equilibrium thresholds close to the first-best. Consider the case where $\overline{\gamma}_m^{*v} < \hat{\gamma}$. With bargaining, increasing m has two opposite effects. Given the debtor's offer, using arguments identical to the preceding subsection, $\overline{\gamma}_{m,n}^{*v}$ is decreasing in m. Consider the debtor's best response $\left[(\frac{1}{2})^n \sum_{k \geq m'n}^{k \leq n} \binom{n}{k}\right]$. Note that for $m' < m$, $\left[(\frac{1}{2})^n \sum_{k \geq m'n}^{k \leq n} \binom{n}{k}\right] < \left[(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}\right]$ as increasing m reduces the maximum offer the debtor is willing to make. It follows that, in general, in a Bayesian equilibrium, the overall effect of increasing m could be ambiguous. Indeed, consider the case where there are only two creditors. When $m = \frac{1}{2}$, $(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k} = \frac{3}{4}$ while when $m = 1$, $(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k} = \frac{1}{4}$. By computation, note that $\gamma_{\frac{1}{2},2}^{*A} < \gamma_{1,2}^{*A}$ when $[q'\underline{\eta} + (1-q')\overline{\eta}] > \frac{4}{3}[g-l] + 12\varphi$. In this case, increasing m from $\frac{1}{2}$ to 1 *increases* the Bayesian equilibrium threshold.

Nevertheless, we derive a sufficient condition for $\overline{\gamma}_m^{*v}$ to be decreasing in m. Consider the expression

$$-\frac{1}{2}[q'\underline{\eta} + (1-q')\overline{\eta}]\left[(\frac{1}{2})^n \sum_{k \geq mn}^{k \leq n} \binom{n}{k}\right] + (g-l)\frac{\sum_{j=mn}^{n-1} f(v,j)}{f(v, mn-1)}$$

This expression can be rewritten as

$$\frac{\sum\limits_{j=mn}^{n-1} f(v,j)}{f(v,mn-1)}\left[-\frac{1}{2}[q'\underline{\eta}+(1-q')\overline{\eta}\left[(\frac{1}{2})^n\sum_{k\geq mn}^{k\leq n}\binom{n}{k}\right]]\frac{f(v,mn-1)}{\sum\limits_{j=mn}^{n-1} f(v,j)}+g-l\right]$$

Note that $\left[(\frac{1}{2})^n\sum\limits_{k\geq mn}^{k\leq n}\binom{n}{k}\right]<1$ and $\frac{\sum_{j=mn}^{n-1} f(v,j)}{f(v,mn-1)}>1$ for all values of m and therefore, the expression within the brackets in the preceding expression is strictly positive whenever $g-l-[q^{'}\underline{\eta}+(1-q^{'})\overline{\eta}]>0$. Therefore, for values of φ close to zero, it follows that a sufficient condition for $\overline{\gamma}_m^{*v}$ to be decreasing in m is that the inequality $g-l-[q^{'}\underline{\eta}+(1-q^{'})\overline{\eta}]>0$ must be satisfied.

The following is the interpretation for the inequality $g-l-[q^{'}\underline{\eta}+(1-q^{'})\overline{\eta}]>0$. This inequality provides a joint restriction on the creditors' and debtor's expected payoffs: essentially we want the first-mover advantage in the asset grab race triggered by a project termination to be large relative to debtor's expected surplus if the project is not terminated. In general, strengthening CACs has an ambiguous effect on the Bayesian equilibrium threshold and thus on the probability of project termination even though we derive a sufficient condition, which ensures that the Bayesian equilibrium threshold be decreasing in m. When this condition holds, it is optimal to choose $m=1$ as the optimal ex post choice of CACs threshold.

Next, we study the case when for some v, $\overline{\gamma}_m^{*v}>\hat{\gamma}$. What is important in our analysis of the debtor's best response is the quantity $\theta((1+r)b\eta,\overline{\gamma}_m^v-\varepsilon)$. When $\gamma=\overline{\gamma}_m^v-\varepsilon$, we are in Region B. In this case, for each η, the per capita transfer the debtor will make will be such that the debtor goes from Region B to Region D. In going from Region B to Region D, the debtor gives up some of her non-contractible continuation payoff but at the same time ensuring that the project continues with probability 1 to $t=2$. Therefore, there are two cases to consider: case (a) when $\overline{\gamma}_m^v-\varepsilon<\hat{\gamma}$ and case (b) when $\overline{\gamma}_m^v-\varepsilon>\hat{\gamma}$. In case (a), $\theta((1+r)b\eta,\overline{\gamma}_m^v-\varepsilon)=(\frac{1}{2})^n\sum\limits_{k\geq mn}^{k\leq n}\binom{n}{k}$. However, in case (b), making a transfer of $(\frac{1}{2})^n\sum\limits_{k\geq mn}^{k\leq n}\binom{n}{k}$ makes the future return of the project greater than $(1+r)b$. Let

