Collective Action Clause Thresholds in the Presence of Moral Hazard

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Abstract

As a response to recurring roll-over crises of sovereign debtors the IMF has recently advocated the inclusion of so called collective action clauses (CAC) in sovereign bond contracts. These clauses allow the financial terms of a bond contract to be changed by a specified fraction of bondholders while binding in dissenting creditors. Thereby they abrogate the coordination problem among bondholders that gives rise to self-fulfilling crises. However, it was also argued that CAC, by facilitating repudiation, render debtors without proper incentives to undertake policies directed to repay in full. This paper addresses the effect of the specified approval quota on the debtor's behaviour. The trade-off between inefficient roll-over crises and debtor moral hazard is formalized in a model with endogenous short-term debt. It is shown that higher thresholds tend to have a disciplining effect on the debtor. Some characteristics of the optimal contract are presented.

Keywords: Sovereign Debt, Financial Crisis, Collective Action Clauses

JEL classification: F33, F34, G15, H63

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1 Introduction

In the 1990's sovereign debtors, especially emerging market countries, have experienced numerous financial crises. These crises differed from the known repayment problems of sovereigns in the preceding era in two aspects: Firstly, bond financing had increased rapidly following the solution of the 1980's debt crisis with the Brady plan.[1] As a result, creditors were more anonymous and their number surged. This aggravated the coordination problems among creditors. Secondly, these crises were mostly perceived as problems of illiquidity rather than insolvency.[2] Accordingly, crises were not solely explained by unsound domestic budget policies.

One theoretical explanation is the existence of self-fulfilling crises in the presence of maturity mismatch, i.e. if a long-term project is financed by short-term debt. If a first-come-first-served constraint applies the rollover decision of each creditor depends on his beliefs about the other creditors' rollover decision. This leads to multiple equilibria where either all investors withdraw or roll over.[3]

As a response the IMF, the G10 and other international finance officials are now advocating the use of collective action clauses (CAC) in sovereign bond contracts and recently they have indeed been included in several issues.[4] Nevertheless, there is still concern that making CAC inclusion mandatory would cut off countries with unfavorable fundamentals from financial markets.[5] Collective Action Clauses stipulate that the terms of a bond contract can be changed by a prespecified majority of bondholders and that such a decision is binding for dissenting creditors as well. This solves the coordination problem among creditors. However, it can be shown that a contract with the risk of a crisis due to early liquidation is second best if debtor moral hazard is an issue.[6] In such models the threat of early liquidation disciplines the debtor. COntracts that allow for inefficient outcomes are implemented to deal cope with moral hazard. Following this line of argument, measures that prevent crises may as well lead to the breakdown of the market. This paper addresses the question how CAC interact with debtor moral hazard and how the choice of the quota in CAC affects this problem. It identifies a trade-off between stability and

[1]See Cline (2000)[4].

[2]See Eaton and Gersovitz (1981)[6] on this issue.

[3]This theory goes back to the classical work by Diamond and Dybvig (1983)[5] on self-fulfilling banking crises.

[4]The first noteworthy mention was Eichgreen and Portes (1996)[7]. Official statements include the Rey Report by the Group of Ten (1996)[12] and several IMF reports (2003)[10]. An overview of the current situation is in Galvis and Saas (2004)[8].

[5]See for example Shelifer (2003)[13].

[6]See Calomiris and Kahn, 1991 [3] and Jeanne, 2003)[11]

appropriate incentives.

In the model a capital scarce country finances a long term project with short term bonds. The allocation of final output to the debtor and creditor is determined by an initial policy choice of the debtor country. If the creditors realize that the debtor is trying to divert assets they can liquidate the project. This will mean a loss to creditors, but is more favorable to them than being cheated upon by the debtor.

After signing the contract the debtor learns about the prospect of the creditor-unfriendly policy and chooses whether to divert assets or not. Because this information is unknown to creditors they can not infer exactly which policy was chosen. Then, creditors receive a noisy signal on the countries policy choice and vote whether to roll over the claims. If they withdraw the project is liquidated and the limited funds are used to repay each creditor an equal fraction of her claim. Last, if the project is continued it terminates and payoffs are made.

In equilibrium the creditors play a threshold strategy conditional on their signals. Creditors receive heterogeneous signals so a higher quota implies that a creditor with a less favorable signal is pivotal. Consequentially, the conditional rollover probabilities are decreasing as the threshold rises. The paper shows that this has a disciplining effect on the debtor. This effect is linked to the private information of the country: By setting a higher quota the creditors know that the country will only pursue the bad policy if the prospect of the creditor-unfriendly policy was very good.

The optimal threshold is then derived from a maximization problem of the country. It turns out that the optimal contract is the social second best in this context, i.e. it is the contract with the highest probability of project success. However, it can be shown that this does not correspond with the contract that is most disciplining. Intuitively, this is because the latter contract would render a rollover too difficult. Comparative statics of the model show that some first glance intuitions do not necessarily hold. Neither the precision of the country's public information to the market, nor the transparency and predictability of its policy choice have an unambiguos effect.

The framework is taken from Jeanne (2003) where he endogenizes the role of short term debt for sovereign lending in the presence of moral hazard. Most importantly, heterogenous creditors are introduced in order to focus on the role of collective action clause thresholds. The model is also similar to the one developed in Calomiris and Kahn (1991) where they show that a demandable debt contract is optimal to discipline a potentially fraudulent banker. Haldane et al (2004) also address the question of optimal collective action clause thresholds. In their model there is no debtor moral hazard. The tradeoff in their model is that a higher threshold decreases the debtors payoff in the event of a crisis, although raising it's probability. The optimal choice of the threshold depends on the country's risk preference.

The paper is structured as follows. Section 2 introduces the framework of the model. In section 3 the equilibrium is derived. In section 4 the optimization problem of the country is analyzed and the optimal contarct is characterized. Section 5 concludes.

2 The Model

2.1 Payoffs

In the model world sovereign debt is subject to severe enforcement problems. I assume that countries are only enforced to repay, because they face a disadvantage from being in default. If this default cost exceeds the outstanding debt the country repays, otherwise it will default. Default costs are assumed to be a fraction of output so this fraction, θ, is pledeagble. The country can invest in a profitable project. The project yields a save real return of one unit and demands an investment $I < 1$. The project is long-term, i.e. it lasts two periods. If the project is liquidated earlier the return is diminished severely, i.e. output is only equal to $\alpha < 1$. The bond contract specifies a repayment R and the country will actually repay $min\{\theta, R\}$.

