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Political Economics of External Sovereign Defaults[⋆]

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Abstract

We study how excessive debt-GDP ratios affect political sustainability of prudent fiscal policy in country members of a monetary union. We develop a model with free choice of distinct rent-seeking groups to cooperate (or not) in providing public goods, in seeking rents, and in austere debt issuing through international markets. Noncooperation of rent-seeking groups on fiscal prudence triggers collective fiscal impatience: fiscal debt is issued excessively because each group expropriates extra rents before other groups do so, too. Such collective fiscal impatience leads to a vicious circle of high international interest rates and external-debt default. Our calibration suggests that debt-GDP ratios below 137% foster cooperation among rent-seeking groups, which avoids collective fiscal impatience and default. Our analysis helps in understanding the politicoeconomic sustainability of sovereign rescue packages, emphasizing the need for fiscal targets and for possible debt haircuts.

Keywords: sovereign debt, rent seeking, world interest rates, international lending, incentive compatibility, tragedy of the commons, EU crisis

JEL classification: H63, F34, F36, G01, E44, E43, D72

1. Introduction

The Maastricht treaty has been explicit about two fiscal requirements in order to justify participation in the Eurozone: (i) that the fiscal deficit-GDP ratio never exceeds 3%, and (ii) that the fiscal debt-GDP ratio never exceeds 60%. Here we investigate whether such fiscal rules go beyond narrow-minded economic accounting. Specifically, we examine whether quotas on fiscal debt-GDP ratios guarantee the political feasibility of fiscal prudence once a country is already member of a monetary union.

As Figure 1 indicates, corruption and fiscal profligacy correlate strongly across Eurozone countries, and corruption is particularly acute in the EU periphery.[1] The channel we explore is whether outstanding debt-GDP ratios affect the practices of well-organized groups within partisan politics that seek fiscal rents. In particular, we investigate whether debt-GDP ratios provide incentives to rent-seeking groups to cooperate (or not) in order to comply with fiscal-prudence practices. Our emphasis on such cooperation decisions is corroborated by excerpts of IMF country reports (see Appendix A), which refer to Eurozone countries that either received rescue packages or faced high 10-year bond spreads during the sovereign crisis. IMF monitoring experts explicitly state the need for coalition governments or for partisan cooperation in order to implement programs of controlled fiscal spending. Our model seeks to understand which economic fundamentals make such partisan cooperation possible and politically sustainable, with special emphasis on the role of debt-GDP ratios.

Table 1 shows why debt-GDP ratios may affect incentives for cooperation on prudent policies. In Table 1, the cooperation strategy is denoted by "C" and the no-cooperation strategy by "NC". If $V_i^C > V_i^{NC}$, $i \in \{1, 2\}$, i.e., if cooperation is more rewarding for

[1] The correlation coefficient between fiscal surplus/deficit-GDP ratios and the corruption perception index is 73%. Grechyna (2012) reports similar correlation results to this depicted by Figure 1, referring to OECD countries.

both players, then there are two Nash equilibria, namely, (C, C) and (NC, NC). If, instead, $V_i^C < V_i^{NC}$, $i \in \{1, 2\}$, i.e., if noncooperation is more rewarding for both players, then there are three Nash equilibria, (NC, NC), (C, NC) and (NC, C). Yet, in this second case, no cooperation is a sure outcome. Levels of debt-GDP ratios affect cooperation decisions because cooperation on fiscal prudence involves a high cost of servicing the outstanding debt. So, if debt-GDP levels are high, then, noncooperation among rent seekers, followed by default, may be more profitable for each rent-seeking group, even if default has long-term negative consequences. As the cooperation game in Table 1 shows, if the debt-GDP ratio implies lower values of cooperation for rent-seeking groups, then any chance for cooperation vanishes.

		Player 2	
		C	NC
Player 1	C	$\left(V_1^C, V_2^C\right)$	$\left(V_1^{NC}, V_2^{NC}\right)$
	NC	$\left(V_1^{NC}, V_2^{NC}\right)$	$\left(V_1^{NC}, V_2^{NC}\right)$

Table 1

Our model seeks to understand which economic fundamentals shape the values of V_i^C and V_i^{NC}, $i \in \{1, 2\}$, in games of the form given by Table 1, so as to uncover the determinants of threshold debt-GDP ratios that encourage political cooperation on fiscal prudence. To this end, we introduce the mechanism explained by the game of Table 1 in a dynamic environment with three modeling features: (i) sovereign bond rates are determined in international capital markets, (ii) rent-seeking groups jointly influence debt dynamics, government spending, and taxes, and, (iii) sovereign defaults happen because, under certain circumstances, international bond rates become prohibitively high and governments are unable or unwilling to pay.

In our model, the mechanism that gives rise to a vicious circle of high interest rates and default is the emergence of a commons problem, similar to tragedy-of-the-commons problems arising in renewable-resource conservation analysis. If two or more rent-seeking groups decide to not cooperate forever, then there is excessive debt issuing, a form of endogenous fiscal impatience. Collective impatience appears because noncooperating rent-seeking groups exploit additional resources earlier, before other groups do so as well. The higher the number of rent-seeking groups the higher the collective impatience. This impatience causes a mismatch between creditors and a government: the rate of time preference of creditors is lower than that of the borrowing government. This mismatch leads to high interest rates and immediate sovereign default. Our model also implies that after such a default the creditors never lend to the impatient government again.

A calibration exercise indicates that, if there are only two rent-seeking groups, then, above a cutoff debt-GDP ratio of about 137%, rent-seeking groups prefer to not cooperate, to default, and to never borrow from external creditors again. Extracting noncooperative rents from balanced budgets becomes preferable beyond 137%, since noncooperative rents under fiscal autarky will be higher compared to shared cooperative rents minus the servicing cost of a high debt.

Insights on the determinants of such debt-GDP-ratio cuttoff levels help in understanding the design of bailout rescue packages.[2] A binding commitment for a haircut tries to exclude an equilibrium in which rent-seeking groups would want to swing to noncooperation even for one period. Securing that debt-GDP ratios stay below such cutoff levels may contribute to the politicoeconomic sustainability of debt. We also find that international agreements (among foreign governments or by the IMF) to roll over fiscal debt using lower pre-agreed

[2] In our Online Appendix we provide evidence on observations motivating us to suggest that corruption and rent-seeking, as endemic problems in Eurozone periphery countries, play a central role as both causes and effects within the vicious circle of the Eurozone sovereign crisis.

interest rates increase the debt-GDP-ratio cutoffs that support cooperation. So, lower interest rates foster political cooperation among rent-seeking groups, making rescue packages politically feasible even at high outstanding debt-GDP ratios.[3]

Related literature includes Eaton and Gersovitz (1981), who study government borrowing in a dynamic setting, and show that lenders –taking into account the cost and benefit of default by the government– impose debt ceilings on governments. Cole and Kehoe (2000) study debt crisis that arise from a loss of confidence on governments' ability to roll over fiscal debt. Conesa and Kehoe (2012), extend Cole and Kehoe (2000) by introducing incentives for governments to default or not, gambling on the possibility of recovery of fiscal revenues. Arellano (2008) extends Eaton and Gersovitz (1981) by modelling endogenous default risk. Beetsma and Uhlig (1999) stress the importance of the stability and growth pact of the EU for the control of inflation, emphasizing a fiscal externality imposed on all countries in a monetary union. This externality is created by shortsighted policy makers who issue excessive debt in anticipation of loosing office. Roch and Uhlig (2011) combining the insights of Cole and Kehoe (2000), Arellano (2008) and Beetsma and Uhlig (1999), characterize debt dynamics and study bailouts of troubled countries. Yue (2010) introduces debt renegotiation after a default to rationalize the levels of debt reduction in emerging economies observed in the data. Our paper differs from all the above in that we focus on the political-economic aspects of sovereign debt. We do so from a new angle that we believe captures important features of fiscal policy making in the EU periphery countries. Finally, our rent-seeking mechanism reminds of the one used in Tornell and Lane (1999), yet we do not have endogenous growth or international trade of productive capital in our model, as we

[3] High interest rates make the servicing burden of new debt socially unsustainable as it implies higher taxes and/or lower public consumption, reducing welfare. Our model's mechanics are compatible with these features, which perhaps explain the stated rationale behind bailouts: the need to make the servicing costs of debt socially and politically bearable. Indeed, one feature of bailout plans in the EU is the tool of lowering interest rates.

focus on sovereign debt, introducing the option of cooperation among rent seekers.

2. Model

2.1 The domestic economy

2.1.1 Production

The domestic economy is populated by a large number of identical infinitely-lived agents of total mass equal to 1. A single composite consumable good is produced under perfect competition, using labor as its only input through the linear technology,

$$y_t = z_t \cdot l_t \ , \tag{1}$$

in which y is units of output, l is labor hours, and z is productivity. Assume that there is no uncertainty and that productivity at time 0 is $z_0 > 0$, growing exogenously at rate γ, i.e.,

$$z_t = (1+\gamma)^t z_0 \ . \tag{2}$$

2.1.2 Non rent-seeking households

A representative non rent-seeking household (one among a large number of such households) draws utility from private consumption, c, leisure, $1-l$ (a household's time endowment per period is equal to 1), and also from the consumption of a public good, G, maximizing the life-time utility function

$$\sum_{t=0}^{\infty} \beta^t \left[\ln(c_t) + \theta_l \ln(1-l_t) + \theta_G \ln(G_t)\right] \ , \tag{3}$$

in which $\beta \in (0,1)$ is the utility discount factor, while $\theta_l, \theta_G > 0$ are the weights on leisure and public consumption, G, in the utility function. Public consumption is financed via both income taxes and fiscal debt. Yet, for simplicity, we assume that agents in this economy cannot hold any government bonds, so fiscal debt is external in all periods. Finally, we assume that agents cannot have access to domestic government bonds in the future, and that there is no storage technology. Under these assumptions, the budget constraint of an individual household is,

$$c_t = (1 - \tau_t)\, z_t l_t \ . \tag{4}$$

The representative non-rent-seeking household maximizes its lifetime utility given by (3), subject to equation (4), by choosing the optimal stream of consumption and labor supply throughout the infinite horizon, $(\{(c_t, l_t)\}_{t=0}^{\infty})$, subject to any given stream of tax rates and public-good quantities, $\{(G_t, \tau_t)\}_{t=0}^{\infty}$. Since the solution to this problem is based on intra-temporal conditions only, we obtain a simple formula, namely,

$$l_t = \frac{1}{1+\theta_l} = L \ , \quad t = 0, 1, ... \ , \tag{5}$$

with L being both the individual and the aggregate labor supply. That labor supply does not respond to changes in marginal tax rates is due to using logarithmic utility. Under logarithmic utility the income and substitution effects of taxation on leisure cancel each other out.

2.1.3 Rent-seeking groups and rent-seeking households

We introduce N rent-seeking groups in the domestic economy. These groups have the power to expropriate resources from the fiscal budget. In each period $t \in \{0, 1, ...\}$, a rent-seeking group $j \in \{1, ..., N\}$ manages to extract a total rent of size $C_{j,t}^R$. While total population in the economy has normalized size 1, the population mass of each rent-seeking group is μ_j with $\sum_{j=1}^{N} \mu_j < 1$. In each rent seeking group there is a large number of individuals, with each individual being unable to influence the group's aggregate actions. Let all households participating in a rent-seeking group j be identical within the group for all $j \in \{1, ..., N\}$, and having equal shares of private individual rents, $c_{j,t}^R$.

We assume that consumption, $c^R_{j,t}$, due to participation in a rent-seeking group is a differentiated good from the typical consumer basket intended for private consumption, c. Units of $c^R_{j,t}$ correspond to various in-kind private benefits specific to rent-seeking unions, for example, subsidies for gasoline, housing benefits, etc.

An individual rent seeker who is a member of $j \in \{1, ..., N\}$ does not control the level of consumption $c^R_{j,t}$ that she obtains from the group through any form of private effort or cost.[4] So, the utility function of this individual rent-seeker of group j is,

$$\sum_{t=0}^{\infty} \beta^t \left[\ln(c_{j,t}) + \theta_l \ln(1 - l_{j,t}) + \theta_G \ln(G_t) + \theta_R \ln\left(c^R_{j,t}\right) \right] \ , \tag{6}$$

with $\theta_R > 0$, and her economic problem is maximizing (6) subject to the budget constraint

$$c_{j,t} = (1 - \tau_t)\, z_t l_{j,t} \ . \tag{7}$$

Optimal choices for a rent seeker are given by,

$$l_{j,t} = l_t = \frac{1}{1 + \theta_l} = L \ , \quad t = 0, 1, ... \ . \tag{8}$$

Since labor supply is identical across rent seekers and non rent seekers, private consumption is also the same across rent seekers and non rent seekers, namely,

$$c_{j,t} = c_t = (1 - \tau_t)\, z_t L \ . \tag{9}$$

2.1.4 Aggregate production and fiscal budget

Combining L with (1) and (2) gives the competitive-equilibrium GDP level,

$$Y_t = (1 + \gamma)^t \, z_0 L \ . \tag{10}$$

[4] We assume that even if rent-seeking groups have to lobby, this is a costless collective action: it requires no individual effort or any other sacrifice.

For simplicity, we assume that the domestic government issues only one-period zero coupon bonds. So, in every period there is a need for full debt rollover to the next period.[5] The government's budget constraint is,

$$\frac{B_{t+1}}{1+r_{t+1}} = B_t + G_t + \sum_{j=1}^{N} C_{j,t}^{R} - \tau_t Y_t \ , \tag{11}$$

in which Y_t is aggregate production in period t, B_{t+1} is the value of newly issued bonds in period t that mature in period $t+1$, evaluated in terms of the consumable good in period $t+1$, and r_{t+1} is the interest rate which reflects the intrinsic return of a bond maturing in period $t+1$. Assuming that the one-year zero-coupon bond delivers one unit of the consumable good at maturity, B_t reflects the quantity of bonds maturing in period t. In (11) we have also assumed that the price per unit of $c_{j,t}^{R}$ equals the consumer-basket price.

2.1.5 Impact of tax rates on GDP performance versus impact of tax rates on welfare

The absence of any marginal tax rates in equation (10) demonstrates that our logarithmic-utility setup neutralizes the impact of taxes on GDP performance and rules out dynamic Laffer curves. While taxes do not affect GDP performance, they directly reduce consumption and utility (see equation (4)). So, taxes have a profound impact on welfare. Also, despite that taxes do not have the classic distortionary effects on GDP performance, our analysis does not rule out considerations about an economy's ability to repay fiscal debt. As it will be clear later, international interest rates at which a country borrows externally influence its ability to repay fiscal debt in the future. It is an analytical advantage that our model clearly distinguishes the impact of interest-rate pressure on the ability to repay from other factors affecting GDP performance.