$$\phi(\overline{\gamma},m)=\min\left\{\frac{(1-(\overline{\gamma}-\varepsilon))}{\eta},(\frac{1}{2})^n\sum_{k\geq mn}^{k\leq n}\binom{n}{k}\right\}$$

The debtor's best response must satisfy the equation

$$[1-\phi(\overline{\gamma}_m^v, m)]\eta = (1-\theta((1+r)b\eta, \overline{\gamma}_m^v - \varepsilon))\,\eta$$

It follows that, $\theta((1+r)b\eta, \overline{\gamma}_m^v - \varepsilon) = \phi(\overline{\gamma}_m^v, m)$ and therefore, $\tau^e = \phi(\overline{\gamma}_m^v, m)$. It follows that the Bayesian equilibrium threshold, $\overline{\gamma}_m^{*v}$, is given by the expression

$$\overline{\gamma}_m^{*v} = g - \frac{1}{2}[q'\underline{\eta} + (1-q')\overline{\eta}]\phi(\overline{\gamma}_m^v, m) + \frac{(g-l)\sum\limits_{j=mn}^{n-1} f(v,j) - \varphi \sum\limits_{j=0}^{n(m)} f(v,j)}{f(v, mn-1)}$$

With these computations, all our preceding results go through. We summarise the above discussion with the following proposition:

Proposition 2 *With bargaining, the existence of self-fulfilling Bayesian equilibrium thresholds driven by coordination failure between creditors is a robust possibility. Moreover, there is an excessive probability of project termination relative to the first-best benchmark. In general, strengthening CACs has an ambiguous impact on the Bayesian equilibrium thresholds. However, if* $g-l-[q'\underline{\eta}+(1-q')\overline{\eta}] > 0$*, for each* $v \in [0,1]$, $\overline{\gamma}_m^{*v}$ *is decreasing in* m.

2.4 Structural adjustment

Next, we introduce costly structural adjustment effort in our model. Conditional on default, we now allow the sovereign debtor to choose a costly, irreversible action a from a set of actions $\{\underline{a}, \overline{a}\}$, where $\overline{a} > \underline{a}$, with a cost $c(a)$, measured in $t=1$ payoff units. We interpret this action as structural adjustment effort by the debtor. The probability distribution over γ, $f(.)$, now depends on a. Formally, we now have a family of probability distribution over γ, $f_a(.)$, indexed by a such that $f_{\overline{a}}(.)$ first-order stochastically dominates $f_{\underline{a}}(.)$. Moreover, conditional on a, γ, Ω, the perceived conditional distribution over $\{\underline{\Omega}, \overline{\Omega}\}$ is given by $\{q_a, 1-q_a\}$ with $q_{\bar{a}} < q_{\underline{a}}$. Conditional on default, the sequence of events is: (i) the debtor chooses a and then nature chooses γ, Ω; (ii) each creditor observes a private signal σ_i on γ and does not observe the structural effort chosen by the debtor[15] and the debtor observes γ, Ω; and (iii) simultaneously, the debtor makes an offer and each creditor decides whether or not to reject the debtor's offer. As before, we assume that, conditional on γ, Ω, all probability distributions are independently generated.

Conditional on λ, $\lambda \in \{\underline{a}, \overline{a}\}$, let $\{q_\lambda, 1-q_\lambda\}$ denote the posterior distribution over $\{\underline{\Omega}, \overline{\Omega}\}$. From the perspective of the debtor, in the post-default bargaining

[15] For instance, it takes time for the debtor's action to be revealed and creditors have to decide whether or not to terminate the project before the action of the debtor is revealed.