One key feature of the model is that the country can undertake two different types of policies: an investor-friendly and an investor-unfriendly. I assume that the country can determine the cost of default in the long run. If it undertakes a policy that keeps default costs high it can commit to a high repayment. Without commitment default costs and pledgeable output will be low. For example, an economy that is strongly dependent on imports and exports will experience more severe economic decline due to default than one that is almost autark. Another example would be that a country could implement a regulatory scheme on domestic banks that makes them less vulnerable to a default on sovereign claims. In terms of the model this implies that default costs, i.e. the parameter θ can take different values. If θ is high the country commits to a higher repayment and is thus a more creditworthy borrower. I will label this investor-friendly policy simply the *good* policy. Consequentially, the policy that makes default less costly is the *bad* policy. So,

$$U = \theta = \begin{cases} \bar{\theta} & \text{if the policy is } \textit{good} \text{ and} \\ \underline{\theta} & \text{if the policy is } \textit{bad}. \end{cases}$$

Initially the country is pursueing the good policy. In the initial period the country decides whether it sticks to the good policy or switches to the bad one. If the country decides to switch this will not be effective until the last period. So the impact of the bad policy comes with delay. The idea behind this is that a policy turnover is not effective over night. Following the examples I gave above, it is for example unrealistic for a country to overcome import dependence over night.

The policy can be thought of as an *asset diverting* policy, because it only affects the allocation of output, not its size. In the interim period the creditors can liquidate the project and evade a possible fraud. We assume that liquidating the project is profitable for the creditors if the bad policy was chosen, i.e. $\underline{\theta} < \alpha\bar{\theta}$. We assume that the liquidation value of the project is sufficient to allow external financing, i.e. $I > \alpha\bar{\theta}$. It follows that $\alpha\bar{\theta} < R \leq \bar{\theta}$. So the creditors payoff X will be:

$$U = \begin{cases} R & \text{if the project is continued and the policy is } \textit{good} \text{ and} \\ \underline{\theta} & \text{if the project is continued and the policy is } \textit{bad} \text{ and} \\ \alpha\bar{\theta} & \text{if the project is liquidated.} \end{cases} \tag{1}$$

The debtor country will settle with the remainder of the project return:

$$X = \begin{cases} 1 - R & \text{if the project is continued and the policy is } \textit{good} \text{ and} \\ 1 - \underline{\theta} & \text{if the project is continued and the policy is } \textit{bad} \text{ and} \\ \alpha(1 - \bar{\theta}) & \text{if the project is liquidated.} \end{cases} \tag{2}$$

2.2 Timing, Information and Contracting

The model world lasts for four periods, $0, 1, 2, 3$. In period 0 the country can invest in the project that terminates in the last period. The country has no wealth so that it needs external financing. It offers a bond contract to a mass of risk neutral creditors. The risk-free world interest rate is normalized to zero. Bonds are assumed to be the only measure of external financing. We assumed that $I > \alpha\theta$ which implies that the project is long-term from the creditors point of view, i.e. it can not be financed if it is liquidated in the interim period for sure. This implies that a long-term contract is infeasible.

In the model the CAC will take the form of a roll-over clause.[7] It asks creditors to vote whether they accept to receive the repayment not until the final period. The contract also specifies a quota κ that determines the fraction of creditors required for the change in the financial terms of the contract. The specified repayment is R.

In period 1 the country learns it's type γ and thereafter decides whether it switches to the bad policy. The type is private information to the debtor and contains information on the relative prospect of both policies. The country will choose the good policy if

$$E[X_{good}] \geq E[X_{bad}] + \gamma \tag{3}$$

and the bad policy else. An interpretation of the type could for example be that the country receives news about the availability and prices of its imports and exports. In this example, if the country learns that it's future gains from trade are high it will be less likely to default. Alternatively, γ could also reflect political uncertainty. In this interpretaition γ is simply an unforseeable bias in the policymakers favor for either policy. The type γ is distributed with mean zero and variance σ_γ.

In period 2 short-term debt expires. The debtor will allways desire to continue the project to maximize it's payoff. I assume that there are no other creditors supplying funds in the interim period. Accordingly, the country will exercise the CAC with certainty. This assumption incorporates the notion that old-established creditors do have a stronger incentive to engage into further financing of a struggling country.[8] Therefore the country will prefer to recontract with existing creditors in times of financial distress.

The debtors offer will then be voted upon by the creditors. In case the necessary quota for consent is met, the agreement will be binding for all creditors. If the offer is rejected the creditors will collectively sue the debtor country. They will extract all output pledgeable in that period and share it on a pro-rata basis. This embeds the fact that CAC usually provide a *sharing clause* so that no sequential service constraint applies.

In period 2, before casting her vote, each creditor receives a private signal. The signal contains noisy information of the policy that was undertaken, i.e.

$$z_i = \theta + \eta + \epsilon_i, \tag{4}$$

where ϵ_i represents some private noise term of creditor i and η is a common noise term, that reflects market uncertainty. Both types of noises are distributed

[7] See Buiter and Sibert (1999)[1]

[8] See Bulow and Rogoff (1989)[2]

normally with mean zero and variances σ_η and σ_ϵ respectively.

I assume that information efficiency does not hold, i.e. that information remains private after the signal is received. This restrictive assumption is necessary to implement a heterogenous structure of the creditors that allows the analysis of the coordination problem. This is less of a problem since equation (4) can also be interpreted differently: all creditors receive the same public information but have a different perception of the consequences, or the signal has implications that are private information. For example each creditor may have other investment ongoing in the same country that would be affected by the sovereign default. This would provide each creditor with an individual assessment of the situation. In the last period the project terminates and outstanding debt is settled.

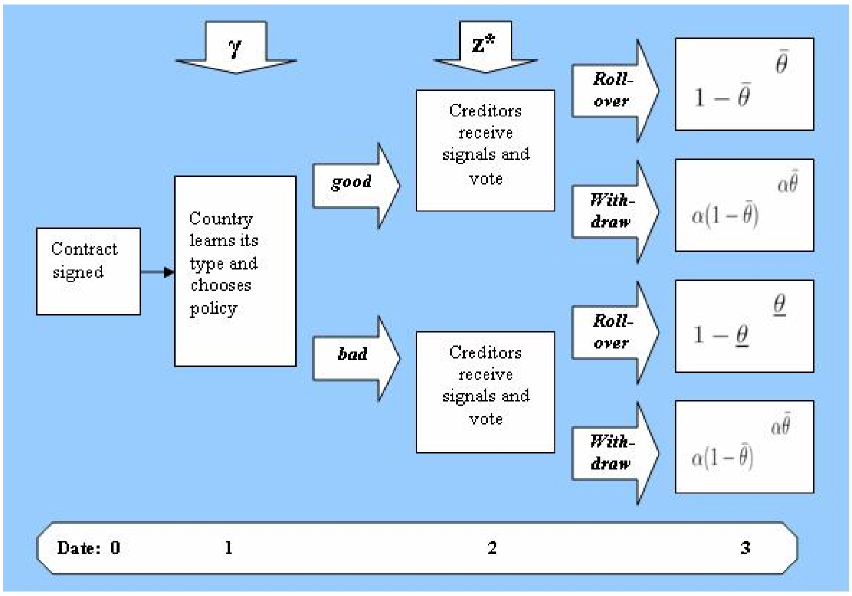


Figure 1: The debt contract defines a sequential game: first, the country learns its type and decides upon the policy; second, the creditors receive a signal and decide collectively whether to roll-over the claims or not.

