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Essays on Sovereign Debt and the Macroeconomy

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Introduction

English version

In this thesis, we present three papers related to sovereign debt. In the first two chapters, we study the importance of political frictions in explaining the large levels of sovereign debt to GDP observed in the data. In the third chapter, we evaluate the effects of banking regulation on sovereign exposures on macroeconomic activity. In the first chapter, we explore the channel through which political frictions generates borrowing or saving incentives in a consumption model with full commitment to debt repayment. In particular, we argue that an important and not-yet analyzed determinant of the observed heterogeneity of government debt across countries is the interaction between political conflicts and transparency of institutions. When the incumbent has preferences over the distribution of resources across different groups, in a transparent economy political uncertainty leads to precautionary savings. Nevertheless, assuming that in more non-transparent economies the probability of an incumbent to be re-elected is more strongly a function of current economic conditions, then political uncertainty leads to borrowing incentives. We structurally estimate the two frictions (political conflict and lack of transparency) by using their macroeconomic implications, and we compare the estimated frictions with their proxies in the data. In the second chapter, we show that the existence of borrowing incentive generated by political frictions can generate large levels of debt to GDP, also when the agent is allowed to default on his debt. In particular, we introduce political uncertainty in the standard default model of Arellano2008: the incumbent has an exogenous probability of not being reelected in the next period, but in the cases when she decides to default, there is a larger probability of losing power. The calibrated model matches business cycle moments and generates realistic levels of sovereign debt in Argentina. The estimated political cost of default from the model is shown as being consistent with the decline in confidence in the Argentinian government documented around its 2001 default event. Finally, in the third chapter, we argue that favorable risk weighting on sovereign exposures induced by Basel regulation influences at the margin the composition of assets in banks' balance sheets at the cost of penalizing lending activity. To quantify the effect of the distortion induced by this regulation, we build a standard RBC model calibrated to the Euro Area economy. Increasing risk weights on government bonds has positive long-run effects and stabilization properties with respect to the business cycle. In particular, this policy makes the steady state lending spread on firm loans decline, stimulating investment and output. Moreover, it stabilizes the lending spread leading to a lower volatility of investment and output.

Version française

Dans cette thèse, nous présentons trois articles relatifs à la dette souveraine. Dans les deux premiers chapitres, nous étudions l'importance des frictions politiques pour expliquer les niveaux élevés de dette souveraine par rapport au PIB observés dans les données. Dans le troisième chapitre, nous évaluons les effets de la réglementation bancaire sur les expositions souveraines sur l'activité macroéconomique.

Dans le premier chapitre, nous explorons le canal par lequel les frictions politiques génèrent des incitations à épargner ou à emprunter dans un modèle de consommation avec un engagement total en faveur du remboursement de la dette. Nous soutenons en particulier que l'interaction entre les conflits politiques et la transparence des institutions est un facteur important et pas encore analysé de l'hétérogénéité de la dette publique observée entre pays. Lorsque le gouvernement a des préférences sur la répartition des ressources entre différents groupes, dans une économie transparente, l'incertitude politique conduit à une épargne de précaution. Néanmoins, en supposant que dans des économies plus opaques, la probabilité qu'un gouvernement soit réélu dépend de manière plus importante des conditions économiques actuelles, l'incertitude politique conduit alors à des incitations à emprunter. Nous estimons structurellement les deux frictions (conflit politique et opacité) en utilisant leurs implications macroéconomiques, et nous comparons les frictions estimées avec indicateurs similaires provenant de l'ensemble de données "Quality of Governments".

Dans le deuxième chapitre, nous montrons que l'existence d'une incitation à emprunter générée par des frictions politiques peut être à l'origine des niveaux élevés d'endettement par rapport au PIB, même lorsque les agents sont autorisés à faire défaut sur leur dette. Pour montrer cet argument, nous introduisons l'incertitude politique dans le modèle d'Arellano (2008). Le gouvernement a une probabilité exogène de ne pas être réélu au cours de la prochaine période, mais cette probabilité de perdre ses fonctions est plus grande dans les cas où il décide de faire défaut sur sa dette. Le modèle calibré capture les statistiques du cycle économique et génère des niveaux réalistes de dette souveraine en Argentine. Le coût politique du défaut, estimé par le modèle, est cohérent avec la baisse de confiance dans le gouvernement argentin documentée autour de son événement de défaut de 2001.

Enfin, dans le troisième chapitre, nous soutenons que la pondération favorable des expositions souveraines dans le calcul du risque induite par la réglementation de Bâle influence la composition des actifs dans les bilans des banques au prix d'une pénalisation de l'activité de crédit. Pour quantifier l'effet de la distorsion induite par ce règlement, nous construisons un modèle standard de RBC calibré pour l'économie de la zone euro. L'augmentation des pondérations des obligations d'état dans le calcul du risque a des effets bénéfiques à long terme ainsi que des propriétés de stabilisation par rapport au cycle économique. Cette politique fait baisser le taux d'intérêt des prêts aux entreprises en état stationnaire, stimulant ainsi les investissements et la production. De plus, elle stabilise l'écart de taux d'intérêt entre l'épargne et le crédit, ce qui a pour effet de réduire la volatilité de l'investissement et de la production.

To my family, Cecilia and Teresa, and my parents.
Thank you for your support along the way

Transparency, Political Conflict, and Debt*

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Abstract

In this paper we argue that an important and not-yet analyzed determinant of the observed heterogeneity of government debt across countries is the interaction between political conflicts and transparency of institutions. In the empirical part of the paper we show that whereas these two variables, *per-se*, are not significant determinants of observed debt levels across countries, their interaction is a key factor to explain debt-levels heterogeneity. Specifically, political conflicts imply higher borrowing only in non-transparent economies. In the theoretical model we propose a rationale for this effect. When the incumbent has preferences over distribution of resources across different groups, in a transparent economy political uncertainty leads to precautionary savings. Nevertheless, assuming that in more non-transparent economies the probability of an incumbent to be re-elected is more strongly a function of current economic conditions, then political uncertainty leads to borrowing incentives. We structurally estimate the two frictions in our model (political conflict and lack of transparency) by using their macroeconomic implications. Then, we compare the estimated frictions with the proxies for political conflict and lack of transparency in the data and we find a significant relationship, which supports our theory.

JEL Classification: E2 - F41 - D72

Keywords: Sovereign Debt, Quality of Institutions, Saving decision, Political uncertainty.