game, the cost incurred by structural adjustment effort is a sunk cost. It follows that, by substituting $\{q_\lambda, 1-q_\lambda\}$ for $\{q, 1-q\}$, our analysis of the post-default bargaining game carries over to this case as well. Let $\overline{\gamma}_m^*$ denote the Bayesian equilibrium threshold prevailing in the post-default bargaining game. Given $\overline{\gamma}_m^*$, the probability of project termination, $s\left(\overline{\gamma}_m^*\right)$, is given by the expression

$$(\overline{\gamma}_m^* - \varepsilon) + \frac{(F(\overline{\gamma}_m^* + \varepsilon) - F(\overline{\gamma}_m^* - \varepsilon))}{2}\left\{1 + \left(\frac{1}{2}\right)^n \sum_{j=mn}^{n-1} \binom{n-1}{j} \left(1 + \binom{n-1}{mn-1}\right)\right\}$$

It follows that the benefit to the debtor from choosing action a when the project continues to $t = 2$, $b(q_a, \overline{\gamma}_m^*)$, is given by the expression

$$(1 - s\left(\overline{\gamma}_m^*\right))\left(1 - \phi\left(\overline{\gamma}_m^*, m\right)\right)\left[q_a \underline{\Omega} + (1 - q_a)\,\overline{\Omega}\right]\left(\frac{1}{(1+r)b}\right).$$

It follows that the expected benefit to the debtor from choosing action a, $b(a, \overline{\gamma}_m^*) = (1 - s\left(\overline{\gamma}_m^*\right))\, b(q_a, \overline{\gamma}_m^*)$. Given $\overline{\gamma}_m^*$, the debtor chooses a to maximise the expression $b(a, \overline{\gamma}_m^*) - c(a)$. Note that as q_a is a decreasing function of a, $b(., \overline{\gamma}_m^*)$ is an increasing function of a if $c(.)$ is an increasing function of a. Note that, in general, the impact of strengthening CACs is ambiguous. On one hand, increasing m increases $(1 - \theta\left((1+r)b\eta, \gamma\right))$. However, as the impact of increasing m is ambiguous on $\overline{\gamma}_m^v$and therefore on $s\left(\overline{\gamma}_m^v\right)$, the overall effect of increasing m on $b(a, \overline{\gamma}_m^*)$ is also ambiguous. A necessary condition for strengthening CACs to have a positive effect on $b(a, \overline{\gamma}_m^*)$ is that $s\left(\overline{\gamma}_m^v\right)$ be decreasing in m. Note that, when the sufficient condition which ensures that strengthening CACs lowers crisis risk holds, strengthening CACs has a positive impact on the debtor's incentive to undertake structural adjustment effort.

We summarise the above discussion with the following proposition:

Proposition 3 *In general, strengthening CACs has an ambiguous impact on the debtor's incentives to choose high structural adjustment effort. However, when the sufficient condition which ensures that strengthening CACs lowers crisis risk holds, strengthening CACs has a positive impact on the debtor's incentive to undertake structural adjustment effort.*

3 Endogenising the probability of default

3.1 Ex ante debtor moral hazard

In this section, we take a first step towards endogenising the probability of default by introducing ex ante debtor moral hazard in our model. In our set-up, formally, the difference between ex ante debtor moral hazard and structural adjustment effort arises from our assumption that the ex ante actions of the debtor affect the probability of default while structural adjustment effort affects the probability distribution over γ.

We denote the ex ante action of the debtor by a_0, where $a_0 \in \{G, B\}$ with $c^{a_0} \in \left\{c^G, c^B\right\}$, measured in $t = 1$ payoff units, denoting the cost for effort. We assume that it is more costly to the debtor to exert good effort than to choose bad effort, i.e. $c^G > c^B$. Let p^{a_0} denote the ex ante probability of default when the action $a_0 \in \{G, B\}$ is chosen by the debtor. We assume that the probability of default is higher if the debtor chooses bad effort, i.e. $p^B > p^G$. As before we assume that the sovereign debtor obtains a non-contractible payoff $\Omega \in \left\{\underline{\Omega}, \overline{\Omega}\right\}$ and if the project is terminated at $t = 1$ the debtor obtains a zero payoff. For ease of exposition, we will also assume that, conditional on default, creditors have to decide whether or not to terminate the project before observing the ex ante choice of action by the debtor.

Conditional on default, let x denote the debtor's expected payoff conditional on default. Then, the debtor's payoff from choosing good effort is given by the expression $(1 - p^G)\Omega + p^G x - c^G$ while the debtor's payoff from choosing a bad effort is given by the expression $(1 - p^B)\Omega + p^B x - c^B$. The incentive compatibility constraint, which ensures that the sovereign debtor chooses good effort, is determined by the following expression

$$(1 - p^G)\Omega + p^G x - c^G \geq (1 - p^B)\Omega + p^B x - c^B$$

This yields an upper bound on x namely

$$x \leq \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$$

Since we assume that $c^B < c^G$ and $p^G < p^B$, $\left[\frac{(c^B - c^G)}{(p^B - p^G)}\right] < 0$. As $x \geq 0$, if $\Omega + \frac{(c^B - c^G)}{(p^B - p^G)} < 0$, there is no solution to the debtor's ex ante incentive problem. On the other hand, if $\Omega > \frac{c^G - c^B}{p^B - p^G}$ a solution is possible.