[5] This assumption of issuing exclusively one-year zero-coupon bonds rules out concerns about strategic supply of bonds with different maturity. The short maturity time of bonds does not affect our qualitative results.

2.1.6 Policy-setting mechanism

The levels of fiscal spending, G_t, the tax rate, τ_t, and the level of debt one period ahead B_{t+1}, are the Nash equilibrium of a dynamic game among rent-seeking groups, which also determines its extracted rents in each period. There is no explicit majority voting on these policy variables, assuming that all existing rent-seeking groups actively and simultaneously influence policy making in each period. We do not model alternating political parties and associated rent-seeking groups in power, as this would complicate the derivation of equilibrium without adding insights to the model. Having all rent-seeking groups acting simultaneously conveys the mechanics of a commons problem adequately: a rent-seeking group tends to expropriate extra rents before other groups do so as well. The qualitative equivalence of asynchronous fiscal profligacy to a commons problem with simultaneous moves is demonstrated by Persson and Svensson (1989).

In addition, there is no within-type heterogeneity across rent seekers and non-rent seekers. We assume that rent-seekers have established their political influence which has become a structural feature of policy making.

2.1.7 Policy setting with exogenous interest rates and without the option of cooperation

If rent-seeking groups were not present, a social planner would set policies so as to maximize the utility of a representative non-rent-seeking household.[6] Such a policy-setting concept, based on maximizing social welfare, would reflect the need of political support for any proposed policies. In the presence of rent-seeking groups, fiscal policy is set by these rent-seeking

[6] Without rent-seeking groups, a social planner would substitute the competitive-equilibrium solution given by equations (5) and (10) into (3), and would proceed by maximizing the resulting indirect-utility function by choosing $\{(\tau_t, B_{t+1})\}_{t=0}^{\infty}$, after having imposed the fiscal-budget constraint given by (11) and a transversality condition for fiscal debt.

groups, with each group maximizing the group's utility, subject to the rent-seeking behavior of other rent-seeking groups. In particular, rent-seeking groups compete noncooperatively with other groups for rents. At the same time, rent-seeking groups ensure that they have the support of the broader public. In order to gain the support of the broader public, each rent-seeking group $j \in \{1, ..., N\}$ maximizes a convex combination of, (i) the sum of individual utilities of non rent seekers and, (ii) the group's utility derived by the stream of the group's consumption $\left\{C_{j,s}^{R}\right\}_{s=t}^{\infty}$.

We focus on time-consistent (Markovian) policies and rent-extraction strategies. For an exogenous stream of international-market interest rates, $\{r_s\}_{s=t+1}^{\infty}$, the Bellman equation of rent-seeking group $j \in \{1, ..., N\}$ is given by,

$$\hat{V}^j\left(B_t, z_t \mid \left\{\mathbb{C}_i^R\right\}_{\substack{i=1\\i\neq j}}^{N}, \{r_s\}_{s=t+1}^{\infty}\right) = \max_{\left(\tau_t, C_{j,t}^R, B_{t+1}\right)} \left\{\theta_l \ln(1-L) + \ln(z_t) + \ln(1-\tau_t)\right.$$

$$+\theta_G \ln\left[\frac{B_{t+1}}{1+r_{t+1}} - \left(B_t + C_{j,t}^R + \sum_{\substack{i=1\\i\neq j}}^{N} \mathbb{C}_i^R\left(B_t, z_t \mid \{r_s\}_{s=t}^{\infty}\right) - \tau_t Y_t\right)\right] + \theta_R \ln\left(C_{j,t}^R\right)$$

$$\left. +\beta \hat{V}^j\left(B_{t+1}, (1+\gamma) z_t \mid \left\{\mathbb{C}_i^R\right\}_{\substack{i=1\\i\neq j}}^{N}, \{r_s\}_{s=t+2}^{\infty}\right)\right\}, \quad (12)$$

in which $\mathbb{C}_i^R\left(B_t, z_t \mid \{r_s\}_{s=t}^{\infty}\right)$ is the Markov-Perfect rent-extraction strategy of rent-seeking group $i \in \{1, ..., N\}$. Given a pre-specified stream of interest rates,

> **Definition 1** *Given a stream of interest rates, $\{r_s\}_{s=t+1}^{\infty}$, a (Markov-Perfect) Domestic Equilibrium under No Cooperation (DENC) is a set of strategies, $\left\{\mathbb{C}^{i,R}\right\}_{i=1}^{N}$ of the form $C_{i,t}^R = \mathbb{C}_i^R\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)$ and a set of policy decision rules $\{\mathbb{T}, \mathbb{B}\}$ of the form $\tau_t = \mathbb{T}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)$ and $B_{t+1} = \mathbb{B}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)$, such that each and every rent seeking group $j \in \{1, ..., N\}$ maximizes (12) subject to $\{\mathbb{T}, \mathbb{B}\}$, and $\left\{\mathbb{C}_i^R\right\}_{i\neq j}$.*

We assume symmetry in political influence and size of groups, namely,

$$\mu_j = \mu \quad \text{for all } j \in \{1, ..., N\} \ . \tag{13}$$

2.1.8 Exact Domestic Noncooperative solution

Proposition 1 summarizes the rent-seeking political equilibrium for a given set of interest rates.

Proposition 1 *For all $t \in \{0, 1, ...\}$, given a stream of interest rates, $\{r_s\}_{s=t+1}^{\infty}$, there exists a symmetric DENC given by,*

$$\frac{G_t}{Y_t} = \frac{(1-\beta)\,\theta_G}{1+\theta_G+\theta_R+(N-1)(1-\beta)\,\theta_R}\left[\underbrace{\frac{z_t \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)}{Y_t}}_{\text{Economy's worth/GDP}} - \underbrace{\frac{B_t}{Y_t}}_{\text{Fiscal debt/GDP}}\right] , \tag{14}$$

in which

$$\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right) = \left[\prod_{s=t+1}^{\infty}\frac{1}{1+\tilde{r}_s} + 1 + \sum_{s=t+1}^{\infty}\frac{1}{\prod_{j=t+1}^{s}(1+\tilde{r}_j)}\right]\cdot L \ , \tag{15}$$

with

$$1+\tilde{r}_t \equiv \frac{1+r_t}{1+\gamma} \ ,$$

while

$$\tau_t = \mathbb{T}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right) = 1 - \frac{1}{\theta_G}\frac{G_t}{Y_t} \ , \tag{16}$$

$$\mathbb{C}_i^R\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right) = \mathbb{C}^R\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right) =$$
$$= \frac{(1-\beta)\,\theta_R}{1+\theta_G+\theta_R+(N-1)(1-\beta)\,\theta_R}\cdot\underbrace{\left[z_t\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right) - B_t\right]}_{\text{Economy's net worth}} , \tag{17}$$

for all $i \in \{1, ..., N\}$, while,

$$\frac{B_{t+1}}{Y_{t+1}} = \frac{\mathbb{B}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)}{Y_{t+1}} =$$

$$= \frac{1 + r_{t+1}}{1 + \gamma} \left[\beta_N \frac{B_t}{Y_t} + (1 - \beta_N) \frac{z_t \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right)}{Y_t} - 1 \right] , \tag{18}$$

with

$$\beta_N = \frac{1 + \theta_G + \theta_R}{1 + \theta_G + \theta_R + (N - 1)(1 - \beta)\theta_R} \beta , \tag{19}$$

Proof See Appendix B. □

2.1.9 International interest rates, chosen policies, and the ability to repay sovereign debt

Equation (14) is intuitive. Notice that $\partial \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right) / \partial r_s < 0$ for all $s \geq t + 1$ and all $t \in \{0, 1, ...\}$, according to equation (15). This reduction in economy's worth $\left(z_t \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right) / Y_t \right)$ which occurs due to the increase in any future period's interest rate, affects all policies. Any interest-rate increase reduces G_t/Y_t (see (14)), it increases tax rates (see (16)), and it also reduces rents (see (17)). Most importantly, any interest-rate increase reduces the economy's ability to repay sovereign debt through collecting taxes.

The role of increasing the debt-GDP ratio is exactly the same as an interest-rate increase. The term B_t/Y_t in equations (18), (14), (16), and (17), reveals that future taxes must pay back the outstanding sovereign debt-GDP ratio, which also contributes to reducing G_t/Y_t and rents, and to increasing tax rates.

2.1.10 Postponed fiscal prudence and the number of rent-seeking groups: fiscal impatience due to a commons problem

Equation (18) conveys the presence of fiscal prudence in this model. Next period's optimal debt-GDP ratio decreases if future interest rates are foreseen to increase. Since $\partial \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right) / \partial r_s < 0$ for all $s \geq t+1$, equation (18) implies that next period's debt-GDP ratio falls, because of the foreseen increase in rolling over debt issued in the future.

Policy setting by multiple noncooperating rent-seeking groups has a profound effect on postponing fiscal prudence. Since $\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)$ is multiplied by the factor $(1-\beta_N)$, and $\partial\left(1-\beta_N\right)/\partial N > 0$ (see equation (19)), an increase in the number of rent-seeking groups strengthens the fiscal-prudence-postponement characteristic. Postponement of fiscal prudence stems from two opposing forces. On the one hand, rent-seeking groups want to conserve the fiscal budget, in order to be able to extract more in the future. So, they exhibit fiscal prudence by having the optimal next period's debt-GDP ratio strategy depending positively on the term $\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)$ with $\partial\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)/\partial r_s < 0$ for all $s \geq t+1$. On the other hand, as the number of rent-seeking groups increases, fiscal debt is issued excessively today, as is revealed by equation (17): after calculating aggregate rents,

$$\sum_{i=1}^{N}\mathbb{C}_i^R\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right) = N\cdot\mathbb{C}^R\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)$$

$$= \underbrace{\frac{N\cdot(1-\beta)\,\theta_R}{1+\theta_G+\theta_R+(N-1)(1-\beta)\,\theta_R}}_{\Phi(N)}\cdot\underbrace{\left[z_t\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)-B_t\right]}_{\text{Economy's net worth}} \tag{20}$$

we notice that the fraction of economy's net worth expropriated by all rent-seeking groups is increasing in the number of (symmetric) groups ($\Phi'(N) > 0$ in equation (20)). Aggregate rents increase in the number of rent-seeking groups because each noncooperating rent-seeking group expropriates additional rents before other groups do so, too. This effect, driven by $\Phi'(N) > 0$, leads to collective fiscal impatience across rent-seeking groups that do not cooperate, describing a classic commons problem, in a similar fashion to problems of resource conservation. This commons problem dominates, and leads to fiscal-prudence postponement.

Yet, this dynamic game has another set of players, the external creditors. Fiscal-prudence postponement due to an increase in the number of noncooperating rent-seeking groups is a central reason why external creditors may require extra compensation through suggesting higher interest rates in order to roll fiscal debt over to the next period. This mechanism is clarified after putting supply and demand together in the bonds market in order to determine international interest rates.

2.2 The external creditors

We denote all external-creditor variables using a star. For simplicity, assume that external creditors only hold bonds from one country, and maximize their total life-time utility derived from consumption,

$$\sum_{s=t}^{\infty} \beta^{(s-t)} \ln\left(c_s^*\right) \tag{21}$$

subject to the budget constraint,[7]

$$B_{s+1}^* = \left(1 + r_{s+1}\right)\left(B_s^* - c_s^*\right) \ . \tag{23}$$

Notice that the rate of time preference, $(1-\beta)/\beta$, in the utility function of creditors, (21), is equal to the rate of time preference of domestic households.

The solution to the problem of maximizing (21) subject to (23) is,

$$c_t^* = (1-\beta) B_t^* \quad c_s^* = (1-\beta)\beta^{(s-t)} \prod_{i=t+1}^{s} \left(1 + r_i\right) B_s^* \ , \ s = t+1, t+2, \ldots \ ,$$

which implies,

$$B_{t+1}^* = \beta\left(1 + r_{t+1}\right) B_t^* \ . \tag{24}$$

[7] Notice that in case creditors held bonds from M different countries, the budget constraint given by equation (23) would be, instead,

$$\sum_{j=1}^{M} \frac{B_{j,s+1}^*}{1 + r_{j,s+1}} = \sum_{j=1}^{M} B_{j,s}^* - c_s^* \ , \quad s = t, t+1, \ldots \ , \tag{22}$$

in which $B_{j,s}^*$ is the outstanding debt of country $j \in \{1, \ldots, M\}$ and $r_{j,s+1}$ is the interest rate that markets give to country j's debt. The interior solution to maximizing (21) subject to (22) is characterized by $c_{s+1}^*/c_s^* = \beta\left(1 + r_{j,s+1}\right)$, which implies that the interest rate is the same across all countries ($r_{j,s+1} = r_{i,s+1}$ for all $i, j \in \{1, \ldots, M\}$). All crucial features of the demand function and the implied interest rates for any specific country $j \in \{1, \ldots, M\}$ resulting from maximizing (21) subject to (22) are not affected by the presence of other countries. For simplicity we assume that there is only one country with external fiscal debt. Evidently, the budget constraint given by (23) is a special case of (22) for $M = 1$.

Equation (24) determines the demand for bonds by external creditors in period $t+1$. Logarithmic preferences are responsible for this compact algebraic solution given by (24), which implies that demand for external debt in period 1 depends only on the return of bonds issued in period t and maturing in period $t+1$, r_{t+1}.[8]

2.3 Determining interest-rate levels if rent-seeking groups always cooperate

We examine the case in which $N \geq 2$ rent-seeking groups cooperate by forming a single government coalition comprised by all existing rent-seeking groups in the economy (universal coalition). Within this universal coalition, rent-seeking groups equally share a total amount of rents, C_t^R, with each group receiving C_t^R/N in each period. We derive the supply of bonds decided by such a coalition and we equate it to the demand for bonds by external creditors in order to calculate international interest rates.