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1 Introduction

The macroeconomic literature has largely investigated the cross-country heterogeneity of macroeconomic variables, especially considering business cycle statistics, namely the variability of output, consumption, investment, and interest rates; however, the heterogeneity and the determinants of debt dynamics across countries is a much less examined issue.[1] In this paper we argue that an important and not-yet analyzed determinant of debt incentives is the interaction between political conflicts and transparency of institutions. The rationale behind this effect stems from how these two variables affect strategical political incentives to borrow.

Our contribution is both empirical and theoretical. First, from an empirical point of view, we analyze how our two institutional variables of interest, namely *political conflicts* and *lack of transparency*, affect observed public debt for a comprehensive set of economies. We focus on these two variables for the following reasons. Political conflicts aim to capture the degree of disagreement within a country, which affects the opportunity cost of not-being elected. We proxy political conflicts with measures of fractionalization within a country, as supported by a large body of research.[2] In a nutshell, in our paper political conflict captures how much at stake there is in an election. Our second variable of interest is *lack of transparency*, which aims to capture the difficulties for voters to recognize the true ability of policy makers, and, therefore, their propensity to base their electoral preferences on recent economic performance. This effect could arise for several reasons: for example, governments might lack of transparency in communicating their policies; also, corruption might affect policy makers' credibility; especially in emerging and developing countries governments might restrict the freedom and independence of the media and, more generally, freedom of expression is not guaranteed.[3]

Our main empirical result shows that, whereas *political conflict* and *lack of transparency*, *per-se*, are not significant determinants of observed debt levels across countries, their interaction is a key factor to explain debt-levels heterogeneity. To test this hypothesis we perform cross-country regressions of debt-to-GDP data using our proxies of *political conflict* and *lack of transparency*. Our sample includes 66 countries that are heterogenous in terms of

[1]See Semlali (1997) and Uribe (2013) for a review.

[2]According to Easterly and Levine (1997) ethnic diversity tends to slow growth by making more difficult to agree on the provision of public goods and policies. Alesina et al. (2001) argue that fractionalization is relevant in explaining the diversity of public policies in the US and in Europe. They argue that European countries are more generous to the poors relative to the US as a result of racial heterogeneity in the US and American political institution.

[3]As suggested by Rogoff and Sibert (1988), the existence of information frictions on the ability of the policy maker implies voters will make decisions according to the state of the economy (c.d. retrospective voting behaviour), as a result of a signal extraction game between voters and politicians.

economic development: we have included OECD economies, emerging economies, and developing economies. Our findings can be summarized as follows. First, the simple regression of debt levels on political conflict and lack of transparency yields non-significant (but positive) coefficients: this means that political conflict, per-se, does not contribute significantly to increasing debt. Second, and more importantly, when we add an interaction term between the two variables, the interaction term is positive and significant, while the coefficient associated to political conflict changes the sign and become negative. This implies that if political conflict increases in a transparent economy (low lack of transparency values), its effect on debt is negative (which means it incentivizes saving); on the contrary, in a non-transparent economy (high lack of transparency values) large political conflicts induce borrowing (more debt). This result is robust to adding additional control variables and to a more complete second order regression.

The rationale behind these findings stems from the following intuition. As pointed out in Alt and Lassen (2006) and Shi and Svensson (2006), when governments might have unobservable characteristics, in non-transparent economies voters must rely simply on economic conditions as a possible signal about the quality of the government. The incentives to bust economic condition by using of public debt is a function of the opportunity cost of losing elections, which relates to the degree of political conflict. In a transparent economy, inflating economic performances via debt is not beneficial since voters can disentangle this effect from the true ability of the government. On the contrary, when the economy is non-transparent, voters might be more likely to show support to the current government if the country enjoys larger amount of resources, thus increasing incentives to borrow for the incumbent.

In our theoretical contribution, we propose a rather simple model that can explain our empirical findings. The starting point is a conventional open-economy real business cycle model similar to Uribe and Yue (2006): an economy is endowed with an exogenous and persistent stream of output and the incumbent makes intertemporal decision on debt to smooth consumption over time. We add political uncertainty into this model: in each period the incumbent has a certain probability to be re-elected. In addition, we include also political conflict and transparency. Regarding political conflict, similarly to Alesina and Tabellini (1990b), parties have preferences over distribution across different groups and decide the allocation of consumption according to these preferences. A single parameter, which we refer to as the degree of political conflict, determines how unequally the incumbent would like to split aggregate resources. The higher is the degree of political conflict, the larger are the benefits from being in power.[4]

[4]We believe that the assumption on political frictions operating through redistribution of resources is

We emphasize that when political uncertainty is characterized by a constant probability to be reelected, political conflicts *per-se* are not necessarily able to produce borrowing incentives. For example, when the incumbent has Constant Relative Risk Aversion (CRRA) preferences with risk aversion coefficient greater than one, political uncertainty and political frictions alone, i.e. in a transparent economy, induce precautionary savings. In fact, with these preferences, the incumbent would like to transfer resources from her incumbent-state to a possible future opposition-state, thus leading to incentives to postpone consumption. This feature is consistent with our empirical result that political conflict, in a transparent economy, has a negative sign on its relationship with debt.

Then, we introduce the feature of *lack of transparency*. We assume that in non-transparent economies, the probability of an incumbent to be re-elected is more strongly a function of current economic conditions.[5] Empirical studies, such as Pacek and Radcliff (1995), Lewis-Beck and Stegmaier (2000), and Bartels (2013), support the notion that economic performance is a crucial determinant of electoral outcomes and political approval. In our model we show that political conflict *together with* retrospective voting induces borrowing incentives for the incumbent. Intuitively, when the electorate is particularly sensitive to economic conditions, an incumbent is willing to borrow in order to increase current consumption to gain political advantage against the opposition.

Finally, we bring the model to the data. We use the theoretical predictions of our model on a set of observable macroeconomic and political variables to estimate both the degree of transparency and political conflict that are able to match these moments. Recall the two main theoretical findings: first, without lack of transparency, stronger political conflict lead to larger *saving* incentives; second, when lack of transparency is instead high, stronger political conflict leads to larger *borrowing* incentives. These predictions have effects on average debt, average length of government spells, consumption variance, and trade-balance variance. Therefore, we make use of these predictions to structurally estimate the degree of transparency and political conflict for each country that it is able to make these model predictions as close as possible to their observed counterpart. This strategy yields a cross section set of estimates for our two parameters of interest, the degree of political conflict and lack of transparency. Notice that we use only observed macroeconomic moments to estimate these frictions, without using

realistic. There is broad evidence that economic inequality is also related to conflicting preferences over redistribution especially in countries where ethnical heterogeneity is large (see Horowitz (1985)).