Suppose $\Omega > \frac{c^G - c^B}{p^B - p^G}$. Consider, first, the situation where after default occurs but before creditors decide whether or not to terminate the project and the debtor cannot choose to put in structural adjustment effort. In other words, the payoff x is determined by the Bayesian equilibrium of the post-default bargaining game. There are several possibilities. First, conditional on default, the Bayesian equilibrium threshold in the post-default bargaining game is $\overline{\gamma}^* = 1$. In this case, $x = 0$ and the debtor will choose $a_0 = G$ but the probability of project termination is inefficiently high. Second, conditional on default, $\left(1 - s\left(\overline{\gamma}^R_m\right)\right) b(q) > \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$. Again, in this case, the only way creditors can ensure that the debtor's ex ante incentives are satisfied is by coordinating on $\overline{\gamma}^* = 1$ in the post-default bargaining game and the probability of project termination is inefficiently high. Third, either (a) both $\left(1 - s\left(\overline{\gamma}_m^R\right)\right) b(q) < \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$ and $\left(1 - s\left(\overline{\gamma}_m^A\right)\right) b(q) < \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$ or (b) $\left(1 - s\left(\overline{\gamma}_m^R\right)\right) b(q) < \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$ but $\left(1 - s\left(\overline{\gamma}_m^A\right)\right) b(q) > \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$. In this case, it is possible for creditors to choose a probability of project termination closer to the the first-best benchmark and still ensure that the debtor's ex ante incentives are satisfied but there is still the possibility of coordination failure and the probability of project termination is still inefficiently high.

Next, keeping the assumption that $\Omega > \frac{c^G - c^B}{p^B - p^G}$, consider the situation where after default occurs but before creditors decide whether or not to terminate the project, the debtor can put in unobservable structural adjustment effort. In this case, the interesting possibility is that there might be a conflict between the debtor's ex ante and post-default incentives. Specifically, for some Bayesian equilibrium threshold $\overline{\gamma}_m^*$ and some conditional distribution over $\left\{\underline{\Omega}, \overline{\Omega}\right\}$ is given by $\{q_a, 1 - q_a\}$, it is a possible that $b(\bar{a}, \overline{\gamma}_m^*) - c(\bar{a}) > \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$ but $b(\underline{a}, \overline{\gamma}_m^*) - c(\underline{a}) < \Omega + \frac{(c^B - c^G)}{(p^B - p^G)}$.

What is the effect of strengthening CACs on the ex ante debtor incentive? Since, in general, the impact of strengthening CACs on the set of Bayesian equilibrium thresholds is ambiguous, strengthening CACs, thus, also has an ambiguous impact on ex ante debtor moral hazard. However, when the sufficient condition which ensures a lower crisis risk holds, strengthening CACs has an adverse impact on the debtor ex ante incentive, therefore, debtor moral hazard could be priced efficiently.

Finally, consider the case where, conditional on default, all private creditors observe a public signal $\lambda \in \{G, B\}$ where, conditional on $a_0 \in \{G, B\}$, $\lambda = a_0$ with probability $\delta > \frac{1}{2}$. For simplicity, assume that, conditional on default, there is no issue of structural adjustment effort. In this case, creditors can use λ to coordinate their actions in the post-default bargaining game so that which Bayesian equilibrium threshold creditors coordinate on can be made a function of λ. For instance, creditors could coordinate on the Bayesian equilibrium where every offer of the debtor is rejected if $\lambda = B$ and on the Bayesian equilibrium threshold $\overline{\gamma}_m^{*A}$ if $\lambda = G$. Conditional on λ, let $\overline{\gamma}(\lambda)$ denote the Bayesian equilibrium threshold prevailing in the post-default bargaining game. Now, of course, the payoff to the debtor in the post-default situation can be made conditional on her choice of action. In this case, if $a_0 = G$, conditional on default, the debtor obtains a payoff $x^G = \delta\left(1 - s\left(\overline{\gamma}_m^A\right)\right) b(q)$ while if $a_0 = B$, the debtor obtains a payoff $x^B = (1 - \delta)\left(1 - s\left(\overline{\gamma}_m^A\right)\right) b(q)$. As $\delta > \frac{1}{2}$, $x^G > x^B$. In this case the debtor's ex ante incentive constraint is