The Bellman equation of rent-seeking group $j \in \{1, ..., N\}$ under cooperation is given by,

$$V^{C,j}(B_t, z_t) = \max_{\left(\tau_t, C_t^R, B_{t+1}\right)} \left\{ \theta_l \ln(1-L) + \ln(z_t) + \ln(1-\tau_t) \right.$$
$$+ \theta_G \ln\left[\frac{B_{t+1}}{1+R^C(B_t, z_t)} - \left(B_t + C_t^R - \tau_t Y_t\right)\right] + \theta_R \ln\left(\frac{C_t^R}{N}\right)$$
$$\left. + \beta V^{C,j}\left(B_{t+1}, (1+\gamma) z_t\right) \right\}, \quad (25)$$

[8] Without logarithmic utility, the typical decision rule determining the demand of bonds in period 1 is of the form $B_{t+1}^* = h\left(\{r_s\}_{s=t+1}^{\infty}, B_t^*\right)$, i.e., it depends on all future interest rates, $\{r_s\}_{s=t+1}^{\infty}$. In the special case of logarithmic utility, h is of the more restricted form $h\left(\{r_s\}_{s=t+1}^{\infty}, B_t^*\right) = \tilde{h}(r_{t+1}, B_t^*) = \beta(1+r_{t+1}) B_t^*$. That $\tilde{h}(r_{t+1}, B_t^*)$ is independent from any interest-rate changes in the continuation stream $\{r_s\}_{s=t+2}^{\infty}$ does not mean that creditors with logarithmic preferences are not forward-looking any more. It is that income- and substitution effects on consumption/savings cancel each other out one-to-one, for all future transition paths under logarithmic utility. So, under (21), the effects of any continuation stream $\{r_s\}_{s=t+2}^{\infty}$ only reflect the impact of the constant rate of time preference on current decisions, through the presence of the discount factor, β, in $\tilde{h}(r_{t+1}, B_t^*) = \beta(1+r_{t+1}) B_t^*$.

in which the interest-rate rule, $r_{t+1} = R^C(B_t, z_t)$, is determined by equating supply and demand in the international market for bonds. Due to the symmetry of rent-seeking groups there is unanimity within the universal coalition, with the values driving all decisions, $\left(\tau_t, C_t^R, B_{t+1}, G_t\right)$, corresponding to the value function $V^{C,j}(B_t, z_t)$ of (25). Definition 2 specifies international-market equilibrium under cooperation of rent-seeking groups.

Definition 2 *An International Equilibrium under Cooperation (IEC) is a set of strategies, $\mathbb{C}^{R,C}$ of the form $C_t^{R,C} = \mathbb{C}^{R,C}(B_t, z_t)$ and a set of policy decision rules $\left\{\mathbb{T}^C, \mathbb{G}^C, \mathbb{B}^C\right\}$ of the form $\tau_t = \mathbb{T}^C(B_t, z_t)$, $G_t = \mathbb{G}^C(B_t, z_t)$, and $B_{t+1} = \mathbb{B}^C(B_t, z_t)$, a bond-demand strategy of creditors, $B_{t+1}^* = \mathbb{B}^*(B_t, z_t)$, and an interest-rate rule, $R^C(B_t, z_t)$, such that $\left\{\mathbb{T}^C, \mathbb{B}^C, \mathbb{C}^{R,C}, \mathbb{G}^C\right\}$ guarantee that each and every rent seeking group $j \in \{1, ..., N\}$ maximizes (25), subject to rule $R^C(B_t, z_t)$, creditors' $\mathbb{B}^*$ complies with equation (24), and with $R^C(B_t, z_t) = r_{t+1}$ satisfying $\mathbb{B}^C(B_t, z_t) = \mathbb{B}^*(B_t, z_t)$, for all $t \in \{0, 1, ...\}$.*

2.3.1 Exact International Cooperative solution

Proposition 2 characterizes the rent-seeking political equilibrium under cooperation among rent-seeking groups (IEC).

Proposition 2 *For all $t \in \{0, 1, ...\}$, the IEC interest rates are constant, given by,*

$$R^C(B_t, z_t) = r^{ss} = \frac{1+\gamma}{\beta} - 1 \ , \quad t = 0, 1, ... \ , \tag{26}$$

the debt-GDP ratio remains constant over time,

$$\frac{\mathbb{B}^C(B_t, z_t)}{Y_t} = \frac{B_t}{Y_t} \equiv b_t^C = b_0 \equiv \frac{B_0}{Y_0} \ , \quad t = 0, 1, ... \ , \tag{27}$$

the public-consumption-to-GDP ratio, the rents-to-GDP ratio and the tax rate, all remain constant over time, with,

$$\frac{\mathbb{G}^{C}\left(B_{t},z_{t}\right)}{Y_{t}}\equiv g_{t}^{C}=\bar{g}^{C}=\frac{\left(1-\beta\right)\theta_{G}}{1+\theta_{G}+\theta_{R}}\left[\underbrace{\frac{1}{1-\beta}}_{\text{Economy's worth/GDP}}-\underbrace{b_{0}}_{\text{Fiscal debt/GDP}}\right]\ ,\quad t=0,1,\ldots\ , \tag{28}$$

$$\frac{\mathbb{C}^{R,C}\left(B_{t},z_{t}\right)}{Y_{t}}=\frac{\theta_{R}}{\theta_{G}}\bar{g}^{C}\ ,\quad\text{and}\ \ \mathbb{T}^{C}\left(B_{t},z_{t}\right)=\tau_{t}^{C}=\bar{\tau}^{C}=1-\frac{1}{\theta_{G}}\bar{g}^{C}\ ,\quad t=0,1,\ldots\ . \tag{29}$$

Proof See Appendix B. □

2.4 Determining interest-rate levels if rent-seeking groups never cooperate

The Bellman equation of rent-seeking group $j\in\{1,...,N\}$ under no cooperation is given by,

$$V^{NC,j}\left(B_{t},z_{t}\mid\left\{\mathbb{C}_{i}^{R,NC}\right\}_{\substack{i=1\\i\neq j}}^{N}\right)=\max_{\left(\tau_{t},C_{j,t}^{R},B_{t+1}\right)}\Bigg\{\theta_{l}\ln\left(1-L\right)+\ln\left(z_{t}\right)+\ln\left(1-\tau_{t}\right)$$
$$+\theta_{G}\ln\left[\frac{B_{t+1}}{1+R^{NC}\left(B_{t},z_{t}\right)}-\left(B_{t}+C_{j,t}^{R}+\sum_{\substack{i=1\\i\neq j}}^{N}\mathbb{C}_{i}^{R,NC}\left(B_{t},z_{t}\right)-\tau_{t}Y_{t}\right)\right]$$
$$+\theta_{R}\ln\left(C_{j,t}^{R}\right)+\beta V^{NC,j}\left(B_{t+1},\left(1+\gamma\right)z_{t}\mid\left\{\mathbb{C}_{i}^{R,NC}\right\}_{\substack{i=1\\i\neq j}}^{N}\right)\Bigg\} \tag{30}$$

in which $r_{t+1}=R^{NC}\left(B_{t},z_{t}\right)$ is the interest-rate rule. Definition 3 specifies international-market equilibrium under noncooperation of rent-seeking groups.

Definition 3 *An International Equilibrium under No Cooperation (IENC) is a set of strategies,* $\left\{\mathbb{C}_{i}^{R,NC}\right\}_{i=1}^{N}$ *of the form* $C_{i,t}^{R,NC}=\mathbb{C}_{i}^{R,NC}\left(B_{t},z_{t}\right)$ *and a* *set of policy decision rules* $\left\{\mathbb{T}^{NC},\mathbb{G}^{NC},\mathbb{B}^{NC}\right\}$ *of the form* $\tau_t = \mathbb{T}^{NC}(B_t, z_t)$, $G_t = \mathbb{G}^{NC}(B_t, z_t)$, *and* $B_{t+1} = \mathbb{B}^{NC}(B_t, z_t)$, *a bond-demand strategy of creditors,* $B^*_{t+1} = \mathbb{B}^*(B_t, z_t)$, *and an interest-rate rule,* $R^{NC}(B_t, z_t)$, *such that* $\left\{\mathbb{T}^{NC},\mathbb{B}^{NC},\mathbb{C}^{R,NC},\mathbb{G}^{NC}\right\}$ *guarantee that each and every rent seeking group* $j \in \{1, ..., N\}$ *maximizes (30), subject to rule* $R^{NC}(B_t, z_t)$ *and subject to strategies of other rent-seeking groups* $\left\{\mathbb{C}_i^{R,NC}\right\}_{\substack{i=1\\i\neq j}}^{N}$, *creditors'* $\mathbb{B}^*$ *complies with equation (24), and with* $R^{NC}(B_t, z_t) = r_{t+1}$ *satisfying* $\mathbb{B}^{NC}(B_t, z_t) = \mathbb{B}^*(B_t, z_t)$, *for all* $t \in \{0, 1, ...\}$.

2.4.1 Exact International Equilibrium Under No Cooperation

Proposition 3 conveys the key feature of our model.

Proposition 3 *If* $N \geq 2$, *the only possible IENC is immediate full debt default without return to credit markets again.*

Proof See Appendix B. □

The formal proof of Proposition 3 is extensive. Yet, the key behind the default result given by Proposition 3 is the endogenous impatience mechanics that we have already stressed for the domestic equilibrium under no cooperation (DENC) through Proposition 1. Specifically, the endogenous factor β_N, specified by equation (19), which implies $\partial\beta_N/\partial N < 0$, causes a mismatch in the market-clearing equation of external debt. Specifically, external creditors foresee that multiple rent-seeking groups have the tendency to issue debt excessively in all periods. So, external creditors understand that the domestic economy will be unable to repay the debt asymptotically. As a result, external creditors suggest to roll over debt at a sequence of high interest rates that oblige the domestic economy to provide its total worth to creditors asymptotically. So, the domestic economy can do nothing but default. An equivalent way of stating this result: external creditors are unwilling to lend a country in which effective impatience for debt issuing does not match the rate of time preference of creditors.

In brief, when $N \geq 2$, the endogenous-fiscal-impatience aspect of the commons problem arising among rent-seeking groups, is responsible for the immediate sovereign default. Furthermore, if this noncooperation among rent-seeking is permanent, then permanent is also the exit of the domestic economy from external-debt markets.

3. Debt-GDP ratios and participation in a monetary union: implications for rescue packages

Participation in a sustainable monetary union implies that fiscal debt is paid back in the common currency. The ability of each member state to issue and sustain external fiscal debt is crucial for the sustainability of a banking system in which foreign banks may play the role of external creditors. While we do not model banks explicitly, we stress that an international agreement about either, (a) entrance into a monetary union, or (b) a rescue package for debt rollover of a member state, should guarantee that rent-seeking groups which tend to act separately, should have incentives to cooperate forever. Here we focus on (b), a rescue package which aims at a particular agreement: that rent-seeking groups will commit to a non-default and that they will be cooperating forever, sharing their rents.[9]

3.1 Two rent-seeking groups and Markov-perfect-Nash -equilibrium selection

Even in the one-stage, normal-form game of cooperation decisions, presented by Table 1 in the Introduction, there are multiple Nash equilibria. If cooperation is less rewarding for both

[9] This focus of ours is inspired by the rescue packages of the post-2009 sovereign-debt crisis which emphasized the target of no defaults, because of fears of "domino effects" on previously rescued banks.

players ($V_i^C < V_i^{NC}$, $i \in \{1,2\}$), then a cooperation outcome is impossible. The only way to make a cooperation outcome possible is to ensure that cooperation is more rewarding for both players ($V_i^C > V_i^{NC}$, $i \in \{1,2\}$). Here we show that in a dynamic game, $V_i^C > V_i^{NC}$, $i \in \{1,2\}$, hinges on the debt-GDP ratio level.

A dynamic game with infinite horizon and a free option to cooperate or not in each period can have multiple equilibria as well, even if we restrict our attention to Markov-perfect cooperation-decision Nash equilibria.[10] Yet, Propositions 2 and 3, together with Table 1, illuminate that the strategies according to which two rent-seeking groups either, (i) cooperate forever, or (ii) never cooperate and default, in which case they keep not cooperating forever under a balanced fiscal budget, are both Markov-perfect cooperation-decision Nash equilibria.[11]

Let's start examining case (ii) above, i.e., default with no cooperation before and afterwards. Moving one period ahead after the full default, debt remains 0 forever (see Proposition 3), and the game is not a dynamic game anymore, but similar to the normal-form game of cooperation decisions, with the sole difference that GDP grows exogenously and sums of discounted utilities over an infinite horizon are computed. After some algebra, we find that

$$V^{C,j}\left(B_t = 0, z_t\right) > V^{NC,j}\left(B_t = 0, z_t \mid \left\{\mathbb{C}_i^{R,NC}\right\}_{\substack{i=1\\ i\neq j}}^{2}\right) \Leftrightarrow 1+\alpha > 2^{\alpha} \ , \tag{31}$$

$j \in \{1,2\}$ in which,

$$\alpha \equiv \frac{\theta_R}{1+\theta_G+\theta_R} \ . \tag{32}$$

By its definition, $\alpha \in (0,1)$, and it is straightforward to verify that $1+\alpha > 2^{\alpha}$ is a true statement for all $\alpha \in (0,1)$. So, $V^{C,j}(0, z_t) > V^{NC,j}(0, z_t)$ for $j \in \{1,2\}$ and all $t \in \{1, 2, ...\}$.

[10] Definition B.1 in Appendix B states formally the concept of a Markov-perfect cooperation-decision Nash equilibrium.

[11] A formal proof of this claim, that strategies (i) and (ii) are both Markov-perfect cooperation-decision equilibriums, appears in the proof of Proposition 4 in Appendix B.

As we have noticed above for the normal-form game, whenever cooperation is more rewarding for both players, then there are two Nash equilibria, (C, C) and (NC, NC). So, by the unimprovability principle (cf. Kreps 1990, pp. 812-813), the strategies described by (ii) above, no cooperation in period 0, immediate default and no cooperation thereafter forever, is a Markov-perfect Nash equilibrium.

Having established that no cooperation and default is a Markov-perfect Nash equilibrium allows us to study a sovereign-debt rescue initiative in a monetary union more formally. Specifically, other member states may consider no cooperation among rent-seeking groups and sovereign default as being the worst possible outcome in a period that banks are fragile. The reason is that the magnitude of a full default by a sovereign state may be a big shock for banks holding external debt in the monetary union.[12] In addition, convincing rent-seeking groups to follow a strategy of cooperation forever, in order to avoid the problems of fiscal impatience and fiscal profligacy is the most desirable outcome. Proposition 4 establishes that this cooperation equilibrium is a Markov-perfect Nash equilibrium, and it identifies the debt-to-GDP ratios that make its adoption and enforceability desirable by two rent-seeking groups.

Proposition 4 *If $N = 2$, then the strategies according to which the two rent-seeking groups cooperate forever is a Markov-perfect cooperation-decision Nash equilibrium, which holds if,*

$$V^{C,j}\left(B_t, z_t\right) \geq V^{NC,j}\left(B_t = 0, z_t \mid \left\{\mathbb{C}_i^{R,NC}\right\}_{\substack{i=1 \\ i \neq j}}^{2}\right) \Leftrightarrow b_t \leq \frac{1}{1-\beta}\left(1 - \frac{2^{\alpha}}{1+\alpha}\right) \equiv \underline{b}\ , \tag{33}$$

for all $t \in \{0, 1, ...\}$, in which α is given by (32).