[5] Our reduced-form way to model lack of transparency can be justified by the concept of retrospective voting, as introduced by Nordhaus (1975), in which voters myopically reappoint the incumbent conditionally on current economic conditions, and then extended in Rogoff and Sibert (1988) and Rogoff (1990), which rationalize this behaviour in a rational expectation model by means of a multidimensional signalling game, where parties have time-persistent preferences and voters try to extract the competence of the incumbent by observing economic conditions.

any information about the observed degree of these frictions. Hence, the second natural step is to investigate how our estimates correlate, in the cross-section, with observed proxies of political conflict and lack of transparency. Our finding can be summarized as follows. First, the model strongly support the existence of these frictions. Second, the estimated frictions positively and significantly relate to their data counterparts. Third, once one takes into account possible sources of bias, coming from observing imperfect measures of the frictions and from estimating the frictions with a stylized model that might ignore important effects, the positive relationship becomes even stronger. Hence, we are confident that the mechanism proposed in our model can rationalize the empirical importance of the interaction between political conflict and lack of transparency as observed in the data.

The structure of the paper is as follows. In Section 2 we validate the main theoretical results on the cross section of debt to output ratios across countries. In Section 3 we present our model and the political economy environment, In Section 4 we describe the estimation strategy and we test the relevance of our model. In Section 5 we present the final remarks.

2 Transparency, Political Conflict, and Debt

There are two key variables in our analysis: *lack of transparency* and *political conflict*. The goal of this paper is to show how these two variables interact with public debt in the data, and then to provide a theoretical explanation for that interaction using a model.

2.1 Lack of Transparency

In our empirical analysis we measure *lack of transparency*, henceforth simply *transparency*, in a given country using the average of two different proxies. The first proxy is the variable *Functioning of Government (FOG)*, which examines to what extent the freely elected head of government and a national legislative representative determine the policies of the government; if the government is free from pervasive corruption; and if the government is accountable to the electorate between elections and operates with openness and transparency. The second one is the variable *Freedom of Expression and Belief (FEB)*, which measures the freedom and independence of the media and other cultural expressions; the freedom of religious groups to practice their faith and express themselves; the academic freedom and freedom from extensive political indoctrination in the educational system; and the ability of the people to engage in private (political) discussions without fear of harassment or arrest by the authorities. Countries are graded from the worst to the best. Both proxies have been rescaled to belong in the interval $[0, 1]$. See Appendix A for a description of the data sources. Our benchmark measure of *transparency* for country i is the equally weighted average of the inverse of the two proxies: $Transp_i = \frac{1}{2}\frac{1}{FOG_i} + \frac{1}{2}\frac{1}{FEB_i}$, where FOG_i and FEB_i are the value observed in the first year available, i.e. 2005.[6] Therefore, the higher is the value of this variable, the worst is the transparency in that country (Swaziland, value equal to 0.91), and the lower is its value, the highest is the transparency in that country (Australia, value equal to 0).

2.2 Political Conflict

The second variable of interest is *political conflict*, henceforth simply *conflict*. The existence of a conflict between individuals or groups in a given country generates different distribution of aggregate resources benefitting the group in power. Measuring this type of conflict is not straightforward from the data. Following Easterly and Levine (1997), we define the variable political conflict for country i, $Conflict_i$, with ethnic, linguistic and religious fractionalization, by using the one-time measure as computed by Alesina et al. (2003).[7] Fractionalization expresses the probability that two randomly selected individuals from the population will not belong to the same ethnic/linguistic/religious group. The existence of different groups per se does not imply that a conflict in the economy exists, but it is strongly correlated with it.[8]

2.3 Transparency, Political Conflict, and Debt

In this section we investigate whether *political conflict* and *lack of transparency* are important determinants of the level of debt observed in a country. We show a novel finding, not yet highlighted in the literature: whereas these two measures do not have a significant impact, *per-se*, their interaction is an important driver of debt accumulation. In fact, we find that countries in which both political conflict and lack of transparency are high tend to accumulate larger levels of debt. However, in more transparent economies, the larger degree of political conflicts leads to more savings.

To test this hypothesis formally, and in order to control for additional country character-

[6] As the two variables do not vary much in the sample available, the results of this section hold if we instead consider their average value in the sample period, as shown below in one of the robustness exercise.

[7] Time series variation is not available for this variable, but this should not be a crucial limitation of our analysis, as ethnic, linguistic and religious fractionalization is likely to move very slowly over time.

[8] Alesina and Drazen (1991) argue that a war of attrition between interest groups can postpone macroeconomic stabilization. In Alesina and Spolaore (1997) a public good like a school brings less satisfaction to everyone in an ethnically diverse situation because of the different preferences for language of instruction, curriculum, location, etc. So less of the public good is chosen by society, lowering the level of output or growth.

Table 1 – Summary Statistics of benchmark variables

	Debt/GDP	Conflict	Lack of Transp.	Interaction
mean	0.53	0.17	0.28	0.05
0%	0.12	0.01	0.0	0.00
25%	0.32	0.09	0.04	0.00
50%	0.51	0.15	0.20	0.03
75%	0.70	0.22	0.45	0.07
100%	1.36	0.42	0.91	0.34

Note: In this Table we present the summary statistics of the benchmark measures of Debt-to-GDP ratio, Conflict, Lack of Transparency, and interaction among the latter two variables. $Debt/GDP_i$ is calculated as the sample average in country i (see Appendix 8). Lack of transparency is the first observation available in the sample period available, i.e. 2005-2008, while the measure of political conflict is the only observation available, as it is a one-time measure as computed by Alesina et al. (2003).

istics, we perform cross-country regressions of debt-to-GDP data using our proxies of political conflict and transparency. Specifically, we estimate the following cross-section regression:

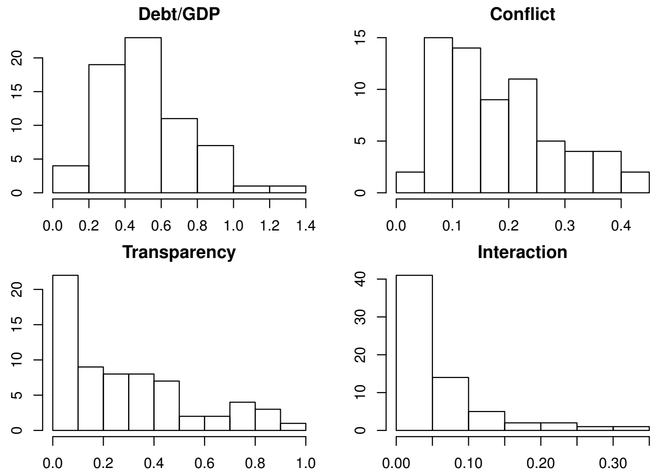
$$D_i = \kappa_0 + \kappa_1 Conflict_i + \kappa_2(Conflict_i * Transp_i) + \kappa_3 Transp_i + \kappa_J X_{J,i} + \epsilon_i, \qquad (1)$$

where D_i denotes the average level of debt-to-GDP level of country i in the samples available, measured as a fraction; $Conflict_i$ and $Transp_i$ are the proxy for political conflict and lack of transparency, as discussed in the previous section; $X_{J,i}$ denotes possible additional regressors; and ϵ_i are regression errors that are assumed to be independent and identically distributed.[9] As for the dependent variable, debt-to-GDP, we use the sample average over the period for each country, reported in the first column of Table 8 in Appendix A.7. Regarding explanatory variables, our benchmark approach is to take the first observation available for each country to reduce the potential endogeneity among variables in the regression. However, we also check the robustness of our results to include explanatory variable as sample averages, in one of the different specifications. Summary statistics of debt, political conflict and transparency are provided in Table 1, while a plot of the distribution of debt-to-GDP ratio, transparency, conflict, and their interaction is displayed in Figure 1. A detailed description of data sources can be found in Appendix A.

We first provide a taxonomy of the relationship between debt, transparency, and conflict, by showing statistics about average debt-to-GDP for four classes of countries, identified by having lower or higher conflict/lack of transparency than the median values. As Table 2 displays, conditional on having low conflicts, less and more transparent countries have similar levels of debt to output ratios. On the contrary, higher lack of transparency is related to higher level of debt for countries with high level of political conflict. Finally, a higher degree

[9] The limitation of the dataset and the slow-moving nature of lack of transparency does not allow to explore the time variation of that variable; in fact, among all the years and all the countries available we observe only 63 instances of changes of transparency.

Figure 1 – Distribution of Benchmark variables



Note: In this Figure we plot the cross-section distribution of the benchmark measures of Debt-to-GDP ratio, Conflict, Lack of Transparency, and interaction among the latter two variables. $Debt/GDP_i$ is calculated as the sample average in country i (see Appendix 8). Lack of transparency is the first observation available in the sample period available, i.e. 2005-2008, while the measure of political conflict is the only observation available, as it is a one-time measure as computed by Alesina et al. (2003).

of conflicts implies less debt for more transparent countries, but more debt in less transparent ones.

Table 2 – Transparency, Political Conflicts, and Debt: Data

		Lack of Transparency	
		Below median (*more transparent*)	Above median (*less transparent*)
Conflict	Below median	Avg. Debt/GDP = 0.52 # Countries = 19 (Chile, Findland, Japan)	Avg. Debt/GDP = 0.51 # Countries = 14 (Romania, Honduras, Bangladesh)
	Above median	Avg. Debt/GDP = 0.45 # Countries = 14 (USA, Belgium, Philippines)	Avg. Debt/GDP = 0.63 # Countries = 19 (Thailand, Kenia, Guatemala)

Note: In this table we report average debt-to-output ratio, the number of countries and the names of three countries that belong to one of the four group identified by having higher or lower political conflict (by rows) and lack of transparency (by columns). The thresholds that identify the four groups are the median of the two variables. $Debt/GDP_i$ is calculated as the sample average in country i (see Appendix 8). Lack of transparency is the first observation available in the sample period available, i.e. 2005-2008, while the measure of political conflict is the only observation available, as it is a one-time measure as computed by Alesina et al. (2003).

Estimation results for the model in (1) are reported in Table 3. In regression (1) we display the estimates of the coefficients of the univariate relationship between debt and political conflict. Without any other explanatory variable, the sign is positive but not significant. This means that political conflict, *per-se*, does not contribute significantly to increasing debt. In regression (2) we add lack of transparency: the coefficient associated to this variable is positive and significant, but notice that even when adding this regressor political conflict is still positive and not significant. In regression (3) we first test the mechanism proposed in this paper: compared with regression (2) we have included an interaction term between political conflict and transparency. The interaction is positive and significant, while the coefficient associated to political conflict changes the sign and becomes negative. This implies that as political conflict increases the effect on debt is negative (which means it incentivizes saving) in a transparent economy (low lack of transparency values), while large political conflicts induce borrowing (more debt) in a non-transparent economy (high lack of transparency values). To give an example, if a country had a lack of transparency equal to zero (very transparent), the *marginal* effect of conflict on debt would be negative (thus, inducing savings) and equal to $\kappa_1 = -0.53$. If that country instead had the maximum observed level of lack of transparency equal to 0.916 (non-transparent), the effect of conflict on debt would be positive (thus, inducing borrowing) and equal to $\kappa_1 + 0.916\kappa_2 = 1.55$.[10]

The results are robust to using different specifications and adding controls. In regression (4) we also include additional regressors that have been shown in the literature to be important determinant of debt levels. Variable *Credit* is domestic credit provided by the financial sector and measures the soundness of the financial system: when this proxy increases, the government can borrow more easily from national and foreign investors. *Energy* is measured as energy production per capita: countries that produce energy do not need to rely on international energy markets to satisfy energy demand. The coefficient associated to *GDP per capita* tells that governments of richer countries have lower incentive to borrow. The variable *Growth*, which measures annual growth rate of GDP per capita, has also negative effect on debt, as countries that grow faster have more resources to finance public expenditures. *Majoritarian* is a dummy variable that takes value one if the country had a majoritarian system in the first period available. According to Milesi-Ferretti et al. (2002) the existence of a majoritarian electoral system has an impact on fiscal policy. *Openness* is computed as export plus imports over GDP. Its positive coefficient signals that more open countries are also more financially integrated. *Pop>65* measures the percentage of the population over 65 years old and it proxies public spending in social security. In regressions (3^{cl}) and (4^{cl}) we cluster the standard errors at economic area levels for the two main benchmark models: here the standard errors are more conservative, but the interaction term remains significant at 10%.[11] In regression (5) we included additional squared terms to control for additional non linearities. Given the quadratic terms it is not immediate to observe the change in sign of the effect of transparency. Doing

[10] We can compute the economic magnitude of these estimate by computing the *change* in debt to output ratio, measured as a fraction, from moving from the minimum to the median level of conflict observed in the data (that is from 0.01 to 0.15) both for the most and least transparent economy, as an example. In the first case the *change* in debt to output ratio would be equal to -0.07, while in the second case it would be 0.22. These numbers should be taken only as an indicative measure as political conflict, which is a fractionalization measure, is unlikely to vary that much in a given country.