The model setup defines a sequential game as in figure 2.2. In period 1 the country decides which policy action it chooses, $a \in \{good, bad\}$. In period 2 the creditors decide whether to roll over the countries claims or not, $v \in \{rollover(R), withdraw(W)\}$. With perfect information the efficient equilibrium $(good, R)$ is achieved. Without valuable information, i.e. if the signal is pure noise, the only equilibrium is (bad, W). In this case the game is equivalent to a simultaneous move game and *bad* is the dominant strategy for the debtor country because it yields at least the same payoff as *good* for either vote of the creditors.

3 Solution

3.1 Individual Rational Voting

We proceed by solving backwards: In the final period all informational asymmetries are revealed and the payoffs are made. We begin our analysis in period 2 when the creditors make their roll-over decision. Each creditor will be asked to vote whether he agrees to a roll-over or not. In any case all creditors will receive the same pay-off so there is no room for strategic interaction. Each creditor will vote for the action that maximizes his expected pay-off and will thereby also maximize the other creditors' expected payoff. Only, because creditors have heterogenous private information there will be no unanimity.

The expression for each creditors expected payoff from rolling over the claims is:

$$E[U^R] = P_i R + (1 - P_i)\underline{\theta}$$

where P_i is the probability that creditor i assesses to the event that the chosen policy is good, conditional on the signal z_i and her prior on the country's policy choice. The expected payoff from demanding immediate repayment is $\alpha\bar{\theta}$, so that we can claim that investor i will vote to roll over the claims if and only if:

$$P_i R + (1 - P_i)\underline{\theta} \geq \alpha\bar{\theta} \tag{5}$$

One can show that this implies that each individual creditor follows a threshold strategy around some z^*.

Proposition 1. Individual Threshold Strategy (R_{z^*}): *Each individual creditor will vote in favor of the roll over if and only if $z_i \geq z^*$, i.e.*

$$R_{z^*} : v_i = \begin{cases} R & \text{if } z_i \geq z^* \\ W & \text{either.} \end{cases} \tag{6}$$

Proof of Proposition 1: A switching strategy implies that the right hand side of equation 5 is monotonically increasing in z_i and that the inequality holds in both directions for some values of z_i.

$$\frac{\partial E[U^R]}{\partial z_i} \geq 0 \tag{7}$$

$$\lim_{z_i \to -\infty} E[U^R] \leq \alpha\bar{\theta} \tag{8}$$

$$\lim_{z_i \to \infty} E[U^R] \geq \alpha\bar{\theta} \tag{9}$$

where at least one inequality is strict. Let us now analyze how each creditor processes the information contained in the signal to get an expression for P_i. Bayesian updating implies:

$$Prob(\theta = \bar{\theta}) = \frac{Prob(\tilde{z}_i = z_i|\theta = \bar{\theta})P}{Prob(\tilde{z}_i = z_i|\theta = \bar{\theta})P + Prob(\tilde{z}_i = z_i|\theta = \underline{\theta})(1-P)}$$

The probability that the signal z_i was sent, given the good policy was selected is:[9]

$$\begin{aligned} &Prob(\tilde{z}_i = z_i|\theta = \bar{\theta}) \\ =&Prob(z_i = \bar{\theta} + \eta + \epsilon_i) \\ =&Prob(\eta + \epsilon_i = z_i - \bar{\theta}) \end{aligned} \tag{10}$$

If η and ϵ_i are distributed normally the distribution of $\eta + \epsilon_i$ is also normal. Let us label the density of this common distribution f, then:

$$Prob(\theta = \bar{\theta}) = \frac{f(z_i - \bar{\theta})P}{f(z_i - \bar{\theta})P + f(z_i - \underline{\theta})(1-P)} = P_i$$

To see how the probability changes with different signals we can rearrange

$$P_i = \frac{1}{1 + \frac{f(z_i - \underline{\theta})(1-P)}{f(z_i - \bar{\theta})P}} \tag{11}$$

Let us now define a function

$$g(z_i) = \frac{f(z_i - \bar{\theta})}{f(z_i - \underline{\theta})}$$

[9]The analysis is symmetric for both policies.

and recognize that by the normality of f it has the following properties:

$$\lim_{z_i \to -\infty} g(z_i) = 0 \tag{12}$$

$$\lim_{z_i \to \infty} g(z_i) = \infty \tag{13}$$

$$g'(z_i) > 0 \tag{14}$$

Then we can rewrite equation 11 to

$$P_i = \frac{1}{1 + \frac{(1-P)}{P} \frac{1}{g(z_i)}}$$

With the properties of $g(z_i)$ we can deduct the following properties for $P_i(z_i)$:

$$\lim_{z_i \to -\infty} P_i = 0 \tag{15}$$

$$\lim_{z_i \to \infty} P_i = 1 \tag{16}$$

$$\frac{\partial P_i}{\partial z_i} > 0 \tag{17}$$

It follows that we have that

$$\lim_{z_i \to -\infty} E[U] = \underline{\theta} < \alpha \bar{\theta} \tag{18}$$

$$\lim_{z_i \to \infty} E[U] = \bar{\theta} > \alpha \bar{\theta} \tag{19}$$

so that equation 8 and 9 hold. Finally, equation 17 implies that the condition imposed in equation 7 holds. □

Intuitively, with higher signals it becomes more likely that the good policy was undertaken. Hence, the expected payoff from rolling over the claim is increasing in the value of the signal. At some point z^* it exceeds the payoff from demading immediate repayment. We will now proceed to characterize the switching point z^*. Since equation 5 holds with equality at z^* we know that

$$\frac{f(z^* - \bar{\theta})PR + f(z^* - \underline{\theta})(1-P)\underline{\theta}}{f(z^* - \bar{\theta})P + f(z^* - \underline{\theta})(1-P)} = \alpha \bar{\theta}$$

To characterize the effect of a change in the prior P on the switching point z^* it is convenient to solve for P.[10] One obtains

$$P = \frac{f(z^* - \underline{\theta})(\alpha\bar{\theta} - \underline{\theta})}{f(z^* - \bar{\theta})(R - \alpha\bar{\theta}) + f(z^* - \underline{\theta})(\alpha\bar{\theta} - \underline{\theta})}$$