[12] We use the example of bank fragility only as motivation for this equilibrium selection. An extension in which banks are explicitly modeled is beyond the scope of this paper.

Proof See Appendix B. $\square$

In Proposition 4 notice the converse of (33): if the debt-GDP ratio is higher than a threshold level, $\underline{b}$, then rent-seeking groups have higher utility by defaulting and not cooperating ever after. This is reasonable, because paying back the debt and cooperating entails a tradeoff: on the one hand, rent-seeking groups can divide the coalition rents by two, which leads to rewards in each period, as (31) reveals; on the other hand, they have to bear the cost of servicing the debt. The higher the debt-GDP ratio the lower the cooperation benefits, so default strikes as a better option.

3.1.1 Rescue packages and sovereign-debt haircuts

EU rescue packages imply monitoring of the domestic economy's rent-seeking groups by other member states of the monetary union. Monitoring the ability of a government to satisfy the conditions of a rescue package involves preventing and eliminating excessive rent seeking by groups that influence policymaking. This focus on controlling the behavior of partisan corruption is evident in IMF-report excerpts outlined in Appendix A. Yet, in order to be proactive, it is reasonable to try to make the rescue deal palatable to the rent-seeking groups in order to achieve political sustainability and robustness of the rescue-package deal. So, if b_t is larger than the threshold given by (33), $\underline{b} = \left[1 - 2^{\alpha} / (1 + \alpha)\right] / (1 - \beta)$, then the rescue-package deal may involve a sovereign-debt haircut of magnitude $100 \cdot (b_t - \underline{b})$ percentage points of the domestic economy's GDP.

Another crucial aspect of rescue-package effectiveness is the welfare change for the general public (non rent seekers). In our model, political outcomes, $(G_t,\ \tau_t,\ B_{t+1})$, are determined solely by the Nash-equilibrium decisions of rent-seeking groups. Even after a default that eliminates the burden of servicing the fiscal debt, non-rent-seekers prefer that rent-seeking groups cooperate. This happens because noncooperation implies higher total rents extracted by households in the form of higher τ, and welfare reduction through lower $g \equiv G/Y$. Proposition 5 shows that gains from cooperation are substantial for non-rent-seekers. Specifically, even if $b_t > \underline{b}$, and an exogenous international agreement forces rent-seeking groups to cooperate without a haircut that reduces b_t to $\underline{b}$, then non-rent-seekers would benefit even if they had to service the high debt $b_t > \underline{b}$ thereafter. This happens because full default and non-cooperation would make g to drop. The threshold, $\bar{b} > \underline{b}$, above which servicing the debt becomes unbearable for non-rent-seekers, making them to (desperately) side with rent-seekers in favor of default, is substantially higher than $\underline{b}$, as the calibration section shows.

Proposition 5 *There exists a cutoff debt-GDP ratio,*

$$\bar{b} = \frac{1}{1-\beta}\frac{\alpha}{1+\alpha} \;, \tag{34}$$

in which α is given by (32), with $\bar{b} > \underline{b}$, such that, if $g^C_{\hat{b}}$ corresponds to cooperation among rent-seeking groups together with servicing $\hat{b}$ forever, and if g^{NC}_{default} corresponds to full default and noncooperation forever, then,

$$(i) \quad \hat{b} \;\in\; \left(\underline{b}, \bar{b}\right) \Rightarrow g^C_{\hat{b}} > g^{NC}_{\text{default}} \;, \tag{35}$$

$$(ii) \quad \hat{b} \;>\; \bar{b} \Rightarrow g^C_{\hat{b}} < g^{NC}_{\text{default}} \;. \tag{36}$$

Proof See Appendix B. □

Proposition 5 states that attempts to convince rent-seeking groups to cooperate (see the relevant IMF-report excerpts in Appendix A) would be welcomed by the general non-rent-seeking public if the debt-GDP ratio is not too high. So the model demonstrates that non-rent-seeking households dislike excessive corruption that leads to fiscal profligacy or to defaults, unless the outstanding debt GDP ratios is exceptionally high. In the following section we calibrate our stylized model in order to give a quantitative sense of $\underline{b}$ and $\bar{b}$.

3.1.2 Calibration

Our benchmark calibration focuses on matching data of the European Union (EU) periphery countries, since they are at the center of the EU crisis. Our goal is to identify the cutoff debt-GDP ratio $\underline{b}$. First, we match the total-government-to-GDP spending in these countries which is an average of approximately 45%.[13] In order to find the target value for the total-rents-GDP ratio at the cutoff debt-GDP ratio $\underline{b}$ (denoted by $\underline{c}_R$), we use estimates regarding the size of the shadow economy as a share of GDP reported by Elgin and Oztunali (2012). We make a simple projection of these shadow-economy estimates, assuming that these shares are uniform across the private and the public sector. In other words, the share of rents in total government spending match the size of the shadow economy as a share of GDP.

$\mathbf{C}^{R,C}$ **as % of government spending**	**cutoff debt-GDP ratio** $\underline{b}$
28% (EU periphery)	137%

Table 2

In Table 2 we report the cutoff debt-GDP ratio, $\underline{b}$, corresponding to the 28% rents-to-total-government spending ratio which is the average shadow economy share in EU-periphery countries.[14] We consider EU-periphery countries as our benchmark, since they are at the center of the EU crisis. The assumed rate of time preference, $(1-\beta)/\beta$, is 2.4%. The 137% cutoff level $\underline{b}$ provides higher utility to rent-seekers if they cooperate, compared to defaulting.

[13]Data for G/Y are from the European Central Bank (ECB), Statistical data Warehouse, Government Finance data (Revenue, Expenditure and deficit/surplus), September 2013.

[14]So, the rents-GDP ratio is $28\% \times 45\% = 12.6\%$ in this calibration. In Appendix B we explain how calibration is achieved in this model. Specifically, we prove that calibrating θ_R and θ_G in order to match target values for the government-consumption-GDP ratio and the total-rents-GDP ratio is independent from the values of β at the cutoff level $\underline{b}$.

This 137% debt-GDP ratio is in the ballpark of targets of the "private sector involvement (PSI)" haircut for Greece in the period 2011-2012.[15] Perhaps one factor shaping the target debt-GDP ratio of Greece during the PSI negotiations was the political sustainability of fiscal prudence, through convincing distinct rent-seeking groups to cooperate. This cooperation could be achieved by a coalition government, at least by the two major political parties that used to alternate in power during the previous four decades.

Finally, we find that the cutoff debt-GDP level $\bar{b}$ defined by Proposition 5 is 501%. Beyond $\bar{b}$ non-rent-seekers would support a default even with the rent-seeking groups not cooperating and exploiting excessive rents, because servicing the debt becomes too costly. Perhaps 501% is the cutoff level triggering support to social polarization among rent-seeking groups. Yet, we are not aware of any peace times during which such debt-GDP ratios have been recorded before a default.

Figure 2 depicts a sensitivity analysis of our benchmark calibration. It shows the relationship between the rate of time preference, $\rho = (1 - \beta) / \beta$ and the cutoff level $\underline{b}$. We emphasize that varying ρ means simultaneously changing the rate of time preference of both creditors and of all agents in the domestic economy. As Proposition 2 indicates, under cooperation, international interest rates remain constant, tracking closely the rate of time preference, ρ. Thus, a higher ρ implies higher cost of servicing outstanding debt, decreasing the tolerance to cooperation versus default. This is evident by Figure 2: at levels of ρ above 4%, the cutoff debt-GDP ratio for cooperation versus default falls below 80%. On the contrary, more patient creditors and domestic agents (low ρ), increases the cooperation range, raising $\underline{b}$ above 160% of GDP for ρ less than 2%.

[15] For an extensive review of the Greek sovereign crisis and an outline of PSI see Ardagna and Caselli (2012). For a study reporting the average haircut values between years 1970-2010, see Cruces and Trebesch (2012).

The analysis presented by Figure 2 may provide insights regarding the agreed interest rates of servicing debt under EU rescue packages (Ireland, Greece, Portugal). Since rescue packages involve long-term effective interest rates, lowering the cost of debt servicing may provide more political support in countries with corruption, by creating more incentives for rent-seeking groups to cooperate on fiscal prudence. The Greek PSI program, which involved both a reduction in interest rates and a haircut (see Ardagna and Caselli , 2012), has been followed by political consensus thereafter, providing a good example of this insight.

4. Conclusion

The EU sovereign debt crisis has painfully reminded that sustainability of debt-to-GDP ratios is of first order importance for the stability and future course of the monetary union. Rescue packages were introduced for EU periphery countries. One crucial element and a challenge behind these packages, stressed by official creditors, is the need for cooperation of political parties, in order to achieve fiscal prudence. But EU periphery politics are plagued with rent-seeking activities that overstretch fiscal budgets.

Our model studied the politics of coalition-making among rent-seeking groups, providing a key insight. Reaching a high level of external sovereign debt-GDP ratio takes an economy beyond the perils of mere economic accounting. Beyond some debt-GDP ratio threshold which depends on the influence of rent-seeking groups in policymaking, political resistance to cooperation among rent seekers and parties on prudent policies arises. International markets respond by charging high interest rates, worsening the debt dynamics and making default immediately preferable (and unavoidable) by rent seekers. Rent seekers do not want to service a high outstanding debt, yet their noncooperation triggers the vicious circle of rapidly worsening terms of borrowing. For economies which are prone to corruption and rent-seeking phenomena, the risk of political turmoil makes the requirement of staying within a safety zone of low debt-GDP ratio tighter.

Our framework has accommodated a number of modeling elements with explicitly dynamic policy setting: debt, public consumption, tax rates, and importantly, the free decision of rent-seeking groups to cooperate or not, are all determined in a sequential manner and as a function of outstanding sovereign debt. These modeling features help us to understand what determines cutoff debt-GDP ratios which lead to political turmoil and default. The mechanism triggering the vicious circle of default is a commons problem that leads to a discrepancy between the rate of time preference of creditors and the collective rate of time preference of governments that have multiple noncooperating rent-seeking groups. While commons problems are difficult to resolve, our model points at the importance of keeping debt-GDP ratios low. The role of debt-GDP ratios should prevail in future extensions of our model (e.g., with uncertainty and productive capital) which should be easy to accommodate, given the recursive structure of the dynamic game we have suggested.

Our model suggests that rescue packages may use short-term tools, such as debt haircuts, or provision of low interest rates in order to convince rent-seeking groups to cooperate and to service a debt that costs less. Yet, the long-term goal of rescue packages should be to promote monitoring on reforms that are likely to eradicate rent-seeking groups.

Appendix A – Explicit IMF reference to the need for cooperation among political parties on austerity measures

	Greece	Italy	Portugal	Spain	Ireland
2012	IMF Country Report No. 12/57 "*staff welcomes the commitments from the political parties supporting the present coalition to continue with the objectives and policies of the new program*" (IMF 2012a, p. 44) *"Structural reforms, which are critical to addressing both of these problems, lost considerable momentum during 2011. [...] Retaining broad political support for reforms will be crucial to future success."* (IMF 2012a, p. 42)	2012 Article IV Consultation with Italy- Concluding Statement of the IMF Mission: " *With broad political support, the authorities have embarked on an ambitious and wide-ranging agenda that has lifted Italy from the brink and is now seen as a model for fiscal stabilization and growth-enhancing reforms*". (IMF 2012e, p. 1)	IMF Country Report No. 12/77 "*Prospects of program success remain reasonably strong, given that substantial adjustment and significant reforms is already underway and there is strong political support*". (IMF 2012b, p. 26) IMF Country Report No. 12/179: "*Finally, one year into the program, the authorities are building a convincing track record of meeting adjustment and reform objectives while preserving political support, and prospects of success for the program remain reasonably strong*". (IMF 2012c, pp.19-20)	Transcript of the Updates to the World Economic Outlook/Global Stability Report/Fiscal Monitor Press Briefing 01.2012 *"Political agreement is also needed on a medium-term fiscal adjustment plan that will first stabilize and then bring down the debt-to-GDP ratio"*. (IMF 2012f, p. 1)	IMF Country Report No. 12/264 "*Political commitment to consolidation has been a welcome constant, as reflected in the affirmation by the new government (which took office in March 2011) of the medium-term fiscal targets in the EU–IMF supported program agreed in December 2010*". (IMF 2012d, p. 20)
2011	IMF Country Report No. 11/351: "*Staff welcomes the creation of a national unity government in Greece and the endorsement of program objectives and policies by the three major political parties. The previous lack of broad political support for the program in Greece has emboldened vested interests and has thus contributed directly to the slowdown of reform implementation.*" (IMF 2011f, p. 35)	IMF Country Report No. 11/173: "*The authorities' welcome commitment to reduce the fiscal deficit to close to zero by 2014 needs to be accompanied by action. [...] The large size of the envisaged fiscal retrenchment requires structural changes which must be designed well in advance. This calls for a strong political consensus and careful planning*". (IMF 2011c, p. 30)	IMF Country Report No. 11/279: "*Sustained social and political support is necessary for the comprehensive structural reform program. Strong vested interests could weaken reforms, or reform fatigue could set in, and weaken growth prospects and the required adjustment in the economy*". (IMF 2011e, p. 16)	IMF Country Report No. 11/215*: "Ambitious fiscal consolidation is underway but [...] Such a comprehensive strategy would be helped by broad political and social support"*. (IMF 2011d, p. 1)	IMF Country Report No. 11/109: "*the elections brought in a coalition government with strong ownership of the goals and key elements of the EU/IMF-supported program, much reducing these risks compared with the time of program approval. Yet the capacity to sustain fiscal adjustment and other reforms will depend on signs of concrete results in time". [...] It is welcome that the new government has affirmed their strong commitment to the fiscal consolidation agreed in the EU/IMF-supported program"*. (IMF 2011b, pp. 22-23) IMF Country Report No. 11/47: "*Turning market sentiment to a more positive tone will require sustained implementation and reduced political uncertainty*". (IMF 2011a, p. 7)
2010	IMF Country Report No. 10/110: "*The large multiyear fiscal and structural adjustment requires a decisive break from past behavior. Greece has run into fiscal problems before, which were often resolved only temporarily and by stop-gap measures. A decisive break now requires strong political will and public support. Mitigating factors include a strong mandate of the governing party and measures in the program to protect vulnerable groups.*" (IMF 2010b, p. 21) *"The challenge ahead will be to implement the program rigorously, while securing the necessary public consensus for reforms."* (IMF 2010b, pp. 138-9)		IMF Country Report No. 10/18*: "Political support for reform may need broadening. The Socialist Party was re-elected in September 2009, but lost its overall majority. While there seems consensus among the main parties to comply with the SGP in general, pressure for further stimulus is strong"*. (IMF 2010a, p. 9)	IMF Country Report No. 10/254: "*Policies and staff views: Ambitious fiscal consolidation is underway. [...] Such a comprehensive strategy, especially with broad political and social support, would underpin investor confidence, and time is of the essence*". (IMF 2010c, p. 1)	IMF Country Report No. 10/366: "*Adhering to the fiscal targets and restructuring the financial sector require strong political will and public support*". (IMF 2010d, p. 12)

5. Appendix B – Proofs and formal definitions

Proof of Proposition 1 The first-order conditions of the Bellman-equation problem given by (12) lead to,

$$G_t = \theta_G \cdot (1-\tau_t) \cdot z_t \cdot L \ , \tag{37}$$

$$C^R_{j,t} = \frac{\theta_R}{\theta_G} G_t = \theta_R \cdot (1-\tau_t) \cdot z_t \cdot L \ , \tag{38}$$

and

$$\frac{\theta_R}{(1+r_{t+1})\, C^R_{j,t}} = -\beta \frac{\partial \hat{V}^j \left(B_{t+1}, z_{t+1} \mid \left\{ \mathbb{C}^{R,i} \right\}_{\substack{i=1 \\ i \neq j}}^{N}, \{r_s\}_{s=t+2}^{\infty} \right)}{\partial B_{t+1}} \ , \tag{39}$$

together with the fiscal-budget constraint (11).