[11] We split the countries in the following areas: North Africa & Middle East, Latin & Central America, Asia, Eastern Europe, Africa and Developed countries.

a similar example as before, a country like Brazil (with a conflict level similar to the average and equal to 0.2) would experience a negative *marginal* effect of political conflict on debt, equal to -0.59, if its transparency value were zero, and a positive *marginal* effect, equal to 1.33, with the highest transparency value.[12]

In regression (6) we add squared terms of Conflict and Transparency to the specification in (4). In regression (7) we include area dummies to control for latitude effects. Regression (8) only differs from (7) in the way the regressors are calculated. While in all the other cases each variable enters as the first available observation for each country, here the variable is calculated as an average in the available period. In this way average GDP growth becomes more significant in the regression, but the interaction term is still strongly significant. Regression (9) has the same specification of model (6), but we restrict the analysis to developing countries: our results appear stronger in this case, as the size (in absolute value) of the coefficients associated to political conflict, transparency and their interaction is larger. Furthermore political conflict becomes now significant. Model (10) differs from (7) just for the dependent variable: debt-to-GDP ratios are calculated from 1990 onwards to focus on the period when emerging markets started integrating in the global economy. Also in this case the coefficients associated to our variables of interests are robust in size and sign. Models (11) to (13) differ from (7) for the proxy of lack of transparency used in the analysis. The results seem to be robust to the choice of the transparency index: in regression (11) transparency is defined from *Functioning of Government* described above, while in regression (12) we used *Freedom of Expression and Belief*. In model (13) we define transparency as the average of 7 different proxies. In addition to the proxies included in the benchmark definition of transparency we have added: proxies of freedom of the press and pressures over media content exerted by politics, state laws or more generally influence coming from the economic environment of the media; a measure of political participation (that measures the right of people to freely organize in political parties); and a measure of rule of law (as a measure of reliability of the judiciary system). Finally, in model (14) we exclude countries that have been through a major regime switch from dictatorship to multi-partisan election.[13] The five countries with such a regime change are: Burundi, Hungary, Jordan, Nepal, and Romania.

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[12]As the regression contains second order terms, the marginal effect for political conflict is a function of the conflict level. That is why for the example with picked a country with a value of political conflict equal to the average.

[13]We identify the regime switcher using the variable *No Partiesla Allowed, (NPA)* computed by Institutions and Elections Project, and that in any year takes value of 1 if no parties are allowed and 0 otherwise. The criterion we use to isolate the regime switcher is that a country that starts in a dictatorship (NPA=1) experiences a one-time shift to multi-partisan election (NPA=0).

Table 3 – Transparency, Political Conflicts, and Debt: Regressions

	Model 1	Model 2	Model 3	Model 3^{cl}	Model 4	Model 4^{cl}	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14
Constant	0.47***	0.42***	0.54***	0.54***	0.25	0.25	0.68***	0.30			1.08**				1.013	
	(7.16)	(6.10)	(7.79)	(12.01)	(0.49)	(0.25)	(5.95)	(0.57)			(2.47)				(0.24)	
Interaction			2.27***	2.27*	2.14**	2.14*	2.10***	1.91**	2.43***	2.48***	3.38***	2.00*	2.23**	2.25**	3.07**	2.08**
			(2.99)	(1.81)	(2.22)	(1.74)	(2.92)	(2.05)	(2.67)	(3.9)	(4.05)	(2.00)	(2.55)	(2.54)	(2.41)	(2.10)
Political Conflict	0.35	0.25	-0.53	-0.53*	-0.39	-0.39	-2.32*	-2.21	-1.61	-2.00*	-4.83***	-0.96	-1.36	-1.54	-1.35	-2.52*
	(0.91)	(0.73)	(-1.45)	(-1.71)	(-0.70)	(-0.48)	(-1.74)	(-1.60)	(-1.11)	(-1.70)	(-3.48)	(-0.58)	(-0.98)	(-1.04)	(-0.96)	(-1.78)
Lack-of-Transp.		0.26**	-0.13	-0.13	-0.24	-0.24	0.00	-0.11	0.09	-0.32	0.40	0.59	0.46	-0.27	-0.65	-0.12
		(2.37)	(-0.76)	(-0.79)	(-1.00)	(-0.60)	(0.01)	(-0.27)	(0.19)	(-0.74)	(0.86)	(1.30)	(1.09)	(-0.56)	(-1.06)	(-0.26)
Political Conflict^2							4.32	4.51	3.04	2.76	7.65**	1.53	1.98	3.39	2.20	5.36
							(1.43)	(1.51)	(0.89)	(0.96)	(2.41)	(0.36)	(0.62)	(0.95)	(0.68)	(1.67)
Lack-of-Transp.^{2}							-0.16	-0.14	-0.53	-0.18	-1.07**	-0.98**	-0.87**	-0.09	0.20	-0.15
							(-0.34)	(-0.33)	(-1.22)	(-0.47)	(-2.09)	(-2.17)	(-2.25)	(-0.22)	(0.26)	(0.33)
Credit					0.35***	0.35***		0.32***	0.31***	0.31***	0.61***	0.42***	0.31***	0.31***	0.30***	0.27***
					(3.55)	(2.15)		(3.34)	(3.19)	(4.16)	(5.45)	(4.23)	(3.18)	(2.97)	(3.1)	(2.91)
Energy					-0.17	-0.17		-0.16	-0.07	-0.02	-0.28**	-0.12	-0.05	-0.10	-0.10	-0.17
					(-1.14)	(-1.12)		(-1.02)	(-0.52)	(-0.79)	(-2.35)	(-0.75)	(-0.36)	(-0.74)	(-0.72)	(-1.19)
Business					0.24***	0.24***		0.27***	0.21***	0.10	0.31***	0.34***	0.20***	0.22***	0.24***	0.24***
					(3.37)	(6.20)		(4.23)	(2.96)	(1.56)	(4.99)	(4.23)	(2.82)	(3.16)	(3.55)	(3.97)
GDP per capita					-0.02	-0.02		-0.01	-0.11**	-0.19***	-0.08*	-0.11*	-0.11**	-0.10*	-0.10*	0.01
					(-0.34)	(-0.16)		(-0.25)	(-2.12)	(-4.22)	(-1.71)	(-1.94)	(-2.42)	(-1.85)	(-1.83)	(0.25)
GDP growth					0.06	0.06		0.18	-0.34	-5.40**	-0.29	-0.01	-0.31	-0.28	-0.19	0.09
					(0.11)	(0.12)		(0.32)	(-0.59)	(-2.48)	(-0.64)	(-0.01)	(-0.55)	(-0.49)	(-0.32)	(0.18)
Majoritanian					0.04	0.04		0.06	0.04	0.04	-0.09	0.01	0.03	0.05	0.05	0.07
					(0.65)	(0.58)		(1.02)	(0.68)	(0.65)	(-1.04)	(0.11)	(0.50)	(0.70)	(0.76)	(1.37)
Openess					0.01	0.01		0.01	0.01*	0.01***	0.01	0.01	0.01**	0.01	0.01	0.00
					(1.42)	(1.00)		(1.39)	(1.77)	(2.83)	(1.64)	(0.98)	(2.19)	(1.37)	(1.26)	(1.36)
Pop>65					1.16	1.16		1.45	1.56	1.45	0.46	2.26	1.80	1.19	0.90	1.03
					(1.01)	(0.66)		(1.23)	(0.95)	(1.06)	(0.47)	(1.26)	(1.06)	(0.77)	(0.59)	(0.91)
Area dummies	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0
Expl. Average	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Only developing	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Short Sample Debt	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Transparency alt.	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0
Clustered StdErr	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
No Regime Switch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
N	66	66	66	66		66	66	66	66	66	66	47	66	66	66	61
R^2	0.02	0.09	0.16	0.16	0.37	0.37	0.19	0.40	0.48	0.58	0.63	0.56	0.48	0.48	0.47	0.40
$\bar{R}^2$	0.00	0.06	0.12	0.12	0.24	0.24	0.12	0.25	0.29	0.42	0.49	0.39	0.29	0.29	0.26	0.24