$$(1-p^G)\Omega + p^G x^G - c^G \geq (1-p^B)\Omega + p^B x^B - c^B$$

or

$$\Omega\left(p^B - p^G\right) + \left(c^G - c^B\right) \geq p^B x^B - p^G x^G$$

As $x^G > x^B$, it follows that $p^B x^B - p^G x^G < \left(p^B - p^G\right)\left(1 - s\left(\overline{\gamma}_m^A\right)\right) b(q)$ and in this sense, the debtor's ex ante incentives are more likely to be satisfied when creditors observe a noisy signal on the debtor's ex ante choice of effort although as before there is still the possibility of coordination failure and the probability of project termination is still inefficiently high.

We summarise the above discussion as the following proposition.

Proposition 4 *With ex ante debtor moral hazard, a positive risk of early project termination, conditional on default, is needed to solve the debtor's ex ante incentives. However, the risk of early project termination generated in the post-default bargaining game is inefficiently high relative to a second-best benchmark. Moreover, the possibility of a conflict in the debtor ex ante and post-default incentives is a robust possibility. When strengthening CACs lowers crisis risk, an adverse impact of this on debtor ex ante incentive allows debtor moral hazard to be priced efficiently. In general, strengthening CACs has an ambiguous impact on the debtor's ex ante incentives.*

3.2 Ex ante creditor moral hazard

In this section, we show that, even without debtor moral hazard, a positive probability of default may exist. We derive a lower bound on the number of creditors and, in doing so, show that the probability of default is endogenously generated. We assume that there is a risk-free security with a rate of return denoted by r_f. At this point, we need to be more precise about the cash flows generated by the project. We assume that, at $t = 1$, the cash flow generated by the project, C, can take one of two values $\{C_L, C_H\}$ with the associated probability distribution $\{p, 1-p\}$. We make the assumption that the probability distributions over C, γ and Ω are all independently distributed. For ease of exposition, we will also assume that there is an upper bound on γ given by $\gamma \leq \hat{\gamma}$, where $\hat{\gamma} + \eta = 1$.

Let n_f be the integer such that $n_f r_f b \leq C_L$ but $(n_f + 1) r_f b > C_L$[16]. Starting from a situation where there are n_f creditors, each lending b to the sovereign

[16] We are assuming that the cash flows generated by the project are unaffected by the input of the additional resources of the $\left(n_f+1\right)^{th}$ creditor. We can justify this assumption in two ways. First, the additional resources of the $\left(n_f+1\right)^{th}$ creditor can be used by the sovereign

debtor, we study the entry decision of the $(n_f+1)^{th}$ creditor deciding whether or not to subscribe to the debt issued by the sovereign debtor. With n_f creditors, the probability of default at $t=1$ is zero. The entry of the $(n_f+1)^{th}$ creditor implies that, at $t=1$, there is now a positive probability of default $p>0$. We also assume that all creditors are risk neutral. Why does the $(n_f+1)^{th}$ creditor have an incentive to lend to the sovereign debtor? Although by entering the bond market for sovereign debt, the probability of default becomes strictly positive, as long as the interest rate on sovereign debt adjusts upward to compensate for the added risk of default, the $(n_f+1)^{th}$ creditor's participation constraint can be satisfied. Moreover, which interest rate prevails in the market for sovereign debt will depend on which Bayesian equilibrium is forecasted by the $(n_f+1)^{th}$ creditor in the post-default bargaining game. For the ease of exposition, we assume throughout the remainder of this section that $\gamma \leq \hat{\gamma}$, where $\hat{\gamma}+\eta \leq 1$.

To begin with, consider the case where the $(n_f+1)^{th}$ creditor forecasts that, in the post-default bargaining game, the project is terminated with probability 1, a possible Bayesian equilibrium scenario. Assume that each risk neutral creditor can invest the entire amount b in the risk-free asset. In this case, if the rate of interest on sovereign debt is r, the ex ante payoff of the $(n_f+1)^{th}$ creditor is[17] $p\left(\alpha(1+r)b-L'\right)+(1-p)(1+r)b$. To satisfy the participation constraint of the $(n_f+1)^{th}$ creditor, r must satisfy the equation

$$p\left(\alpha(1+r)b-L'\right)+(1-p)(1+r)b=(1+r_f)b$$

Let $\hat{r}$ denote the unique solution to this equation. As $\alpha(1+r_f)b-L' < (1+r_f)b$, $\hat{r}>r_f$. Therefore, the interest rate on sovereign debt adjusts upward to satisfy the participation constraint of the $(n_f+1)^{th}$ creditor and, in the process, introduces a positive probability of default and, conditional on default, inefficient probability of project termination in the market for sovereign debt.