In order to identify the value function of the Bellman equation given by (12), its associated rent-seeking strategies, and the model's decision rules, we make two guesses. We first take a guess on the functional form of the rent-seeking group consumption strategies, $C^R_{i,t} = \mathbb{C}^{i,R}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right)$. Specifically, in symmetric equilibrium,

$$\mathbb{C}^{i,R}\left(B_t, z_t \mid \{r_s\}_{s=t+1}^{\infty}\right) = \xi_R \cdot (z_t W_{t+1} - B_t) \ \text{, for all } i \in \{1, ..., N\} \ , \tag{40}$$

in which ξ_R is an undetermined coefficient, and,

$$W_{t+1} \equiv \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right) \ ,$$

for notational simplicity, in which $\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty}\right)$ is given by the expression in (15). It can be verified that the expression in (15) is the solution to the difference equation

$$W_{t+1} = \frac{1+\gamma}{1+r_{t+1}} W_{t+2} + L \quad , \quad t = 0, 1, ... \ , \tag{41}$$

which is a recursion fully characterizing W_{t+1} in the guess given by (40). The second guess is on the functional form of the value function of player $j \in \{1, ..., N\}$, in Bellman equation (12). Specifically,

$$\hat{V}^j\left(B_t, z_t \mid \left\{\mathbb{C}^{R,i}\right\}_{\substack{i=1\\ i\neq j}}^{N}, \{r_s\}_{s=t+1}^{\infty}\right) = \zeta + \psi \cdot \sum_{s=t}^{\infty} \beta^{s-t} \ln\left(1 + r_{s+1}\right) + \nu \cdot \ln\left(z_t W_{t+1} - B_t\right) \ , \quad (42)$$

in which ζ, ψ, and ν, are undetermined coefficients, common across all $j \in \{1, ..., N\}$, due to symmetry.

We substitute our guesses (40) and (42) into the Bellman equation given by (12), in order to verify whether the functional forms given by (40) and (42) are indeed correct, and also in order to calculate the undetermined coefficients ζ, ψ, ν, and ξ_R. Before making this substitution, a simplifying step is to use a state-variable transformation, namely,

$$x_t \equiv z_t W_{t+1} - B_t \ ,$$

and to calculate the law of motion of x_t, a function $x_{t+1} = X(x_t)$, that is based on (11), the first-order conditions (37) through (42), and our guesses (40) and (42).

In order to find the law of motion $x_{t+1} = X(x_t)$, we first combine (42) with (39) to obtain $C_{j,t}^R = \theta_R x_{t+1} / \left[\nu\beta\left(1 + r_{t+1}\right)\right]$, and then we combine this result with (38), which leads to,

$$(1 - \tau_t) \cdot \underbrace{z_t \cdot L}_{\substack{\shortparallel \\ Y_t}} = \frac{1}{\nu\beta\left(1 + r_{t+1}\right)} x_{t+1} \ . \quad (43)$$

From the fiscal-budget constraint (11) and the recursion given by (41) we obtain,

$$\underbrace{z_{t+1} W_{t+2} - B_{t+1}}_{\substack{\shortparallel \\ x_{t+1}}} = \left(1 + r_{t+1}\right) \left[\underbrace{z_t W_{t+1} - B_t}_{\substack{\shortparallel \\ x_t}} - (1 - \tau_t) Y_t - G_t - C_{j,t}^R - \sum_{\substack{i=1\\ i\neq j}}^{N} C_{j,t}^R \right] \ ,$$

which we combine with (37), (38), and (40), in order to get,

$$x_{t+1} = \left(1 + r_{t+1}\right) \left\{\left[1 - (N-1)\,\xi_R\right] x_t - \left(1 + \theta_R + \theta_G\right)\left(1 - \tau_t\right) Y_t\right\} \ . \quad (44)$$

After combining (44) with (43) we obtain the law of motion $x_{t+1} = X(x_t)$, namely,

$$x_{t+1} = \frac{1}{1 + \frac{1+\theta_R+\theta_G}{\nu\beta}} \left[1 - (N-1)\,\xi_R\right] x_t \ . \tag{45}$$

With (45) at hand we return to calculating the undetermined coefficients ζ, ψ, ν, and ξ_R. We substitute (42) into the Bellman equation given by (12) and get,

$$\begin{aligned}\zeta + \psi \cdot \sum_{s=t}^{\infty} \beta^{s-t} \ln(1 + r_{s+1}) + \nu \cdot \ln(x_t) &= \theta_l \ln(1 - L) + \ln(L) \\ &+ \ln(1 - \tau_t) + \ln(z_t) + \theta_G \ln(G_t) + \theta_R \ln\left(C_{j,t}^R\right) \\ &+ \beta\zeta + \beta\psi \cdot \sum_{s=t+1}^{\infty} \beta^{s-t-1} \ln(1 + r_{s+1}) + \beta\nu \ln(x_{t+1}) \ .\end{aligned} \tag{46}$$

After combining (37), (38), (43), and (45), we obtain,

$$\begin{aligned}&\theta_l \ln(1 - L) + \ln(L) + \ln(1 - \tau_t) + \ln(z_t) + \theta_G \ln(G_t) + \theta_R \ln\left(C_{j,t}^R\right) \\ &= \theta_G \ln(\theta_G) + \theta_R \ln(\theta_R) - (1 + \theta_G + \theta_R)\left[\ln(\beta) + \ln(\nu) + \ln\left(1 + \frac{1 + \theta_G + \theta_R}{\nu\beta}\right)\right] \\ &\quad + (1 + \theta_G + \theta_R)\left\{\ln\left[1 - (N-1)\,\xi_R\right] + \ln(x_t)\right\} \ .\end{aligned} \tag{47}$$

In addition, equation (45) implies,

$$\beta\nu \ln(x_{t+1}) = \beta\nu \ln(1 + r_{t+1}) + \beta\nu \left\{\ln\left[1 - (N-1)\,\xi_R\right] + \ln(x_t) - \ln\left(1 + \frac{1 + \theta_G + \theta_R}{\nu\beta}\right)\right\} \ . \tag{48}$$

Substituting (48) and (47) into (46) leads to,

$$\begin{aligned}(1 - \beta)\,\zeta &= \theta_l \ln(1 - L) + \theta_G \ln(\theta_G) + \theta_R \ln(\theta_R) - (1 + \theta_G + \theta_R) \ln(\beta\nu) \\ &+ (1 + \theta_G + \theta_R + \beta\nu)\left\{\ln\left[1 - (N-1)\,\xi_R\right] - \ln\left(1 + \frac{1 + \theta_G + \theta_R}{\nu\beta}\right)\right\} \\ &+ (\beta\nu - \psi) \ln(1 + r_{t+1}) + \left[1 + \theta_G + \theta_R - \nu(1 - \beta)\right] \ln(x_t) \ .\end{aligned} \tag{49}$$

In order that the guessed functional forms given by (40) and (42) be indeed correct, equation (49) should not depend on its two variables, x_t and r_{t+1}. Due to this requirement of non-dependence of equation (49) on x_t and r_{t+1}, two immediate implications of (49) are,

$$\nu = \frac{1+\theta_G+\theta_R}{1-\beta} \ , \tag{50}$$

and $\psi = \beta\nu$, so, based on (50), we obtain,

$$\psi = \frac{\beta \cdot (1+\theta_G+\theta_R)}{1-\beta} \ . \tag{51}$$

Combining (43), (45), (37), and (50), we obtain,

$$G_t = \frac{(1-\beta)\,\theta_G\,[1-(N-1)\,\xi_R]}{1+\theta_G+\theta_R} x_t \ . \tag{52}$$

Equations (52) and (38) imply,

$$C^R_{j,t} = \frac{(1-\beta)\,\theta_R\,[1-(N-1)\,\xi_R]}{1+\theta_G+\theta_R} x_t \ . \tag{53}$$

Our guess (40) concerning the exploitation strategy of group $j \in \{1, ..., N\}$ is $C^R_{j,t} = \xi_R x_t$. So, combining (40) with (53) identifies the undetermined coefficient ξ_R,

$$\xi_R = \frac{(1-\beta)\,\theta_R}{1+\theta_G+\theta_R+(N-1)\,(1-\beta)\,\theta_R} \ , \tag{54}$$

which proves equation (17). Based on (54),

$$1-(N-1)\,\xi_R = \frac{1+\theta_G+\theta_R}{1+\theta_G+\theta_R+(N-1)\,(1-\beta)\,\theta_R} \ . \tag{55}$$

Combining (52) and (54) proves equation (14). In addition, the budget-constraint equation (18) is reconfirmed by substituting (52) and (53) into (11), and after noticing that,

$$\beta_N \equiv \beta\,[1-(N-1)\,\xi_R] \ ,$$

which proves formula (19). Equation (16) is proved directly from (37). Finally, after combining (49) with (50), (51), (54), and (55), we can identify the last undetermined coefficient, ζ, which is given by,

$$\zeta = \frac{1}{1-\beta} \left\{ \theta_l \ln(1-L) + \theta_G \ln(\theta_G) + \theta_R \ln(\theta_R) \right.$$
$$+ (1+\theta_G+\theta_R) \left[\frac{\beta}{1-\beta} \ln(\beta) + \ln(1-\beta) + \frac{\beta}{1-\beta} \ln(1+\theta_G+\theta_R) \right]$$
$$\left. - \frac{1+\theta_G+\theta_R}{1-\beta} \ln\left[1+\theta_G+\theta_R+(N-1)(1-\beta)\theta_R\right] \right\} , \qquad (56)$$

completing the proof of the proposition. □

Proof of Proposition 2

Interest-rate levels are determined by equating demand and supply of government bonds in international markets. In particular, the demand for bonds one period ahead, B^*_{t+1}, is given by equation (24). Bond supply is obtained by combining the optimal level of government spending with the fiscal-budget constraint. From Proposition 1 (see equations (18) and (19) for $N = 1$) we know that the supply of bonds in period $t+1$ is given by,

$$B_{t+1} = \beta(1+r_{t+1}) B_t + (1+r_{t+1}) \left[(1-\beta) z_t \mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right) - Y_t \right] . \qquad (57)$$

After applying the equilibrium condition $B_{t+1} = B^*_{t+1}$, and assuming also that $B_t = B^*_t$ (no default in any period), equations (57) and (24) imply,

$$\mathbb{W}\left(\{r_s\}_{s=t+1}^{\infty} \right) = \frac{L}{1-\beta} , \quad t = 0, 1, \ldots . \qquad (58)$$

In the proof of Proposition 1 we have mentioned an easily verifiable result, that the sequence $\{W_{t+1}\}_{t=0}^{\infty}$ corresponding to equation (15) satisfies the recursion given by (41). Specifically, the formula given by (15) is the solution to (41). After substituting (58) into (41), we obtain the level of interest rate r^{ss} given by (26), and the implication that $r_{t+1} = r^{ss}$ for all $t \in \{0, 1, ...\}$.

Equations (27), (28), and (29) are derived immediately after substituting $r_{t+1} = r^{ss}$ for all $t \in \{0, 1, ...\}$ into (18), (14), (16), and (17). In all cases we take into account that, under cooperation, $\beta_N = \beta$. Under cooperation, all formulas are considered as if $N = 1$ with the sole exception that the aggregate rents of the coalition are equally shared among rent-seeking groups, with each rent seeking group receiving $\mathbb{C}^{R,C}(B_t, z_t)/N$. $\square$

Proof of Proposition 3

Equating demand for bonds (equation (24)) and supply of bonds (equation (18)), together with (10), leads to,

$$(\beta - \beta_N)\, b_t = (1 - \beta_N)\left[\frac{W_{t+1}}{L} - \frac{1}{1 - \beta_N}\right] . \tag{59}$$

From (41) it is,

$$\frac{W_{t+2}}{L} = \frac{1 + r_{t+1}}{1 + \gamma}\left(\frac{W_{t+1}}{L} - 1\right) . \tag{60}$$

After considering equation (59) one period ahead and after substituting (60) into it, we obtain,

$$(\beta - \beta_N)\, b_{t+1} = (1 - \beta_N)\frac{1 + r_{t+1}}{1 + \gamma}\left(\frac{W_{t+1}}{L} - 1\right) - 1 . \tag{61}$$

After some algebra, equation (59) gives,

$$\frac{W_{t+1}}{L} - 1 = \frac{1}{1 - \beta_N}\left[(\beta - \beta_N)\, b_t + \beta_N\right] . \tag{62}$$

Substituting (62) into (61) gives,

$$(\beta - \beta_N)\, b_{t+1} = \frac{1 + r_{t+1}}{1 + \gamma} \left[(\beta - \beta_N)\, b_t + \beta_N\right] - 1 \ . \tag{63}$$

Equation (18) can be expressed as,

$$b_{t+1} = \frac{\beta\,(1 + r_{t+1})}{1 + \gamma} b_t \ , \quad \text{for all } t \in \{0, 1, ...\} \ . \tag{64}$$

Substituting (64) into (63) gives two useful equations, a linear first-order difference equation in variable $1/b_t$,

$$\frac{1}{b_{t+1}} = \frac{\beta_N}{\beta} \cdot \frac{1}{b_t} + (1 - \beta) \left(1 - \frac{\beta_N}{\beta}\right) \ , \tag{65}$$

and an equilibrium condition that links up b_t directly with r_t,

$$\left[(1 - \beta)\,(\beta - \beta_N)\, b_t + \beta_N\right] \frac{1 + r_{t+1}}{1 + \gamma} = 1 \ . \tag{66}$$

The solution to (65) is,

$$\frac{1}{b_t} - (1 - \beta) = \left(\frac{\beta_N}{\beta}\right)^t \left[\frac{1}{b_0} - (1 - \beta)\right] \ . \tag{67}$$

Combining (66) and (67) leads to,

$$\frac{1}{1 + \tilde{r}^*_{t+1}} = \frac{\beta - \beta_N}{1 + \left(\frac{\beta_N}{\beta}\right)^t \left(\frac{1}{1-\beta} \cdot \frac{1}{b_0} - 1\right)} + \beta_N \ , \quad t = 0, 1, ... \ , \tag{68}$$

in which $\{\tilde{r}^*_s\}_{s=1}^{\infty}$ is the sequence of international-equilibrium interest rates.