Rearranging yields

$$P = \frac{1}{1 + g(z^*)\frac{R - \alpha\bar{\theta}}{\alpha\bar{\theta} - \underline{\theta}}} \tag{20}$$

We can conclude that P and z^* are inversely related in the optimal voting strategy

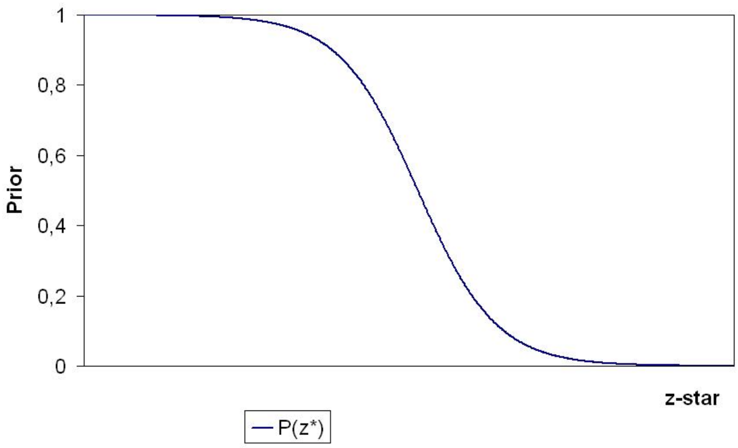


Figure 2: Threshold depending on the prior belief

of a creditor. So a better prior P leads to a lower threshold value z^*. Intuitively, this arises from the fact that the resulting assessment P_i given a specific signal z_i is better if the initial belief about the countries policy is better. A creditor is more likely to prolong the credit the better his prior belief in the countries creditworthyness is. Figure 2 illustrates this.

3.2 The Collective Vote

After assessing the voting decision of each individual creditor we shall now analyze the outcome of the voting. The decisionmaking process is by assumption restricted to voting rules with a required approval to a roll over of κ%. Since those creditors with the highest signals will vote in favor of a role over, this boils down to requiring

[10] Although it is convenient to solve for $P(z^*)$ the causal dependency is the other way around here.

that the creditor with the κth best signal favors the roll over. So the voting rule is:

$$v = v_\kappa$$

where v_κ is the pivotal creditor's vote. The signal the pivotal creditor received is $z_\kappa = \theta + \eta + \epsilon_\kappa$ where ϵ_κ satisfies

$$F_\epsilon(\epsilon_\kappa) = 1 - \kappa \tag{21}$$

So the debt will be rolled over if $z_\kappa = \theta + \eta + \epsilon_\kappa \geq z^*$. By equation 21 ϵ_κ is not random. This arises from the fact that the distribution of the private noise term is known, so that we can identify the private noise faced by the pivotal creditor. We recollect and define y to obtain a condition for a successfull roll-over:

$$y = \theta + \eta \leq z^* - \epsilon_\kappa = y^* \tag{22}$$

Proposition 2. Creditor Collective Threshold Strategy (R_{y^*}): *The creditors will roll over the debt if and only if $y \geq y^*$, i.e.*

$$R_{y^*} : v = \begin{cases} R & \textit{if } y \geq y^* \\ W & \textit{either.} \end{cases} \tag{23}$$

To see how a change in the quota changes the roll-over regime we sub in $z^* = y^* + \epsilon_\kappa$ in equation 20 and get

$$P = \frac{1}{1 + g(y^* + \epsilon_\kappa)\frac{R - \alpha\bar{\theta}}{\alpha\bar{\theta} - \underline{\theta}}} = C(y^*, \kappa) \tag{24}$$

where we define the function $C()$ for easy reference. According to equation 21 we see that a higher quota results in a lower private noise:

$$\frac{\partial \epsilon_\kappa}{\partial \kappa} < 0$$

Since $g'() > 0$ an increase in κ also increases the value for P that is assigned to a value of y^*, so $\frac{\partial C}{\partial \kappa} > 0$. This implies that the same prior P will result in a higher y^*. The intuition is that though z^* stays the same it will be harder to send a signal of the required magnitude to the pivotal creditor when the quota is higher. This is illustrated in figure 3.

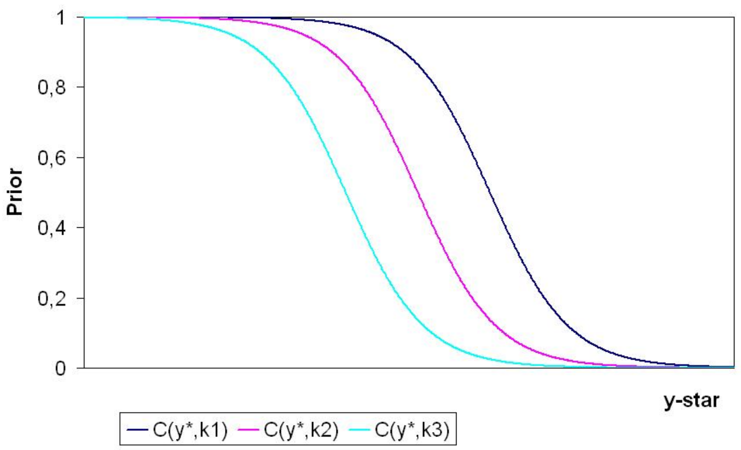


Figure 3: Roll-over regimes for different quotas with $\kappa_1 > \kappa_2 > \kappa_3$

3.3 Debtor Policy Choice

The expected payoff for the country of choosing a policy a will in general be:

$$E[X_a] = Prob(R|a)X_a^R + Prob(W|a)X_a^W \tag{25}$$

where X_a^v is the payoff if the creditors decision is v and the chosen policy was a. Recall from equation 3 that the country will choose the *good* policy if

$$E[X_{good}] \geq E[X_{bad}] + \gamma \tag{26}$$

where γ represents the type of the debtor that gets known to the country in period 1. Importantly, γ becomes known to the debtor right before the policy is chosen, but after the contract is signed. So in the moment the contract is signed, the country is unaware of it's policy preference. Or, to be more precise: the country's general preference for either policy in the model is summarized in the values of $\bar{\theta}$ and $\underline{\theta}$. The variable γ captures an unforeseen shock to this preference, that nevertheless may be crucial for the countries decision.