Note: In this table we report the estimates of the cross-section regression in (1). The dependent variables is the debt-to-GDP ratio for the 66 countries reported in Appendix B. Different specification accounts for several controls. t-statistics are reported in parenthesis. (*) indicates significance at 10%; (**) indicates significance at 5%; (***) indicates significance at 1%. Standard errors are calculated using heteroskedasticity consistency estimator White (1980).

2.4 Transparency of institutions or unsophisticated voters?

One might wonder whether the effect we found for our measure of lack of transparency, which aims to capture institutional frictions that create difficulties for voters to recognize the true ability of policy makers, can be instead interpreted as voters' lack of sophistication, which in contrast should be interpreted as voters' inability to evaluate the political and electoral process, regardless the degree of transparency of the institutions. In order to shed lights on these two interpretations, we first create a *Lack of Sophistication* index, as an average of two different proxies.

The first proxy is the variable *Social Globalization*, and it is measured by three categories of indicators; (i) personal contacts, such as telephone traffic and tourism; (ii) information flows, e.g. number of Internet users; and (iii) cultural proximity, e.g. trade in books and number of Ikea warehouses per capita. The second proxy is the variable *Education*, and it is measured as number of students at universities or other higher education institutions per 100,000 inhabitants of the country.

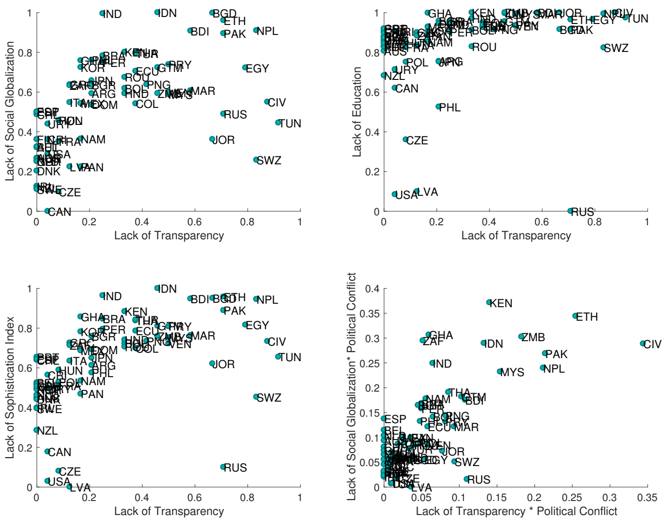
The measure of lack of sophistication is the average of the two proxies and it is rescaled to belong in the interval [0,1]. Hence, a country with value of lack of sophistication equal to zero is the most sophisticated (Latvia), whereas a country with value equal to one is the least sophisticated (Indonesia). See Appendix A.4 for a description of the data sources. Figure 2 displays the relationship between our benchmark measure of lack of transparency and lack of social globalization, lack of education, the overall lack of sophistication index, as well as the relationship between the interaction between lack of transparency and political conflict and lack of sophistication and political conflict. Although obviously positively correlated the transparency and sophistication are far from perfectly correlated.[14]

If we were to estimate the same empirical regression in equation (1) with *Lack of Sophistication* instead of with *Lack of Transparency*, would we obtain the same results? And if we, instead, were to add sophistication as a control, would the results in the previous section change? Table 4 helps answering these questions. Model 1 reports, for reference, the relation between debt and political conflict. Model 2s adds lack of sophistication: the results are very similar to Model 2 of Table 3, both in terms of sign and magnitude. However, as Model 3s displays, the interaction between political conflict and lack of sophistication is insignificant. This confirms that our results in the previous section are related to transparency of institutions rather than unsophisticated voters. Model 4s and Model 5s support this finding, as our parameter of interest, that is the the interaction between political conflict and transparency

[14] The correlation between the two indexes is 0.46, while the correlation between the interactions with political conflict is 0.74.

remains large and positive when controlling for lack of sophistication and its interaction with conflict, while the interaction between political conflict and lack of sophistication is very close to zero.[15]

Figure 2 – Sophistication and Transparency



Note: In this Figure we display the relationship between our benchmark measure of lack of transparency (x-axis) and lack of social globalization, lack of education, the overall lack of sophistication index (y-axis, panel north-west, north-east, and south-west), as well as the relationship between the interaction between lack of transparency and political conflict (x-axis) and lack of sophistication and political conflict (y-axis, panel south-east).