With equation (68) at hand we can identify which b_0 is possible or admissible, through equating supply and demand for bonds in period 0. Recall from equation (15) that,

$$\frac{W_1}{L} = \frac{W\left(\{\tilde{r}_s\}_{s=1}^{\infty}\right)}{L} = \prod_{s=1}^{\infty} \frac{1}{1 + \tilde{r}_s} + 1 + \sum_{s=1}^{\infty} \frac{1}{\prod\limits_{j=1}^{s} (1 + \tilde{r}_j)} \ . \tag{69}$$

A direct implication of equation (68) is that $\lim_{t\to\infty} \tilde{r}^*_t = (1 - \beta)/\beta$, and consequently,

$$\prod_{s=1}^{\infty} \frac{1}{1 + \tilde{r}^*_s} = 0 \ , \tag{70}$$

which is the first term of the right-hand side of (69). In particular, after incorporating (70) and (68) into (69) we obtain,

$$\frac{W\left(\{\tilde{r}_s^*\}_{s=1}^{\infty}\right)}{L} = \frac{1}{1-\beta_N} + \sum_{s=1}^{\infty}\prod_{j=1}^{s}\frac{\beta-\beta_N}{1+\left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\frac{1}{1-\beta}\cdot\frac{1}{b_0}-1\right)} \equiv F\left(b_0\right) \ . \tag{71}$$

In order to understand whether an equilibrium with default is possible in the case of $N \geq 2$, we examine which values of b_0 are possible after equating supply with demand for bonds in period 0. This market-clearing condition is obtained by substituting (71) into equation (59), after setting $t = 0$ for the latter, which gives, $(\beta - \beta_N)\, b_0 = (1-\beta_N)\, F\left(b_0\right) - 1$, or,

$$H\left(b_0\right) \equiv \frac{\beta-\beta_N}{1-\beta_N} b_0 + \frac{1}{1-\beta_N} = F\left(b_0\right) \ . \tag{72}$$

In order to find solutions of (72) that reflect bond-market clearing in period 0, it is helpful to understand some properties of function $F\left(b_0\right)$. Let

$$f\left(b_0, j\right) \equiv \frac{\beta-\beta_N}{1+\left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\frac{1}{1-\beta}\cdot\frac{1}{b_0}-1\right)} \ . \tag{73}$$

From (73) and (71),

$$F\left(b_0\right) = \frac{1}{1-\beta_N} + \sum_{s=1}^{\infty}\prod_{j=1}^{s} f\left(b_0, j\right) > 0 \ , \text{ for all } b_0 \in \left[0, \frac{1}{1-\beta}\right] \ . \tag{74}$$

Since, for all $b_0 \in \left[0, 1/\left(1-\beta\right)\right]$,

$$f_{b_0}\left(b_0, j\right) = \frac{\frac{\beta-\beta_N}{1-\beta}\left(\frac{\beta_N}{\beta}\right)^{j-1}}{\left\{\left[1-\left(\frac{\beta_N}{\beta}\right)^{j-1}\right] b_0 + \frac{1}{1-\beta}\left(\frac{\beta_N}{\beta}\right)^{j-1}\right\}^2} > 0 \ , \tag{75}$$

an implication of (74) and (75) is,

$$F'\left(b_0\right) = f_{b_0}\left(b_0, 1\right) + \sum_{s=2}^{\infty}\sum_{j=1}^{s} f_{b_0}\left(b_0, j\right)\prod_{\substack{l=1 \\ l\neq j}}^{s} f\left(b_0, l\right) > 0 \ . \tag{76}$$

In addition,

$$F(0) = \frac{1}{1-\beta_N} = H(0) \ , \tag{77}$$

since $f(0,j) = 0$ for all $j \in \{1, 2, ...\}$,

$$F'(0) = (1-\beta)(\beta - \beta_N) < \frac{\beta - \beta_N}{1-\beta_N} = H'(0) \ , \tag{78}$$

and

$$F\left(\frac{1}{1-\beta}\right) = \frac{1}{1-\beta_N} + \frac{\beta - \beta_N}{1-(\beta-\beta_N)} < \frac{1}{1-\beta} = H\left(\frac{1}{1-\beta}\right) \ . \tag{79}$$

Equations (76), (77), (78), and (79) show that, as b_0 spans the interval $[0, 1/(1-\beta)]$, (i) function $F(b_0)$ starts from taking the value $1/(1-\beta_N)$, and satisfying the market-clearing condition at $b_0 = 0$, (ii) it continues in the neighborhood of $b_0 = 0$ with slope which is lower than the constant slope of $H(b_0)$, ($F'(0) < H'(0)$), meaning that $F(b_0)$ goes below function $H(b_0)$ in the neighborhood of $b_0 = 0$, (iii) $F(b_0)$ continues as a strictly increasing function all the way up to $1/(1-\beta)$, and (iv) then at $1/(1-\beta)$, $F(1/(1-\beta)) < H(1/(1-\beta))$. Investigating concavity/convexity properties of $F(b_0)$ is a cumbersome task with, perhaps ambiguous results. Properties (i)-(iv) regarding the behavior of $F(b_0)$, reveal that, if $F(b_0)$ was either globally concave or globally convex on the interval $[0, 1/(1-\beta)]$, then it would be immediately proved that $b_0 = 0$ (full default) would be the only value satisfying the market-clearing condition $F(b_0) = H(b_0)$. Since we do not have such a result at hand, we prove that no solutions other than default are possible, proceeding by contradiction.

Suppose that there exists some $\tilde{b}_0 \in (0, 1/(1-\beta))$, such that,

$$F\left(\tilde{b}_0\right) = H\left(\tilde{b}_0\right) \ . \tag{80}$$

From (65) we know that,

$$\tilde{b}_1 = \frac{1}{\frac{\beta_N}{\beta}\frac{1}{\tilde{b}_0} + \xi} = \frac{\tilde{b}_0}{\alpha} \ , \tag{81}$$

in which $\xi \equiv (\beta - \beta_N)(1-\beta)/\beta$ and $\alpha \equiv \beta_N/\beta + \xi \tilde{b}_0$. Since $\tilde{b}_1$ is on the equilibrium path, it should also satisfy,

$$F\left(\tilde{b}_1\right) = H\left(\tilde{b}_1\right) \ . \tag{82}$$

From (72) and (81) it is,

$$H\left(\tilde{b}_1\right) = \frac{1}{\alpha}\frac{\beta - \beta_N}{1-\beta_N}\tilde{b}_0 + \frac{1}{1-\beta_N} \ ,$$

and by substituting (81) into this last expression again, we obtain

$$H\left(\tilde{b}_1\right) - \frac{1}{1-\beta_N} = \frac{1}{\alpha}\left[H\left(\tilde{b}_0\right) - \frac{1}{1-\beta_N}\right] = \frac{1}{\alpha}\left[F\left(\tilde{b}_0\right) - \frac{1}{1-\beta_N}\right] = F\left(\tilde{b}_1\right) - \frac{1}{1-\beta_N} \ , \tag{83}$$

an implication of (80) and (82). From (71) it is,

$$F\left(\tilde{b}_1\right) - \frac{1}{1-\beta_N} = \sum_{s=1}^{\infty}\prod_{j=1}^{s}\frac{\beta - \beta_N}{1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\alpha\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)} \ ,$$

and (83) implies,

$$\sum_{s=1}^{\infty}\prod_{j=1}^{s}\frac{\beta - \beta_N}{1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\alpha\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)} = \frac{1}{\alpha}\sum_{s=1}^{\infty}\prod_{j=1}^{s}\frac{\beta - \beta_N}{1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)} \ . \tag{84}$$

Subtracting the right-hand-side of (84) from the left-hand side and rearranging terms,

$$\sum_{s=1}^{\infty}(\beta - \beta_N)^s\frac{\alpha - 1}{\alpha}\prod_{j=1}^{s}\left[\frac{1}{1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\alpha\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)} - \frac{1}{1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)}\right] = 0 \ ,$$

or,

$$\frac{\alpha - 1}{\alpha}\sum_{s=1}^{\infty}(\beta - \beta_N)^s(1-\alpha)^s \times$$

$$\times\prod_{j=1}^{s}\frac{\left(\frac{\beta_N}{\beta}\right)^{j-1}\frac{1}{1-\beta}\frac{1}{\tilde{b}_0}}{\left[1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\alpha\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)\right]\left[1 + \left(\frac{\beta_N}{\beta}\right)^{j-1}\left(\frac{1}{1-\beta}\cdot\frac{1}{\tilde{b}_0} - 1\right)\right]} = 0 \ . \tag{85}$$

From (81) we know that

$$\alpha = \frac{\tilde{b}_0}{\tilde{b}_1} \ , \tag{86}$$

and from (64) it is,

$$\frac{\tilde{b}_0}{\tilde{b}_1} = \frac{1}{\beta} \frac{1}{1+\tilde{r}_1} \ . \tag{87}$$

Yet, it is verifiable from (68) that for all $\tilde{b}_0 < 1/(1-\beta)$,

$$\tilde{r}_1 > \tilde{r}^{ss} \Leftrightarrow \frac{1}{\beta} \frac{1}{1+\tilde{r}_1} < \frac{1}{\beta} \frac{1}{1+\tilde{r}^{ss}} = 1 \ . \tag{88}$$

Combining (88) with (87) and (86) implies,

$$0 < \alpha < 1 \ . \tag{89}$$

Inequality (89) implies that the left-hand side of (85) is the product of a negative term, $(\alpha - 1)/\alpha$, and an infinite summation of strictly positive terms, contradicting (85). Since the choice of $\tilde{b}_0 \in (0, 1/(1-\beta))$ was arbitrary, the possibility that $N \geq 2$ and positive outstanding fiscal debt is ruled out.

Therefore, $b_0 = 0$ is the only admissible solution. To see that $b_0 = 0$ is admissible, notice that (64) implies $b_t = 0$ for all $t \in \{0, 1, ...\}$, so $F(b_t = 0) = H(b_t = 0)$ is always satisfied.

To sum up, if $N \geq 2$, domestic governments will default. After the default, all future governments will optimally cease the issuing of public deficit. This optimal behavior in our model is demonstrated by equation (64). $\square$

Definition of a Markov-perfect-cooperation-decision Nash equilibrium (MPCDNE)

Let the cooperation decision of rent-seeking group $j \in \{1, ..., N\}$ be denoted by the indicator function

$$\mathbb{I}_{j,t} = \begin{cases} 1 \ , & j \text{ plays "cooperate" in period } t \\ 0 \ , & j \text{ plays "do not cooperate" in period } t \end{cases} .$$

Let the rent-consumption strategies in periods of no cooperation be denoted by $\mathbb{C}_j^{R,NC}$ for all $j \in \{1, ..., N\}$. Let

$$\mathbb{S} \equiv \left\{ \left(\mathbb{C}_i^{R,NC}, \mathbb{I}_i \right) \right\}_{i=1}^{N} ,$$

and two Bellman equations, one related to determining the value of a cooperation decision in the current period,

$$\begin{aligned} V^{C,j}(B, z \mid \mathbb{S}) = \max_{(\tau, C^{R,C}, B')} \Bigg\{ & \ln(zL) + \ln(1-\tau) + \theta_l \ln(1-L) + \theta_R \ln\left(\frac{C^{R,C}}{N}\right) \\ & + \theta_G \ln\left[\frac{B'}{1+R(B, z \mid \mathbb{S})} - \left(B + C^{R,C} - \tau z L\right)\right] \\ & + \beta \Bigg\{ \prod_{i=1}^{N} \mathbb{I}_i(B', (1+\gamma) z \mid \mathbb{S}) V^{C,j}(B', (1+\gamma) z \mid \mathbb{S}) \\ & + \left[1 - \prod_{i=1}^{N} \mathbb{I}_i(B', (1+\gamma) z \mid \mathbb{S})\right] V^{NC,j}(B', (1+\gamma) z \mid \mathbb{S}) \Bigg\} \Bigg\} , \end{aligned} \tag{90}$$

and one related to determining the value of a noncooperation decision in the current period,

$$\begin{aligned} V^{NC,j}(B, z \mid \mathbb{S}) = \max_{\left(\tau, c_j^{R,NC}, B'\right)} \Bigg\{ & \ln(zL) + \ln(1-\tau) + \theta_l \ln(1-L) + \theta_R \ln\left(c_j^{R,NC}\right) \\ & + \theta_G \ln\left[\frac{B'}{1+R(B, z \mid \mathbb{S})} - \left(B + C^{R,C} + c_j^{R,NC} + \sum_{\substack{i=1 \\ i \neq j}}^{N} \mathbb{C}_i^{R,NC}(B, z \mid \mathbb{S}) - \tau z L\right)\right] \\ & + \beta \Bigg\{ \prod_{i=1}^{N} \mathbb{I}_i(B', (1+\gamma) z \mid \mathbb{S}) V^{C,j}(B', (1+\gamma) z \mid \mathbb{S}) \\ & + \left[1 - \prod_{i=1}^{N} \mathbb{I}_i(B', (1+\gamma) z \mid \mathbb{S})\right] V^{NC,j}(B', (1+\gamma) z \mid \mathbb{S}) \Bigg\} \Bigg\} . \end{aligned} \tag{91}$$

Definition B.1 focuses on global cooperation among N rent-seeking groups, excluding cooperating subcoalitions. In the application of this paper we focus on a symmetric equilibrium of the case with $N = 2$, i.e., subcoalitions are impossible.