More generally, assume that the $(n_f+1)^{th}$ creditor forecasts an interior Bayesian equilibrium threshold, $\overline{\gamma}^{*v}_{m,(n_f+1)} < \hat{\gamma}$. Let r^* be the interest rate prevailing in the market for sovereign debt subsequent to the entry by the $(n_f+1)^{th}$ creditor.

Lemma 5 *$r^*>r_f$ and $r^*<\hat{r}$.*

debtor to either reduce the resources it commits to the project or divert the extra resources to other projects. Second, what is really important for our analysis is that, even if increasing the scale of the project impacts positively on the cash flows generated by the project, it simultaneously increases the probability of default.

[17] For ease of exposition, we abuse notation so that the expressions denoting per capita payoffs with n creditors also denotes per capita payoffs with n_f+1 creditors.

Proof. See appendix. ■

It follows that the interest rate charged on sovereign debt subsequent to the entry of the $(n_f + 1)^{th}$ creditor, whichever equilibrium is forecast in the post-default bargaining game, is higher than the risk-free rate of interest. The reason for this is that entry by the $(n_f + 1)^{th}$ creditor introduces a positive probability of default and therefore, a positive probability of crisis risk, and therefore ex-ante, the interest rate adjusts upwards to satisfy the $(n_f + 1)^{th}$ creditor's participation constraint. Nevertheless, the extent of the upward adjustment in interest rates depends on which equilibrium is forecast in the post-default bargaining game. Specifically, the more pessimistic the creditors are about the possibility of coordination failure in the post-default bargaining game, the higher is the interest rate charged on sovereign debt. Note that higher interest rates for sovereign debt are associated with higher forecasts of inefficiently high crisis risk in the post-default bargaining game.

It follows that n, the number of creditor participating in the market for sovereign debt, is greater than $(n_f + 1)$. We conclude that, even if we allow for the possibility that there will be a zero probability of default in the market for sovereign debt, we have demonstrated that the behaviour of the creditor is such that it will generate endogenously a strictly positive probability of default.

In the preceding section, we have already shown that, in general, strengthening collective action clauses has an ambiguous effect on the Bayesian equilibrium threshold. It follows that strengthening CACs has an ambiguous effect on the interest rate charged on sovereign debt as well. However, strengthening CACs will reduce borrowing costs for issuer with high credit rating only when it lowers crisis risk conditional on default. We summarise the above discussion with the following proposition:

Proposition 6 *Even allowing for the possibility of a zero probability of default in the market for sovereign debt, excessive entry by creditors generates endogenously inefficient risk in the market for sovereign debt. More optimistic forecasts about the possibility of creditor coordination in the post-default bargaining game are associated with a lower rate of interest on sovereign debt. When strengthening CACs lowers crisis risk conditional on default, borrowing costs for issuer, with high credit rating, are reduced. However, in general, strengthening CACs has an ambiguous impact on the crisis risk.*

4 Evaluating policy interventions

Consider, to begin with, the role of the IMF. Typically, the IMF has an information advantage over private creditors because the IMF can verify any structural adjustment effort undertaken by the debtor. When there is default, conditional on putting in place appropriate structural effort, the IMF usually provides loans[18] to the debtor so that her debt servicing obligation can be met at $t = 1$. Our model suggests that if, in addition, the IMF conditions its support on the outcome of the post-default bargaining game, any such intervention will have bigger marginal impact on the incentives of the debtor to choose higher structural adjustment effort. Conditional on default, any announcement by the IMF serves as a public signal to the creditors. Why should this help? First, in the post-default bargaining game, the creditors can use this public signal to coordinate on the minimum Bayesian equilibrium threshold. Second, if the announced loan by the IMF is made conditional on Bayesian equilibrium threshold creditors coordinate on, and any loan made by the IMF is directly transferred to the creditors (specifically, the loan amount is decreasing in the Bayesian equilibrium threshold), the marginal impact of any loan on the continuation probability to $t = 2$ made by the IMF will be higher. Therefore, any intervention that occurs conditional on default will have a higher marginal impact on the incentives of the debtor to choose higher structural adjustment effort if it takes into account the inefficiencies in the post-default bargaining game. Nevertheless, unless the first-best is achieved in the post-default bargaining game, by encouraging excessive entry by creditors, inefficient risk will still persist in the market for sovereign debt.