In principle, the collective threshold y^* determines the expected payoffs of both policies because they pin down the probability of a successfull roll-over conditional on the policy chosen. Since the parameters of the model are common knowledge to all agents, the creditors know $E[X_{good}]$ and $E[X_{bad}]$ for each value of y^* that is implied by their rational voting strategies. But since γ is private information to the country they can not infer the policy choice of the country from the design of the contract.[11]

Nevertheless, creditors can precisely assess for which realizations of the shock the country will chose the good policy. Especially, from equation 3 the debtor will choose the good policy if

$$\begin{aligned} E[X_{good}] - E[X_{bad}] &\geq \gamma \\ \Delta &\geq \gamma \end{aligned} \tag{27}$$

where we define Δ as the difference between expected payoffs. Consequently, P can be derived explicitly from the expected debtor payoffs of both policies that depend on y^*.

$$\begin{aligned} P &= \Pr(a = good) \\ &= \Pr(\Delta \geq \gamma) \\ &= F_\gamma(\Delta) \end{aligned} \tag{28}$$

where F_γ is the normal cumulative density of γ. So the debtor will exercise the good policy with higher probability if the excess payoff of the good policy is higher. If both policies would yield the same expected payoff they will be chosen with equal probability, depending on the state of the world γ. If for example, the good policy would yield a higher expected payoff, only substantially positive values of γ would switch the policy decision to the bad policy. Since this is less likely, the good policy would be pursued with a probability greater than one half. For easy reference we define a function that maps y^* into the prior P:

$$P = F_\gamma(\Delta(y^*)) = D(y^*) \tag{29}$$

To analyze the function D we will first take a look at $\Delta(y^*)$. Since F_γ is just a positive monotone mapping into the $[0, 1]$-interval we will be almost done then. The probability that the debt is rolled over successfully is just the probability that the pivotal creditor will vote in favor of a roll over. We know from the previous section that this will be the case if $y = \theta + \eta \geq y^*$. Then we can establish that the probability of a successfull roll-over given that for example, the good policy was

[11] If that would be the case the game would not have an equilibrium. The only way to establish pure strategy equilibria in this game is to have the signal contain perfect information. Otherwise, a prior of $P = 1$ would imply that the creditors roll over the claims with probability one. This would result in the country choosing the bad policy for sure.

undertaken is

$$\begin{aligned}
Prob(R|good) &= Prob(y = \bar{\theta} + \eta \geq y^*) \\
&= Prob(\eta > y^* - \bar{\theta}) \\
&= 1 - F_\eta(y^* - \bar{\theta}) \\
&= \Pi_{good}(y^*)
\end{aligned} \tag{30}$$

So we can express the expected payoffs of both policies as:

$$E[U_{good}] = \Pi_{good}(y^*)(1 - R + (1 - \Pi_{good}(y^*))\alpha(1 - \bar{\theta}) \tag{31}$$

$$E[U_{bad}] = \Pi_{bad}(y^*)(1 - \underline{\theta}) + (1 - \Pi_{bad}(y^*))\alpha(1 - \bar{\theta}) \tag{32}$$

The difference between the payoffs of both policies is:

$$\begin{aligned}
\Delta(y^*) =&\Pi_{good}(y^*)(1 - \bar{\theta} - \alpha(1 - \bar{\theta})) \\
&-\Pi_{bad}(y^*)(1 - \underline{\theta} - \alpha(1 - \bar{\theta}))
\end{aligned} \tag{33}$$

First, note that $\Delta(y^*)$ has the following properties.

$$\lim_{y^* \to -\infty} \Delta = \underline{\theta} - \bar{\theta}$$

$$\lim_{y^* \to \infty} \Delta = 0$$

Second, it will be interesting to see how Δ changes with y^*. Therefore we will need the derivative of the conditional roll-over probability with respect to y^*. From equation 30 we can derive:

$$\frac{\partial \Pi}{\partial y^*} = -f_\eta(y^* - \theta)$$

Then we have that

$$\begin{aligned}
\frac{\partial \Delta}{\partial y^*} =& -f_\eta(y^* - \bar{\theta})(1 - \bar{\theta} - \alpha(1 - \bar{\theta})) \\
&+f_\eta(y^* - \underline{\theta})(1 - \underline{\theta} - \alpha(1 - \bar{\theta}))
\end{aligned} \tag{34}$$

so that immediately follows that

$$\lim_{y^* \to -\infty} \frac{\partial \Delta}{\partial y^*} = 0$$

$$\lim_{y^* \to \infty} \frac{\partial \Delta}{\partial y^*} = 0$$

Rearranging equation 34 we see that this derivative is positive if

$$\frac{1-\underline{\theta}-\alpha(1-\bar{\theta})}{1-\bar{\theta}-\alpha(1-\bar{\theta})} > \frac{f_\eta(y^*-\bar{\theta})}{f_\eta(y^*-\underline{\theta})} \tag{35}$$

Since the right side of equation 35 has the properties of the function $g()$ used earlier

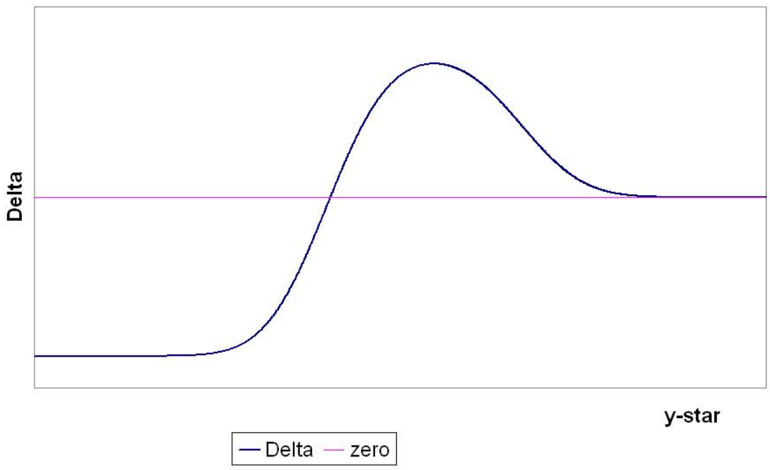


Figure 4: Excess payoff of the good policy

in this section we know that this condition ceases to hold for large values of y^*. Thus we can conclude that the shape of Δ is humped with flat tails. The shape of $\Delta(y^*)$ is illustrated in figure 4.

Since the function F_γ is just a positive monotone transformation into the $[0,1]$-space it is now straightforward to draw $P = D(y^*)$. If the variance of γ is large, deviations from $\Delta = 0$ will only result in moderate differences from $P = \frac{1}{2}$. As the variance of γ becomes small, these deviations become more substantial. For the limiting case where $\sigma_\gamma \to 0$ we are in the case where debtor heterogeneity plays no role. Figure 5 illustrates this. The variance of γ can be interpreted as a measure of policy predictability. It determines the degree to which the policy decision of the country is affected by a shock that is unobservable to the creditors. Or to put it in other words, how sensitive the debtor countries policy is to minor turbulences.

3.4 Equilibrium

In equilibrium the cutoff value of the creditors (y^*) implied by the prior (P) and the quota (κ) must render the debtor with expected payoffs such that the creditors prior is correct. This requires that $C(y^*) = d(y^*)$.