Definition B.1 *A Markov-Perfect-Cooperation-Decision Nash Equilibrium (MPCDNE) is a set of strategies,* $\mathbb{S} \equiv \left\{ \left(\mathbb{C}_i^{R,NC}, \mathbb{I}_i \right) \right\}_{i=1}^{N}$ *of the form* $C_{i,t}^{R,NC} = \mathbb{C}_i^{R,NC}(B_t, z_t \mid \mathbb{S})$ $\mathbb{I}_{i,t} = \mathbb{I}_i(B_t, z_t \mid \mathbb{S})$ with

$$\mathbb{I}_i(B_t, z_t \mid \mathbb{S}) = \begin{cases} 1 \;, & \text{if } V^{C,j}(B, z \mid \mathbb{S}) \geq V^{NC,j}(B, z \mid \mathbb{S}) \;\text{ and } \prod_{\substack{j=1 \\ j \neq i}}^{N} \mathbb{I}_j(B_t, z_t \mid \mathbb{S}) = 1 \\ 0 \;, & \text{if } V^{C,j}(B, z \mid \mathbb{S}) < V^{NC,j}(B, z \mid \mathbb{S}) \;\text{ and } \prod_{\substack{j=1 \\ j \neq i}}^{N} \mathbb{I}_j(B_t, z_t \mid \mathbb{S}) = 1 \;, \\ & \text{or if } \prod_{\substack{j=1 \\ j \neq i}}^{N} \mathbb{I}_j(B_t, z_t \mid \mathbb{S}) = 0 \end{cases}$$

and a set of policy decision rules $(\mathbb{T}, \mathbb{G}, \mathbb{B})$ *of the form,*

$$\tau_t = \mathbb{T}(B_t, z_t \mid \mathbb{S}) = \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \, \mathbb{T}^C(B_t, z_t \mid \mathbb{S}) + \left[1 - \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \right] \mathbb{T}^{NC}(B_t, z_t \mid \mathbb{S}) \;,$$

$$B_{t+1} = \mathbb{B}(B_t, z_t \mid \mathbb{S}) = \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \, \mathbb{B}^C(B_t, z_t \mid \mathbb{S}) + \left[1 - \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \right] \mathbb{B}^{NC}(B_t, z_t \mid \mathbb{S}) \;,$$

$$G_t = \mathbb{G}(B_t, z_t \mid \mathbb{S}) = \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \, \mathbb{G}^C(B_t, z_t \mid \mathbb{S}) + \left[1 - \prod_{i=1}^{N} \mathbb{I}_i(B_t, z_t \mid \mathbb{S}) \right] \mathbb{G}^{NC}(B_t, z_t \mid \mathbb{S}) \;,$$

a bond-supply strategy of creditors, $B_{t+1}^* = \mathbb{B}^*(B_t, z_t \mid \mathbb{S})$, *and an interest-rate rule,* $R^{NC}(B_t, z_t \mid \mathbb{S})$, *such that* $\left(\mathbb{T}^{NC}, \mathbb{B}^{NC}, \mathbb{C}_j^{R,NC}, \mathbb{G}^{NC} \right)$ *guarantee that each and every rent seeking group* $j \in \{1, ..., N\}$ *solves the Bellman equation given* *by (91), $\left(\mathbb{T}^C, \mathbb{B}^C, \mathbb{C}^{R,C}, \mathbb{G}^C\right)$ solves the Bellman equation given by (90), creditors' $\mathbb{B}^*$ complies with equation (24), and with $R^{NC}(B_t, z_t \mid \mathbb{S}) = r_{t+1}$ satisfying $\mathbb{B}(B_t, z_t \mid \mathbb{S}) = \mathbb{B}^*(B_t, z_t \mid \mathbb{S})$, for all $t \in \{0, 1, ...\}$.*

With this definition at hand, we proceed to formally proving Proposition 4.

Proof of Proposition 4

In order to calculate $V^{C,j}(B_t, z_t)$ we substitute the results stated by Propositions 1 and 2 into the Bellman equation given by (12), after taking into account that the total rents of the coalition are divided by 2, which implies that we must subtract $\theta_R \ln(2)/(1-\beta)$. In the proof of Proposition 1 we have already achieved most of this calculation as we have obtained the expressions for ζ, ψ, and ν (c.f. equations (56), (51), and (50), which correspond to the value function given by (42)). From equation (26) in Proposition 2 we know that $W_t/L = 1/(1-\beta)$ for all $t \in \{0, 1, ...\}$, so $V^{C,j}(B_t, z_t)$ becomes,

$$V^{C,j}(B_t, z_t) = \frac{1}{1-\beta}\Bigg\{-\theta_R \ln(2) + \theta_l \ln(1-L) + \theta_G \ln(\theta_G) + \theta_R \ln(\theta_R) + (1+\theta_G+\theta_R)\left[\frac{\beta \ln(1+\gamma)}{1-\beta} + \ln(1-\beta) - \ln(1+\theta_G+\theta_R)\right] + (1+\theta_G+\theta_R)\ln\left(\frac{z_t L}{1-\beta} - B_t\right)\Bigg\}\ . \quad (92)$$

In order to calculate $V^{NC,j}\left(B_t = 0, z_t \mid \left\{\mathbb{C}_i^{R,NC}\right\}_{\substack{i=1\\i\neq j}}^{2}\right)$ we find the static-equilibrium non-cooperative solution for $N = 2$, and calculate the discounted sum of lifetime utility of each group. So,

$$V^{NC,j}\left(B_t = 0, z_t \mid \left\{\mathbb{C}_i^{R,NC}\right\}_{\substack{i=1\\i\neq j}}^{2}\right) = \frac{1}{1-\beta}\Bigg\{\theta_l \ln(1-L) + \theta_G \ln(\theta_G) + \theta_R \ln(\theta_R) + (1+\theta_G+\theta_R)\left[\ln(L) - \ln(1+\theta_G+2\theta_R)\right]$$

$$+\left(1+\theta_G+\theta_R\right)\left[\frac{\beta\ln\left(1+\gamma\right)}{1-\beta}+\ln\left(z_t\right)\right]\Bigg\} \ . \quad (93)$$

Comparing (92) with (93) leads to the cutoff debt-GDP ratio in (33).

In order to verify that the cases in which (i) the two rent-seeking groups never cooperate, (ii) the two rent-seeking groups cooperate forever, are both *Markov-Perfect-Cooperation-Decision Nash Equilibrium (MPCDNE)*, notice that, by definition B.1, (i) can be a MPCDNE, no matter what b_t might be. From Proposition 3 we know that if rent-seeking groups never cooperate, then $b_t = 0$ for all $t \in \{0, 1, ...\}$, which still allows (i) to be an MPCDNE. To see that (ii) is also an MPCDNE, notice that, as long as (33) holds in period 0, then Proposition 2 (c.f. eq. 27) implies $b_t = b_0$, so (33) holds for all $t \in \{0, 1, ...\}$. So, rent-seeking groups cooperating forever is an MPCDNE, as a direct consequence of Definition B.1. □

Proof of Proposition 5

In order to derive $\bar{b}$, notice that

$$g^{NC}_{\text{default}} = \frac{\theta_G}{1+\theta_G+2\theta_R} = \frac{\alpha}{1+\alpha}\frac{\theta_G}{\theta_R} \ , \quad (94)$$

and that (28) implies,

$$g^{C}_{\hat{b}} = \frac{\theta_G}{\theta_R}\alpha\left[1-\left(1-\beta\right)\hat{b}\right] \ . \quad (95)$$

Comparing (94) with (95) gives,

$$g^{C}_{\hat{b}} \geq g^{NC}_{\text{default}} \Leftrightarrow \hat{b} \leq \frac{1}{1-\beta}\frac{\alpha}{1+\alpha} \ ,$$

proving (34), (35), and (36). To show that $\bar{b} > \underline{b}$, use (34) and (33),

$$\bar{b} > \underline{b} \Leftrightarrow 2^{\alpha} > 1 \ ,$$

which is a true statement, proving the proposition. □

Proof that calibrating θ_R and θ_G in order to match target values for the government-consumption-GDP ratio and the total-rents-GDP ratio is independent from the values of β at the cutoff level $\underline{b}$

Let $\underline{g}$ denote the government-consumption-GDP ratio G/Y at the cutoff debt-GDP $\underline{b}$, and let $\underline{c}_R$ denote the total-rents-GDP ratio at the cutoff debt-GDP $\underline{b}$. Substituting the formula given by (33) for $\underline{b}$ into (28), we obtain,

$$\underline{g} = \frac{\theta_G}{\theta_R}\alpha\left[1-(1-\beta)\,\underline{b}\right] = \frac{\theta_G}{\theta_R}\frac{\alpha 2^{\alpha}}{1+\alpha} \ , \tag{96}$$

in which α is given by (32). Equation (29) implies,

$$\frac{\underline{c}_R}{\underline{g}} = \frac{\theta_R}{\theta_G} \Rightarrow \theta_G = \theta_R\frac{\underline{g}}{\underline{c}_R} \ . \tag{97}$$

Using (97), we can express (96) as a function of parameter θ_R alone, obtaining,

$$\underline{g} = \frac{\theta_R\frac{\underline{g}}{\underline{c}_R}}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}\frac{2^{\frac{\theta_R}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}}}{1+\frac{\theta_R}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}} \ . \tag{98}$$

Using (98) together with target calibration values for $\underline{g}$ and $\underline{c}_R$, we can find the specific value of parameter θ_R^* by solving the nonlinear equation

$$f\left(\theta_R\right) = 0 \ ,$$

in which

$$f\left(\theta_R\right) \equiv \frac{\theta_R\frac{\underline{g}}{\underline{c}_R}}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}\frac{2^{\frac{\theta_R}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}}}{1+\frac{\theta_R}{1+\theta_R(1+\frac{\underline{g}}{\underline{c}_R})}} - \underline{g} \ . \tag{99}$$

From (99) we can see that matching target calibration values for $\underline{g}$ and $\underline{c}_R$ is independent from values of β. Finally, from (97), $\theta_G^* = \theta_R^*\underline{g}/\underline{c}_R$. $\square$

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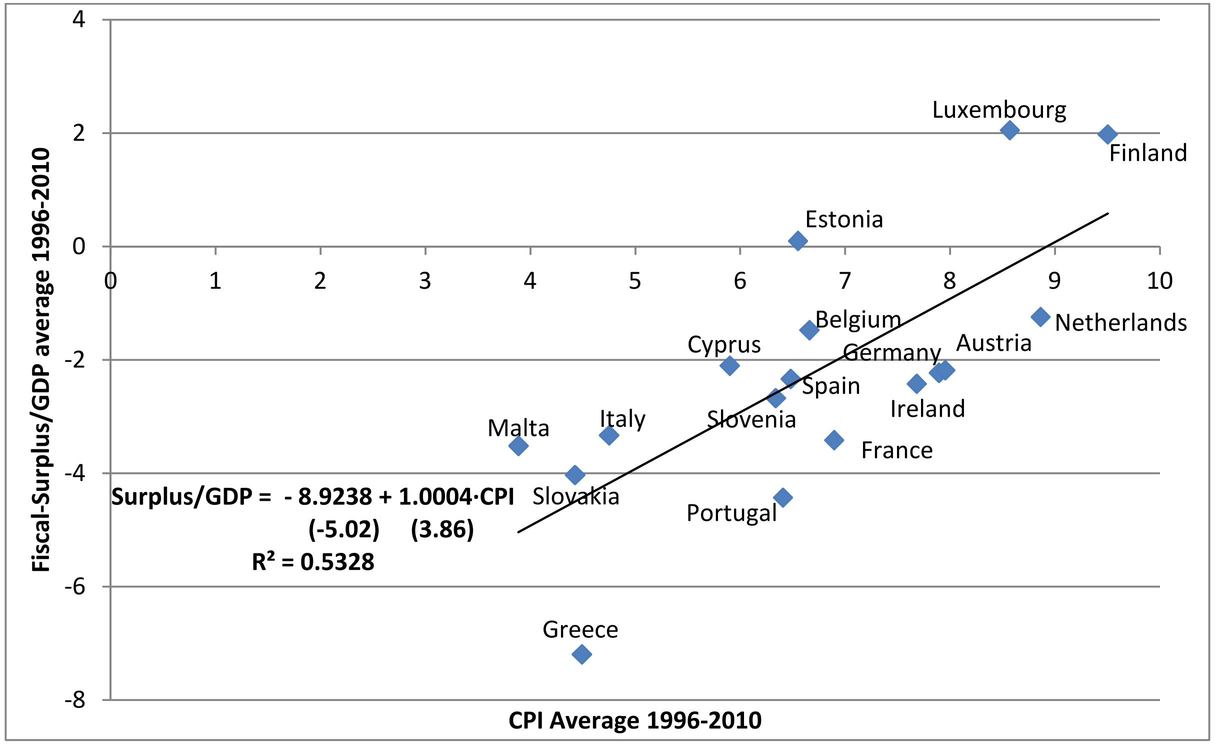

Figure 1 Correlation between the fiscal-surplus/GDP ratio (in percentage points) and the Corruption-Perceptions Index (CPI) for Euro zone countries (t-statistics in parentheses). For Cyprus, Estonia, Malta, Slovakia and Slovenia averages are calculated since four years prior to joining the Euro zone. Sources: Eurostat, Transparency International.