Table 4 – Sophistication, Transparency, Political Conflicts, and Debt

	Model 1	Model 2s	Model 3s	Model 4s	Model 5s
Constant	0.47***	0.30***	0.50***	0.46***	0.46**
	(7.16)	(3.17)	(2.79)	(5.18)	(2.32)
Lack-of-Transp*Pol.Confl				2.23***	2.10***
				(3.03)	(2.79)
Political Conflict	0.35	0.27	-0.62	-0.48	-0.45
	(0.91)	(0.74)	(-0.73)	(-1.34)	(-0.50)
Lack-of-Transp.				-0.14	-0.14
				(-0.86)	(-0.79)
Lack-of-Sofist.		0.29**	-0.01	0.12	0.13
		(2.45)	(-0.04)	(0.95)	(-0.39)
Lack-of-Sofist.*Pol.Confl			1.34		-0.04
			(1.00)		(-0.03)
N	66	66	66	66	66
R^2	0.01	0.08	0.09	0.16	0.16
$\bar{R}^2$	0.00	0.05	0.04	0.11	0.09

Note: In this table we report the estimates of the regression in (1) when including lack of sophistication. The dependent variables is the debt-to-GDP ratio for the 66 countries reported in Appendix B. t-statistics are reported in parenthesis. (*) indicates significance at 10%; (**) indicates significance at 5%; (***) indicates significance at 1%. Standard errors are calculated using heteroskedasticity consistency estimator White (1980).

[15] These results are robust to including the additional regressors as in Table 3, including a full second order specification in conflict, transparency, and sophistication.

3 The Model

In this section we describe our economy of interest. There are two key features of the model. First, we consider *political conflict*: as in Alesina and Tabellini (1990a), the economy is populated by several groups of domestic agents that are represented by political parties. The incentive of an incumbent to favour her group constitutes a political conflict. Second, in our more general framework we introduce the concept of *transparency*. We assume that lack of transparency induces inability of voters to judge and assess politicians. Therefore, a non-transparent environment leads voters to base their support to an incumbent only when her mandate was characterized by good economic performance, which in our model means higher aggregate consumption level and utility. In this sense, we generalize Amador and Aguiar (2011) by assuming that the probability of reelection is constant only in an economy characterized by transparency, and that it is instead a function of previous aggregate consumption levels in an economy where transparency is absent. We will show that these two features jointly are able to replicate the empirical facts displayed in the previous section.

3.1 Preferences

Consider a neoclassical small open economy model with $N+1$ equally sized groups of domestic agents, each represented by a political party. Each period, one of the $N+1$ parties is in office and the incumbent party remains in power with a given probability $p(\cdot)$. Conditional on the incumbent losing the elections, each opponent party has equal probability $\frac{1-p(\cdot)}{N}$ of being elected. In a non-transparent economy the probability of being reelected is a positive function of aggregate consumption, whereas in a transparent economy, that probability is constant and fixed, as in Amador and Aguiar (2011). We model political conflict by using the partisan approach; the party in power decides borrowing and consumption allocation to the different groups. We define the utility at time t of party i when that same party i is in power as:

$$\mathcal{U}^{i,i}(c_t^i) = \theta_{i,i} u(c_t^{i,i}) + \sum_{q \neq i} \theta_{i,q} u(c_t^{i,q}), \tag{2}$$

where $\theta_{i,j} \geq 0$, $\forall i, j$ s.t $\sum_{j=1}^{N+1} \theta_{i,j} = 1$, is the weight that party i associates to the utility of party j, and $c_t^i = \left\{ c_t^{i,1}, \ldots, c_t^{i,N+1} \right\}$ is the consumption allocation decided by party i. A political party i cares about all the agents in the economy, but gives higher weight to agents of its group i, meaning that $\theta_{i,i} \geq \theta_{i,j}$. The instantaneous utility function $u(\cdot)$ is uniformly continuous, twice continuously differentiable, strictly increasing in c, and satisfies the Inada conditions. Similarly, the utility of an opposition party r when party i is in power, is defined as:

$$\mathcal{U}^{i,r}(c_t^i) = \theta_{r,r} u(c_t^{i,r}) + \sum_{q \neq r} \theta_{r,q} u(c_t^{i,q}).$$

Moreover, we assume no discrimination, i.e. each party weights equally the utility of other types of agents and likes to be in power as the other parties do. In this way we have simplified the problem by imposing symmetry, meaning that we are also going to restrict our attention to equilibria that are symmetric. The symmetry assumption imposes that $\theta_{i,i} = \theta \, \forall i$ and $\theta_{i,q} = \frac{1-\theta}{N} \forall i, q$ such that $\frac{1}{N} \leq \theta < 1$; hence, we can simply ignore the identity of the party in power and at the opposition. Therefore, for the rest of the paper and for simplicity we denote the utility of the incumbent i as $U^I(c_t) \equiv \mathcal{U}^{i,i}(c_t^i)$ and the utility of any opposition party, r, as $U^O(c_t) \equiv \mathcal{U}^{i,r}(c_t^i)$. We exclude the case with $\theta = 1$ in order to avoid corner solutions.[16] Each party is born at 0 and lives for T periods and discounts future utility at rate β.

3.2 International Financial Market and Output

The party in power (incumbent) has the ability to borrow or lend using an internationally traded one-period risk-free non-contingent real bond. Borrowing and saving allow the government to diverge the amount of aggregate consumption from the exogenous aggregate income and to distribute it intertemporally. Similarly to a small-open economy setting, the evolution of the debt position of the government is:

$$d_{t+1} - d_t = r_t d_t + c_t - y_t, \tag{3}$$

where d_{t+1} denotes the debt position at the beginning of period $t+1$, chosen in period t, r_t denotes the country interest rate, and y_t is an exogenous stochastic endowment. We assume that each party cannot renege the debt contract in each period even if it was stipulated by another party.[17] We implicitly assume that the country is a small-open economy, which we believe is a reasonable assumption given the set of countries considered in the empirical section; the domestic interest rate is assumed to be the sum of a constant world interest rate $r^* > 0$ and a country-premium that is increasing in a detrended measure of aggregate debt,

[16] See Alesina and Tabellini (1990b) for a model where each party cares only about her personal consumption, in such a case the borrowing implications are very different.