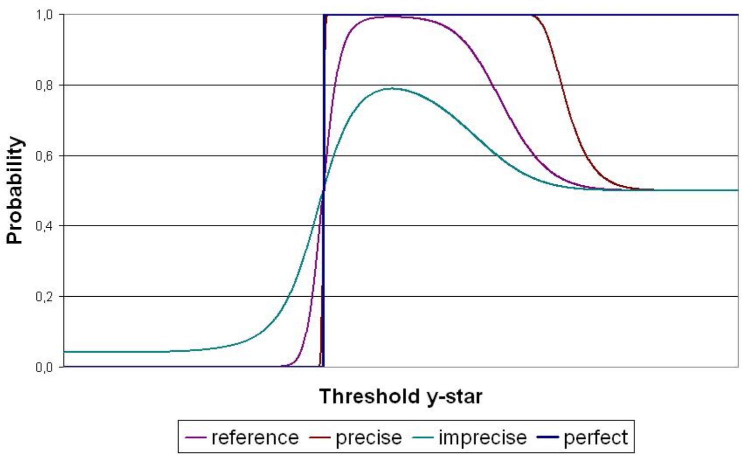


Figure 5: Resulting Probabilities for different degrees of policy predictability

Proposition 3. EQUILIBRIUM: *There exists a unique*[12] *equilibrium* $(\hat{P}, R_{\hat{y}})$ *such that*

$$\hat{y} : \hat{P} = C(\hat{y_\kappa}, \epsilon_\kappa) = D(\hat{y}) \tag{36}$$

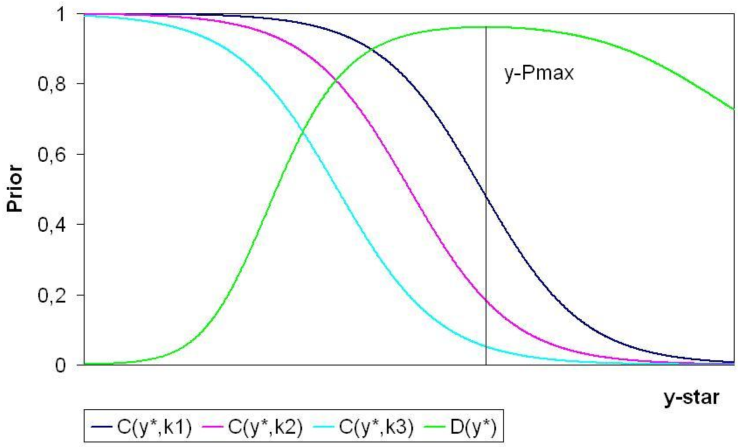


Figure 6: Equilibria for different values of κ

The equilibrium depends on the choice of the quota κ. As we have seen above a higher quota shifts the C-function to the right. The maximum of $D(y^*)$ marks the contract that maximizes the incentive for the debtor country. Let us label this

[12]Numeric simulations show that this equilibrium is unique.

point (P_{max}, y_{Pmax}). For all $y^* < y_{Pmax}$ a higher quota yields an equilibrium with a higher cutoff value y^*, i.e. a tighter roll-over regime, that is associated with a higher probability that the creditor chooses the good policy (see figure 6). In this area a higher quota has a positive incentive effect so that we can say that a higher quota has a disciplining effect on the debtor country. In this range the model embeds a trade-off where better incentives are associated with a loss in efficiency. For higher values of y^* there is no positive incentive effect. Intuitively, as a successfull roll-over becomes very unlikely for both policies, the debtor is almost indifferent between policies.

4 Optimal Quota

4.1 The Optimization Problem

We will now turn to characterize the optimal choice of the quota κ. The contract is designed by the country subject to the restriction that creditors have to buy the bonds. The country maximizes it's discounted cash-flow over all periods. For simplicity we assume that the discount factor is one. The discounted cash-flow is then simply the sum of all payments. In case the project is undertaken the country receives the loan of size L in period 0 of which it has to finance the project with I. Then depending on the roll over decision of the creditors it earns some part of the proceedings of the project in period 2 or 3. These are in expectation worth $E[X]$. So the optimization problem is:[13]

$$\max_{\kappa,R} \ \Xi = +L - I + E[X]$$
$$s.t. \ I \leq L$$

Since creditors are risk neutral and the interest rate is normalized to zero we know that creditors will be willing to lend $L = E[U]$. The sum of $E[U] + E[X]$ is the expected return of the project. Since the project bears no risk in itself it is only depending on the chance of a successfull roll-over. So the debtor's optimization

[13]The country will always desire to undertake the project if possible. Since it has no capital the gains from undertaking the project are never negative.

problem can be rewritten:

$$\max_{\kappa,R} \ \Xi = \Pi - (1-\Pi)\alpha - I$$
$$s.t. \ I \leq P[\Pi_{good}R + (1-\Pi_{good})\alpha\bar{\theta}] + (1-P)[\Pi_{bad}\underline{\theta} + (1-\Pi_{bad})\alpha\bar{\theta}]$$

where Π is the unconditional roll-over probability, i.e.:

$$\Pi = \Pi_{good}P + \Pi_{bad}(1-P)$$

It is convenient to describe the equilibrium in terms of (y^*, R) instead of (κ, R). Note that even though R influences y^* we can choose both variables independently because y^* can be adjusted freely via κ. The objective function is strictly decreasing in R because lowering the repayment increases the return of the good policy which results in a higher P. On the other hand, we have that $\frac{\partial E[U]}{\partial R}$ can be either positive or negative because increasing R has a positive payoff effect and a negative incentive effect. But in equilibrium $\frac{\partial E[U]}{\partial R}$ must be positive. First, since $\frac{\partial E[U]}{\partial R^2} < 0$ it has one maximum in R, $E[U|R_{max}]$. Second, we know that no feasible contract exists with $R \leq \alpha\bar{\theta}$. So if the maximum was to the left of $\alpha\bar{\theta}$ there would be no feasible contract at all. Thus, the maximum must be for $R > \alpha\bar{\theta}$. Since $\frac{\partial \Xi}{\partial R} < 0$ the optimal R will be located to the left of the maximum. We can conclude that the constraint holds binding in equilibrium. This is intuitively obvious, because otherwise the country would borrow more than necessary to finance the project. The first order condition with respect to y^* is:

$$\frac{\partial \Pi}{\partial y^*} = -f(y^* - \bar{\theta})P - f(y^* - \underline{\theta})(1-P) + \frac{\partial P}{\partial y^*}(F(y^* - \underline{\theta}) - F(y^* - \bar{\theta})) = 0 \tag{37}$$

So Π is either monotonically decreasing or it has two locally stable points, a minimum and a miximum. For $y^* \to 0$ it is approaching one and for $y^* \to \infty$ we have that Π is approaching zero. Π will only have a local maximum if $\frac{\partial P}{\partial y}$ takes substantially positive values for some y. This is the case when policy predictability is high, i.e. the variance of γ is low. Intuitively, the incentive effect must be large enough.