Several authors (see, for instance, Sachs, 1995; Buchheit and Gulati, 2002; Krueger, 2002) have argued that a formal sovereign bankruptcy procedure will, in the event of default, lead to more orderly restructuring of sovereign debt. A sovereign bankruptcy procedure will be composed of several elements. Ex ante, this procedure requires the court to establish (and the sovereign debtor to credibly commit to) some 'contractibility' on sovereign debtor's non-contractible payoffs (realised at $t = 2$) to ensure that some foreign interest payments and loans could be diverted in favour of creditors as part of the bargaining process (Tirole, 2002). When a default occurs, conditional on appropriate structural adjustment effort, the bankruptcy court orders a 'standstill', which legitimises the suspension of payments and protects the debtor from litigation (by 'vultures') that might inhibit debtor-creditor negotiations (Miller and Zhang, 2000). The

[18]According to Fischer (2001) and Miller and Zhang (2000), the IMF is effectively gamed into providing bailouts in order to avoid the disorderly default by the sovereign debtor.

standstill provides a breathing space for a 'discovery phase', a period when the bankruptcy court tries to discover the true value of debtor's private payoffs, η, and the project's future net worth, γ, by sending the representatives to check the book of sovereign debtor. Let $\hat{\tau}$ denote the payoff measured in period $t = 1$ units which makes each private creditor indifferent between investing in the project and the risk-free security. Finally, during the resolution phase, the court would enforce a transfer $\hat{\tau} - \gamma$ to each creditor. When $\hat{\tau} - \gamma \leq \eta$, then using the debtor's payoff at $t = 2$ is enough to guarantee participation by creditors in the market for sovereign debt. On the other hand, when $\hat{\tau} - \gamma > \eta$, either the court would have to order a debt restructuring with a debt write-down.

To summarise, first, note that any payments made in the resolution phase can be made conditional on whether or not the debtor undertakes appropriate structural adjustment effort. Second, since this particular formal sovereign bankruptcy procedure makes some of the debtor's payoff contractible ex ante, it is useful to solve the ex ante debtor moral hazard. Third, with debt write-down, this creates a negative impact on the excessive entry by creditors into the market for sovereign debt. Finally, if the bailout is provided instead of having a debt write-down, this still encourages excessive entry thus inefficient risk will still persist in the market for sovereign debt[19] It follows that the formal sovereign bankruptcy procedure, which is similar to the SDRM outlined by Anne Krueger of the IMF, could be used as a complement to CACs.

Next, we study the efficacy of ex ante policy interventions in the market for sovereign debt. Rodrik (1998) suggests that, since financing development by issuing bonds exposes the country to excessive crises, the unrestricted use of such debt instruments should be limited. First, the interest rate on sovereign debt can be capped. Without a cap, the interest rate on some bonds can be very high to compensate the creditors for a higher risk of default. With an interest rate cap, some risky projects will not be financed. Second, the participation of the creditors in the market for sovereign debt can be restricted by reputation. Only those debtors who have bargained in good faith or undertaken appropriate structural adjustment effort in the past will be allowed to borrow. This assumes that there exists a mechanism which could effectively distinguish (a) the debtor who has a past record of mismanaging the borrowed funds from the one that uses the funds to invest in the productive activities; and (b) distinguish which creditors have a past record of lending to a bad reputation debtor. Further, only those creditors who do not have a track record of gambling in the past will

[19]In this case, the negative impact results from the fact that, with bailout, each creditor is effectively insured against the possibility of default .

be allowed to lend. Again, note that with restricted participation, some risky projects will not be financed.

5 Conclusion

We develop a model of sovereign debt crisis when lending takes place through bond markets and find that different types of coordination problems occur in the post-default bargaining game. An extreme form of coordination failure arises when it is always a Bayesian equilibrium for the debtor to make a zero offer and for all creditors to reject the debtor's offer. Other less extreme forms of coordination failure also exist. While strengthening CACs facilitates creditor coordination in the model without bargaining, we find that, in general, with bargaining, strengthening CACs has an ambiguous impact on the Bayesian equilibrium thresholds and crisis risk. We find that any policy response to tackle the inefficiencies identified in the bargaining game will also have impact on the endogenous generation of inefficient risk in the market for sovereign debt. In the future research, we intend to extend the current analysis to allow for a dynamic bargaining between creditors and the sovereign debtor after a default occurs (i.e. a sequential-move game among players).