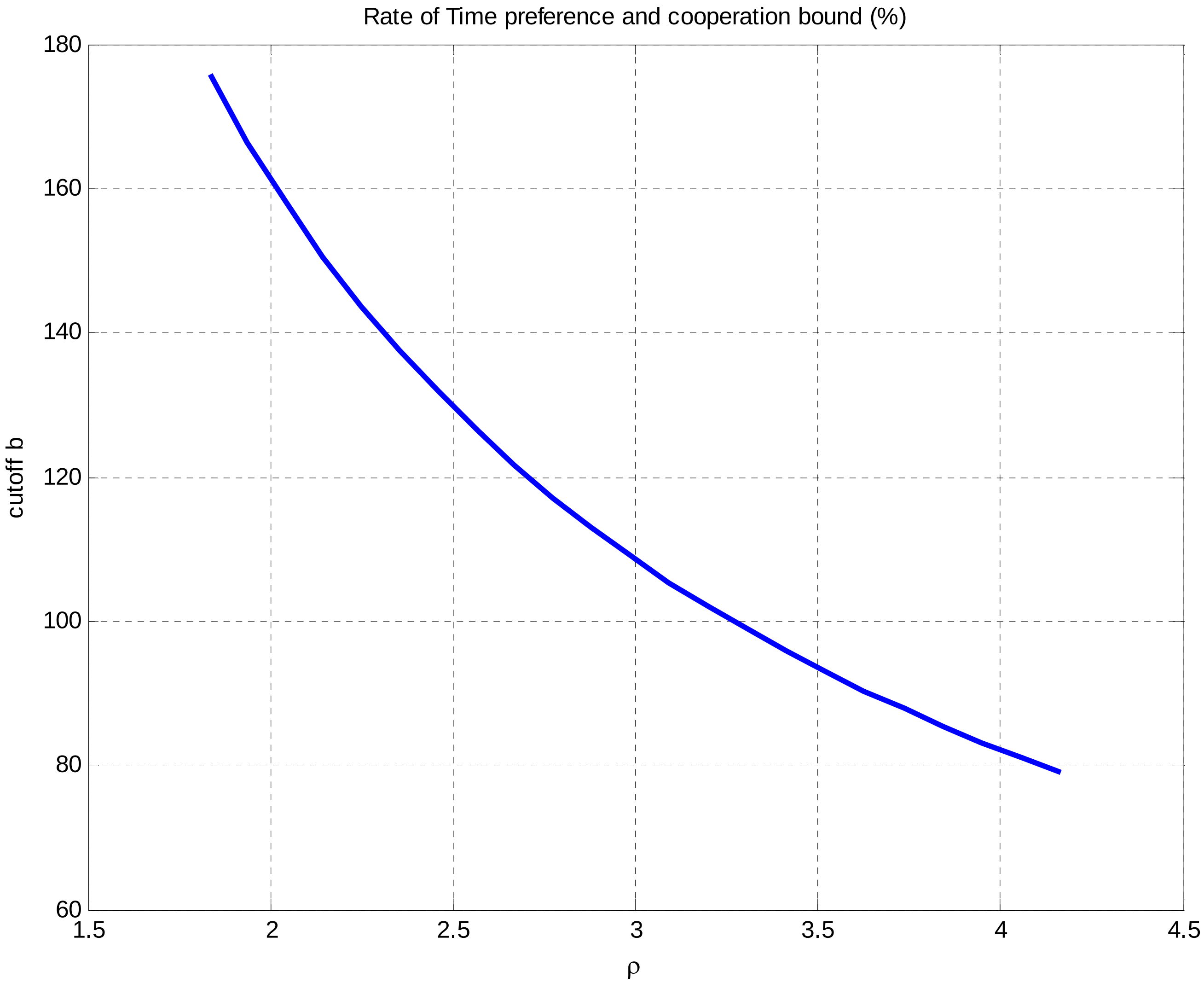
Rate of Time preference and cooperation bound (%)
180
160
140
120
100
80
60
cutoff b
1.5
2
2.5
3
3.5
4
4.5
ρ

Figure 2

Online Appendix

Supplementary Material

for

Rent Seeking and the Political Sustainability of Sovereign Bailouts

by

Carolina Achury, Christos Koulovatianos and John Tsoukalas

Corruption and External Sovereign Debt Inter-linkages in Eurozone Countries

Figure S.1 depicts the evolution of external sovereign debt in years 2003, 2006, and 2009, a year before the sovereign-debt crisis broke out in the Eurozone. Figure S.1 corroborates that, perhaps due to the currency union, Eurozone countries continued to issue external debt, as the Eurozone banking system facilitated the exchange of sovereign bonds among Eurozone commercial banks.

That commercial banks had incentives to buy sovereign bonds of periphery Eurozone countries is corroborated by Figure S.2. Figure S.2 depicts the evolution of 10-year sovereign-bond returns in Eurozone-periphery countries (Greece, Portugal, Italy, Spain, and Ireland) versus Germany, before the entrance to the Eurozone and after the start of the sovereign-debt crisis. All countries that had high interest-rate spreads compared to Germany before entrance to the Eurozone suffer chronically from corruption, according to the Corruption Perceptions Index survey. Table S.1 shows that Greece, Portugal, Italy, and Spain, have been scoring low according to the Corruption Perceptions Index survey throughout the years 1995-2010. The fact that the pre-Eurozone sovereign spreads of these countries vanished rapidly and persistently between years 2001-2008, indicates that Eurozone creditors (including commercial banks) in Eurozone-core countries, bought substantial amounts of sovereign debt. According to Figure S.1, the external debt of Greece, Portugal, Italy and Spain, rose sharply between years 2003-2009, and placed these countries among the top external-sovereign-debt issuers in the world (highest debt-GDP ratios). The key message from Figure S.2 is that countries with high corruption had high sovereign-debt spreads before entering the Eurozone and afterwards, during the sovereign-debt crisis. Ireland, which exhibits low corruption, had sovereign-debt problems only during the sovereign-debt crisis, most likely due to its post-Lehman-Brothers banking crisis, which was combined with a domestic real-estate price drop.

In brief, external sovereign debt of EU periphery countries grew rapidly in the 2000s (Figure S.1), speculating that commercial banks in Eurozone-core countries may have been the main buyer of periphery sovereign debt as indicated by dynamics of 10-year-bond returns before and after the introduction of the Euro (Figure S.2). Euro area commercial banks typically hold a diversified portfolio of government bonds of several union countries and thus can be severely affected by a default through losses on these bonds. Bolton and Jeanne (2011) provide information on Euro area commercial banks foreign debt exposures as of 2010.

The overarching element before the introduction of the Euro and after the sovereign crisis broke out, distinguishing core versus periphery countries in the Eurozone, is that the latter countries always had more corruption (Table S.1). Although our framework does not explicitly model banks, we use corruption and rent seeking as the main driver of developments after the crisis, and we provide insights concerning the political sustainability of bailout plans. First, we speculate that corruption and rent seeking was responsible for having high spreads in high-corruption EU countries before the introduction of the Euro (cheap bonds due to inflationary expectations). Second, we speculate that the low prices of sovereign bonds in high-corruption countries made these bonds attractive for arbitrage by banks in low-corruption Eurozone countries in the 2000s, increasing the external sovereign debt of high-corruption Eurozone countries dramatically. Third, since high-corruption countries held high external debt during the subprime crisis period, some consequences of sovereign default could be transmitted abroad, making the possibility of default higher, and leading bond spreads to rise dramatically (see Figure S.2). Yet, the risk of financial contagion in the Eurozone may be high, motivating bailout-package initiatives. Such a rough outline of causes and effects of the sovereign crisis in the Eurozone is what motivated us to focus our model on the interplay between external debt and corruption in order to study the political sustainability of fiscal targets set by rescue packages.

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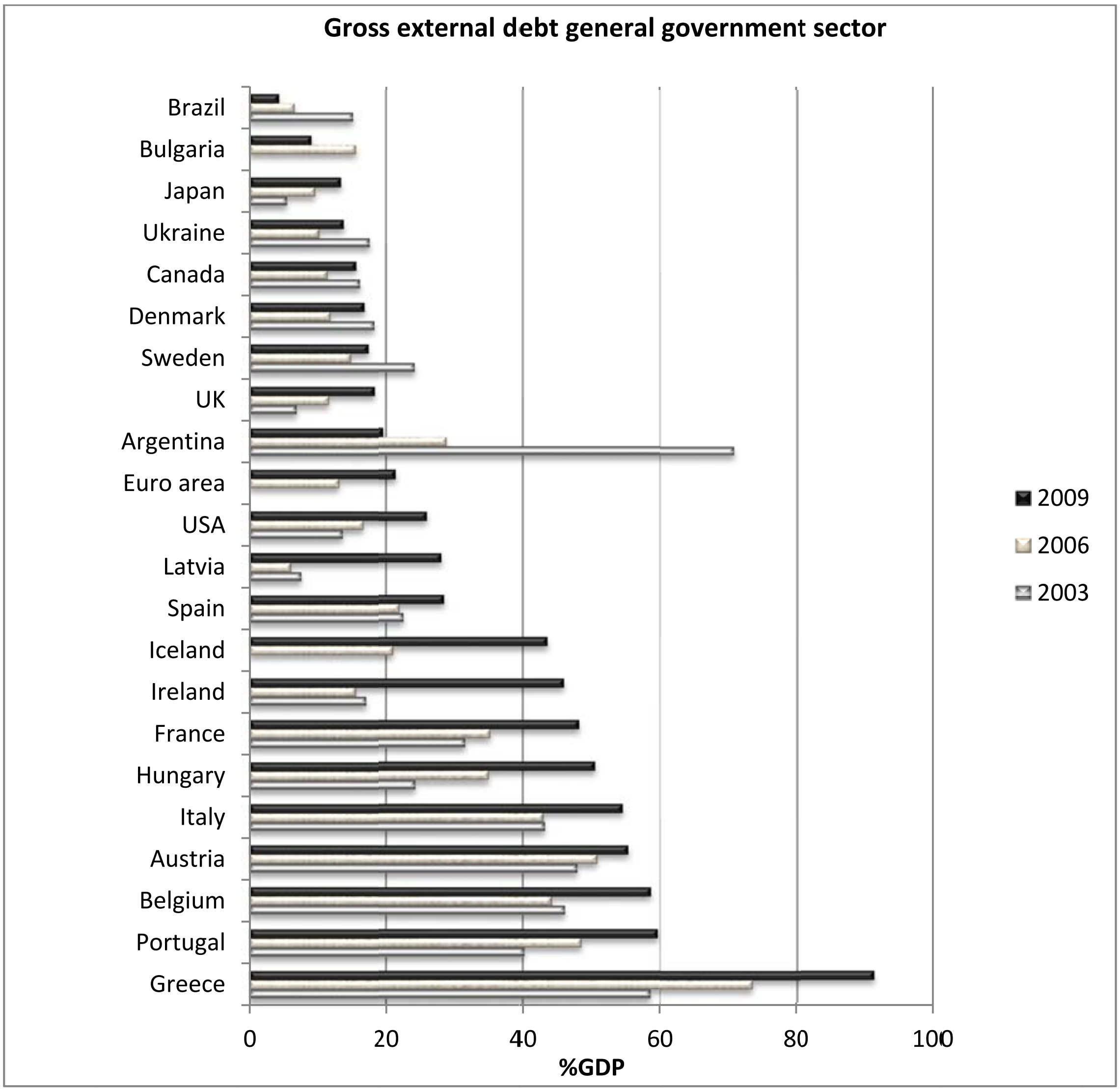

Figure S.1 -- Source: European Central Bank and International Monetary Fund.

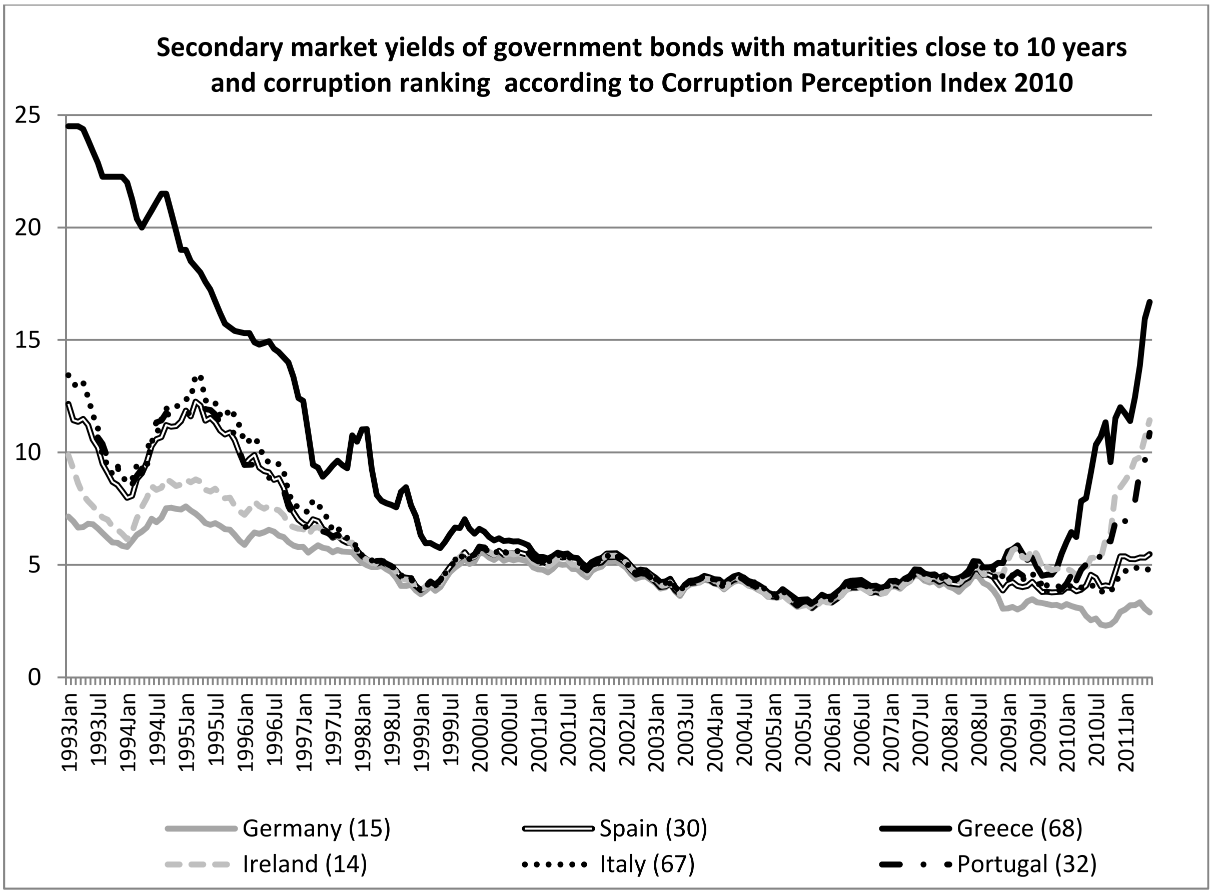

Figure S.2 -- Source: European Central Bank and European Commission, secondary market yields of government bonds with maturities close to 10 years. Numbers appearing in parenthesis in front of every country's name is the ranking according to the Corruption Perception Index 2010 from Transparency International (higher ranking means lower corruption).

Table S.1 -- Corruption Perception Index

Country	1995	1998	2003	2005	2008	2010
	Score (Ranking)					
Ireland	8.57 (10)	8.2 (14)	7.5 (18)	7.4 (19)	7.7 (16)	8.0 (14)
Germany	8.14 (11)	7.9 (15)	7.7 (16)	8.2 (16)	7.9 (14)	7.9 (15)
Spain	4.35 (24)	6.1 (23)	6.9 (23)	7.0 (23)	6.5(28)	6.1 (30)
Portugal	5.56 (20)	6.5(22)	6.6 (25)	6.5 (26)	6.1 (32)	6.0 (32)
Italy	2.99 (31)	4.6 (39)	5.3 (35)	5.0 (40)	4.8 (55)	3.9 (67)
Greece	4.04 (28)	4.9 (36)	4.3 (50)	4.3 (47)	4.7 (57)	3.5 (68)
Best-worst score	9.55-1.94	10-1.4	9.7-1.3	9.7-1.7	9.3-1.0	9.3-1.1

Source: Transparency International
Note: Higher score means lower corruption and numbers appearing in parentheses next to each score is the country’s world-corruption raking based on the score in each particular year.