It is also useful to note some properties of $E[U]$:

$$E[U] = \alpha\bar{\theta} + \Pi_{good}P(R - \alpha\bar{\theta}) + \Pi_{bad}(1 - P)(\underline{\theta} - \alpha\bar{\theta}) \tag{38}$$

$$\lim_{y^* \to -\infty} E[U] = \alpha\bar{\theta} + P(R - \alpha\bar{\theta}) + (1 - P)(\underline{\theta} - \alpha\bar{\theta}) \tag{39}$$

$$\lim_{y^* \to \infty} E[U] = \alpha\bar{\theta} \tag{40}$$

$$\begin{aligned} \frac{\partial E[U]}{\partial y^*} &= \frac{\partial \Pi_{good}}{\partial y^*} P(R - \alpha\bar{\theta}) + \frac{\partial \Pi_{bad}}{\partial y^*}(1 - P)(\underline{\theta} - \alpha\bar{\theta}) \\ &\quad + \frac{\partial P}{\partial y^*}(\Pi_{good}(R - \alpha\bar{\theta}) - \Pi_{bad}(\underline{\theta} - \alpha\bar{\theta})) \end{aligned} \tag{41}$$

It can be shown that $E[U]$ has only one maximum in y, i.e. the shape of $E[U](y)$ is humped. Furthermore, if $\Pi(y)$ has a local maximum it is to the left of the global maximum of $E[U]$.[14] We are now equipped to analyze the optimal contract. Depending on the variance of γ and the amount of finance required to start the project we can distinguish between three types of solutions:

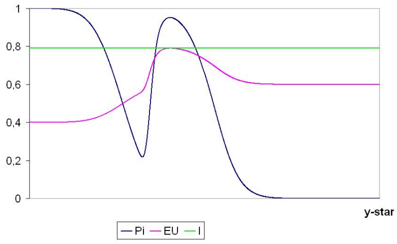
- An inner solution is a pair (y^*, R) that satisfies the first order condition and the constraint with equality. This requires that $\frac{\partial P}{\partial y}$ is high enough so that Π has a local maximum. This is equivalent to demanding a strong incentive effect. We shall label this solution the inner incentive solution.
- It may however be the case that $E[U|R = argmax\,\{E[U]\}\,; y^* = argmax\,\{\Phi\}] < I$. In this case the first order condition cannot be fulfilled and the model has a corner solution. Since $argmax_y(E[U]) > argmax_y(\Pi)$ this solution is to the right of the inner solution. We shall label this solution the corner incentive solution.
- Another situation without an inner solution is if Π either does not have a local maximum or, (since $\lim_{y^* \to 0} \Pi = 1$) that a higher Π is feasible on the left arm of Π. This solution is likely if the incentive effect is small. Consequentially, we label this solution the no-incentive solution.

The different types of solutions are represented in figure 7.

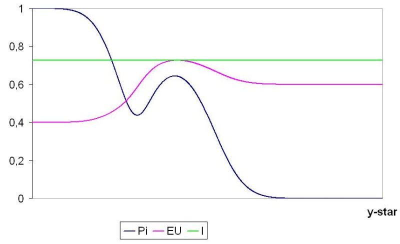
4.2 The No-Incentive Contract Solution

The no-incentive solution is not of particular interest in the context of this paper. This is because as the variance of γ increases moral hazard plays a declining role.

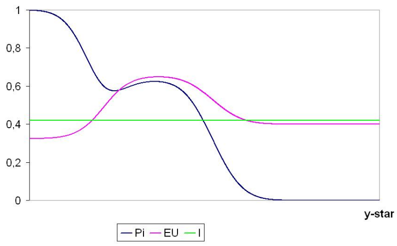
[14] These two properties are not readily apparent in the equations presented here. They can be proven numerically.



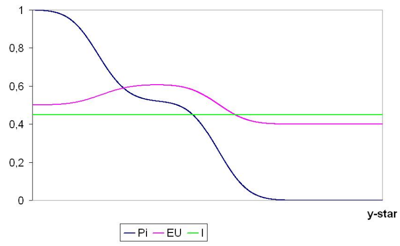
(a) Incentive contract with inner solution



(b) Incentive contract with corner solution



(c) No incentive contract with moderate precision



(d) No incentive contract with very low precision

Figure 7: Different parameter values for I and σ_γ determine the type of the solution. An incentive solution requires sufficiently small σ_γ. No incentive contracts are only feasible for small I.

We have derived above that tightening the roll-over regime (increasing y^*) may positively affect the debtors policy decision, because this may relatively benefit the prospect of the good policy. This effect is less prominent if the debtors decision is essentially driven by a random component. It is then optimal to implement the least y^* that grants the creditors an expected zero real interest in order to maximize the probability of a successfull roll-over. However, since the good policy is only chosen with a relatively low probability, this type of contract can only support credits up to a lower ceiling.

A good example to understand the working of the no-incentive contract solution is to consider the case where the variance of γ approaches infinity, so that the decision of the country is entirely random and expected payoffs are irrelevant for the country's policy choice. In this case P equals $1/2$ independent of y^*. Accordingly, the creditors expected payoff is:

$$E[U] = \alpha\bar{\theta} + \frac{1}{2}(\Pi_{good}(R - \alpha\bar{\theta}) + \Pi_{bad}(\underline{\theta} - \alpha\bar{\theta})) \tag{42}$$

From equation 42 it is apparent that the expected return of the creditors is increasing with y^* for small values of y^*. So implementing a higher collective threshold makes the contract more attractive to the creditors. This reflects the effect that even there is no ex-ante measure to improve the country's policy decision it is of course beneficial for the creditors to detect a fraudelent policy ex-post. For the case of a randomizing debtor, $E[U]$ is actually maximized for $y^* = z^*$, i.e. a quota of $\kappa = 0.5$. Here comes into play that by the construction of the private noise in the model it is possible delegate the decision to the best informed creditor ex-ante. However, it may very well be that a quota far below $\kappa = 0.5$ is optimal if the needed amount of finance to start the project is less then the maximum characterized above. Indeed, it may even be that a quota equal to zero is optimal. Then, the conditional roll-over probabilities are both equal to one and the expected return to the creditors becomes:

$$E[U] = \frac{1}{2}(R + \underline{\theta}) \tag{43}$$

If $\frac{1}{2}(R+\underline{\theta}) > I > \alpha\bar{\theta}$ this is the optimal contract. If I is higher, κ rises accordingly. For this parameter constellation the randomized policy selection is beneficial, because it allows to sign a contract where a rational country would almost surely had selected the bad policy. A contract with $\kappa = 0$ is a long-term contract. The reason why this is possible in this context is that an infinite variance of γ implements a mixed strategy of the country even though the country is not indifferent between the two policies.