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Appendix

Proof of lemma 5

If the rate of interest prevailing in the bond market for the sovereign debtor is r, the ex ante participation constraint requires the $(n_f+1)^{th}$ creditor's ex ante expected per capita payoff from lending money to the sovereign, $E(r, n_f+1, \overline{\gamma}_m^{*v})$, is equal to its opportunity cost, $(1+r_f)b$. Now, if $\gamma < \overline{\gamma}_m^{*v} - \varepsilon$ (an event that occurs with probability $F(\overline{\gamma}_m^{*v} - \varepsilon)$), the payoff to each creditor is $\alpha(1+r)b - L'$

while if $\overline{\gamma}_m^{*v} - \varepsilon < \gamma < \overline{\gamma}_m^{*v} + \varepsilon$, the expected payoff is

$$\frac{1}{2}\left\{\begin{array}{c} \left[\frac{1}{2} + \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)-1}^{n_f} \binom{n_f}{j}\right] (\alpha(1+r)b - L') + \\ \left[\frac{1}{2} - \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)-1}^{n_f} \binom{n_f}{j}\right] (\gamma(1+r)b + \tau^e - L''') \end{array}\right\}$$
$$+\frac{1}{2}\left\{\begin{array}{c} \left[\frac{1}{2} + \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)}^{n_f} \binom{n_f}{j}\right] (\beta(1+r)b - L'') \\ + \left[\frac{1}{2} - \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)}^{n_f} \binom{n_f}{j}\right] (\gamma(1+r)b + \tau^e) \end{array}\right\}$$

and if $\gamma > \overline{\gamma}_m^{*v} + \varepsilon$, the payoff is $\gamma(1+r)b + \tau^e$. Let

$$\begin{aligned} \pi\left(\overline{\gamma}_m^{*v}, r\right) &= F(\overline{\gamma}_m^{*v} - \varepsilon)\left(\alpha(1+r)b - L'\right) + \frac{\left(F(\overline{\gamma}_m^{*v} + \varepsilon) - F(\overline{\gamma}_m^{*v} - \varepsilon)\right)}{2} \\ &\left\{\begin{array}{c} \left[\frac{1}{2} + \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)-1}^{n_f} \binom{n_f}{j}\right] (\alpha(1+r)b - L') \\ + \left[\frac{1}{2} + \left(\frac{1}{2}\right)^{n_f+1} \sum\limits_{j=m(n_f+1)}^{n_f} \binom{n_f}{j}\right] (\beta(1+r)b - L'') \end{array}\right\} \\ &- \frac{\left(F(\overline{\gamma}_m^{*v} + \varepsilon) - F(\overline{\gamma}_m^{*v} - \varepsilon)\right)}{2} \left[\frac{1}{2} - \left(\frac{1}{2}\right)^{n_f+1} \sum_{j=m(n_f+1)-1}^{n_f} \binom{n_f}{j}\right] L''' \\ &+ \int_{\overline{\gamma}_{m,(n_f+1)}^{A} - \varepsilon}^{1} \left(\gamma(1+r)b + \tau^e\right) dF(\gamma) \end{aligned}$$

Therefore, $E(r, n_f + 1, \overline{\gamma}_m^{*v})$ is given by the expression:

$$p\pi\left(\overline{\gamma}_m^{*v}, r\right) + (1-p)\left(1+r\right)b$$

Let r^* denote a solution to the equation $E(r, n_f + 1, \overline{\gamma}_m^{*v}) = (1 + r_f)\, b$. Note that sum of the positive terms in the expression for $\pi\left(\overline{\gamma}_m^{*v}, r\right)$ is less than $(1 + r_f)b$ and, therefore, $\pi\left(\overline{\gamma}_m^{*v}, r\right) < (1 + r_f)\, b$. It follows that $r^* > r_f$ thus the participation constraint of the $(n_f + 1)^{th}$ creditor is satisfied by raising the interest rate on sovereign debt. However, note that, by entering the market for sovereign debt, the $(n_f + 1)^{th}$ creditor introduces risk in the market as there is now a positive probability of default and, conditional on default, there is excessive probability of project termination. ■