Of course, this contract lacks the main intuition of the model. Namely, the trade-off between an ex-post efficient roll-over mechansism and ex-ante incentives. More important, it seems very unlikely that a government is so irrational in its choice, or that unforeseen events play such an important role in a country's policy decision, that this contract might be of importance in the real world.

4.3 The Incentive Contract Solution

If the variance of γ is sufficiently low Π has an inner local maximum. Furthermore, higher values of Π for small y^* are more likely to be insufficient to finance sufficient investment. This is because the debtor will correctly interpret low values of y^* as an invitation to undertake the bad policy successfully. The inner incentive solution is always to the left of the incentive maximum, i.e. $argmax_{y^*}(P) > argmax_{y^*}(\Pi)$. To see this recall that at the local maximum of Π the incentive effect and the effect of decreasing conditinal roll-over probabilities are equal. Henceforth, at the local maximum of Π there is still a positve incentive effect.

Our findings so far suggest that increased policy predictability enables an incentive solution that supports a higher level of borrowing. Furthermore, it seems that an incentive contract solution is more likely to involve a higher value of y^*. This would imply that countries with a lower policy predictability would sign contracts with lower majority quotas. Although this seems surprising at first sight the intuition is quite plausible. If the country's policy decision is driven by factors outside of the contract there is no use in disciplining the debtor with a high quota.

We can also derive this connection for marginal changes in σ_γ if we impose a few restriction on the equilibrium. If we consider the first order condition $\frac{\partial \kappa}{\partial \sigma_\gamma} < 0$ would imply that the local maximum of Π moves left if σ_γ increases. This implies that a marginal increase in σ_γ decreases the first derivative of Π with respect to y^*.

$$\frac{\partial \Pi}{\partial y^* \partial \sigma_\gamma} = \frac{\partial P}{\partial \sigma_\gamma}(-f_\eta(y^* - \bar{\theta}) + f_\eta(y^* - \underline{\theta})) + \frac{\partial P}{\partial y^* \partial \sigma_\gamma}(\Pi_{good} - \Pi_{bad}) < 0 \qquad (44)$$

The condition we have to impose to know that the condition in 44 holds unambiguosly is that $y^* > \frac{\bar{\theta}+\underline{\theta}}{2}$ and that P lies in the intervall $[0.5, \Phi(1) \approx 0.841]$. The latter value is the standard cumulative density evaluated at its standard deviation. We know that $\frac{\partial P}{\partial \sigma_\gamma}$ is negative if $P > 0.5$ because the incentive effect is weakened. Furthermore, $\frac{\partial P}{\partial y^* \partial \sigma_\gamma} = \frac{\partial f_\sigma(\Delta)}{\partial \sigma_\gamma}$ is also negative if we are in the σ_γ surrounding of

$\Delta = 0$ and this is the case if $P < \Phi(1)$. It remains to show that both terms in brackets are positive. The second is always positve since the conditional roll-over probability of the good policy is always higher than of the bad policy. Finally, $f_\eta(y^* - \bar{\theta}) > f_\eta(y^* - \underline{\theta})$ is positive if $y^* > \frac{\bar{\theta}+\underline{\theta}}{2}$ which we assumed above.

On one hand these restrictions are restrictive. On the other hand they incorporate two freatures that are not that far fetched: first, that the information contained in the cut-off signal suggests that the good policy was undertaken and second, that the country is disciplined such that the prior is in an upper area. Also, one should keep in mind, that missing out on these restrictions does not reverse the effect but renders us in an area of ambiguity. The restrictions for $\frac{\partial \kappa}{\partial \sigma_\gamma} > 0$ would be that $y^* < \frac{\bar{\theta}+\underline{\theta}}{2}$ and that $P > \Phi(1)$. This is unlikely, since $y_{Pmax} > \frac{\bar{\theta}+\underline{\theta}}{2}$. Nevertheless, this can be the case if σ_γ is very small.

Another interesting parameter to look at is the signal precision σ_η. For example one would like to identify a trade-off between transparency and the tightness of the roll-over regime: a country that is delivering better information would be able to borrow with a lower quota κ. However, results of this kind cannot be derived within the framework presented here. One reason is that due to the normality of certain distributions the partial derivative of the density with respect to the variance is ambiguos. In the model this implies that the effect on the marginal conditional roll-over probabilities is ambiguos as well. In addition, if we analyze a change in the variance of the signal, we are not done by calculating $\frac{\partial y^*}{\partial \sigma}$ to analyze resulting changes in κ. A change in σ_η does not only influence y^* but also z^*, the individual optimal cutoff signal. An increase in the variance of the signal will unambiguosly increase z^*. So even if we find conditions such that a higher variance of the signal results in an equilibrium with increased y^*, we do not know the consequences on the choice of κ. One can say that each creditor tightens the screws individually if the signal precision declines. It remains elusive whether the optimal κ changes systematically.

5 Conclusion

This paper offers a framework to analyze the choice of the majority action quota in sovereign bond contracts with collective action clauses. The core argument is that debtor moral hazard can be ameliorated by choosing an appropriate quota. The paper shows that, around the equilibrium, increasing the quota has a disciplining effect on the debtor. It then shows that the optimal contract will most likely be chosen such that efficiency is maximized which also implies that the optimal level of incentives is below the maximum level.

The comparative statics of the model mostly bear ambiguos results. It is analyzed how a change in either the predictability of the debtor country's policy or the precision of the signal affect the optimal quota. The degree of policy predictability appears to have a positive effect on the quota: countries with a less transparent and predictive policy decision process tend to sign contracts with lower quotas. This seemingly odd result arises because the incentive effect from raising the quota depends on the country's predictable reaction. If the debtor does not react to a tighter contract with an increased probability to choose the good policy there is no use in making a roll-over more difficult.

A change in the signal precision is not associated with a systematic change of the optimal quota. Declining precision of the signal will lead each creditor individually to assess the roll-over decision more critically. It can however not be shown how the optimal choice of the quota is affected.

The model predicts that country specific parameters like transparency and political stability should not contribute to a large variation in the quotas specified in debt contracts with collective action clauses. This is consistent with real world experience where the quota has mostly been set around 75%. Another reason why this sort of standardisation is perceived in sovereign debt markets could lie outside of the model presented here. If the debtor has private information on some country specific factors at the time the contract is signed adverse selection becomes an issue. One could imagine that a standardization of quotas arises as a pooling equilibrium in this context.

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