[17] See Cuadra and Sapriza (2008) and Prosperi (2016) for a discussion of the case when the government can actually default.

as in Garcia-Cicco et al. (2010), i.e.:

$$r_t = r^* + \xi \left(e^{\tilde{d}_{t+1} - \bar{d}} - 1 \right). \tag{4}$$

The variable $\tilde{d}_t$ denotes the aggregate level of debt, which is taken as given, ξ measures the sensitivity of the interest rate to the debt position, and $\bar{d}$ is a reference point. In equilibrium $\tilde{d}_t = d_t$. Also, since the economy ends at T it must be that $d_{T+1} = 0$.

Remark. As discussed in Schmitt-Grohé and Uribe (2003), standard small open economy model, in which domestic residents have only access to a risk-free bond whose rate of return is exogenously determined abroad, have the undesired property that the steady-state of the model depends on initial conditions, more specifically upon the country's initial net foreign asset position. In other words, the equilibrium dynamics of the model follow a random walk component and the distribution of debt is unbounded. In their seminal paper, Schmitt-Grohé and Uribe (2003) present several ways to *close* small open economy models, that is to slightly modify the model specifications so that the model is stationary, i.e. does not depend on initial condition; assuming a debt-elastic interest rate is one of this approach, which we adopt as it is particularly convenient in our framework.

Output is assumed to follow a first-order autoregressive process, i.e.:

$$\log(y_t) = \rho_y \log(y_{t-1}) + \sigma_y \epsilon_t,$$

where $\epsilon_t \sim N(0, 1)$. In each period, the party in power (incumbent) decides the amount of borrowing (lending) in the one-period bond (d_{t+1}) and the allocations of consumptions across the different type of agents, such that $\sum_{i=1}^{N+1} c_t^i = c_t$.

3.3 Political Economy

We consider a political environment where political power fluctuates between the $N + 1$ parties. Hence, we introduce political uncertainty in the model as an additional stochastic process. Also, as in Acemoglu et al. (2011), the incumbent decides consumption allocation between groups, but in our case the incumbent decides the amount of debt next period.[18] As in Acemoglu et al. (2011) the timing is as follows:

1. In each period t, we start with one party, i, in power.

2. Exogenous output y_t realizes.

[18] Acemoglu et al. (2011) considers a closed economy with zero external borrowing.

3. Party i chooses the level of aggregate consumption c_t by choosing the quantity of debt to carry to the next period, d_{t+1}.

4. Given the level of aggregate consumption c_t, party i chooses consumption allocations for each type of agents, c_t^i, subject to the feasibility constraint $\sum_{j=1}^{N+1} c_t^j = c_t$.

5. Political uncertainty resolves. In an economy with transparency, the re-election probability parameter p, which determines the likelihood that an incumbent will be in power also in the next period, is constant. Instead, with lack of transparency p follows a first order Markov process. In this case, then, the probability of party j to retain office in $t+1$ depends on the level of aggregate consumption c_t, and it is equal to $p(c_t)$, where $p(\cdot)$ is a continuously differentiable and increasing function. If the incumbent j is not reappointed (event with probability $1 - p(c_t)$), then the opposition parties have equal probability of being in power. Hence, each opposition party will be in office in period $t+1$ with probability $\frac{1-p(c_t)}{N}$.

In Appendix C we describe in detail the Symmetric Markov Perfect Equilibrium that arises from this political environment.

Remark. In the rest of the paper we assume that the function $p(c)$ is given and exogenous. This approach allows us to clearly analyze the difference between the standard case in which the reelection probability is constant to the one in which it depends on economic conditions. Although certainly interesting, micro-funding that function is outside the scopes of this paper, which, in contrast, focuses on the effects of that function, more than on its genesis.

In our framework the political setup induces two kinds of frictions:

1. The uncertainty from political elections together with the political conflict creating disagreement about redistribution (as in Alesina and Tabellini (1990a));

2. The strategic behaviour of the incumbent to increase her probability of re-election by increasing aggregate consumption via borrowing in a non-transparent economy. (see Rogoff (1990) and Rogoff and Sibert (1988))

In the next sections we show that, with commonly used utility function, political uncertainty [1] is not in general sufficient to create incentives for the incumbent to borrow. In contrast, the strategic behaviour induced by lack of transparency [2] is able generate significant amount of borrowing in the economy. This result implies that heterogeneity in the degree of transparency and political conflict can produce large heterogeneity in borrowing decisions that is observable in the data.

3.4 The Benchmark: Transparent Economy with No Political Conflict

In order to study the role of political conflict and lack of transparency in consumption-saving decisions, we use the following strategy. First, we shut down both channels to consider a benchmark model without frictions. Then, we add first political conflicts alone, and we compare the resulting borrowing incentives with the frictionless model. Finally, we include also lack of transparency and we investigate how borrowing incentives are driven by the interaction of these two frictions. To obtain useful analytical results, we first simplify the model assuming that the economy lasts only two periods, $t = 1, 2$, and that output, y, and the interest rate, r, are constant. Since the economy lasts only two periods, no borrowing is allowed in the last period and it will be not optimal to save in the last period; hence $d_3 = 0$. We also assume that the discount factor is $\beta^{-1} = 1 + r$, so that there is no other borrowing or lending incentive in the model other than the one resulting from political frictions.

As a benchmark for comparison we consider a model in which all frictions are eliminated, which happens when a party weights equally the instantaneous utility of each group, i.e. when $\theta_{q,i} = \frac{1}{N+1}$ $\forall q, i \in 1, ..., N+1$. In this case each party is indifferent to be in power or in opposition as that would imply an identical consumption distribution; hence, we have that: $U^I(c_t) = U^O(c_t) = u\left(\frac{c_t}{N+1}\right)$. As evident, in this case the political economy component of the model is shut down, since any incumbent will equally distribute aggregate consumption across agents, and, as a result, the political uncertainty does not play any role. Hence, the solution of the borrowing problem is determined by maximing the intertemporal utility as:

$$\max_{\{c_1,c_2,d_2\}} u\left(\frac{c_1}{N+1}\right) + \beta u\left(\frac{c_2}{N+1}\right)$$
$$\text{s.t. } d_{t+1} = (1+r)\, d_t + c_t - y, \text{ for } t = 1, 2 \quad \text{and } d_3 = 0,$$

with d_1 given. The equilibrium of the frictionless model is given by:

$$u'\left(\frac{y + d_2 - (1+r)\, d_1}{N+1}\right) = u'\left(\frac{y - (1+r)\, d_2}{N+1}\right). \tag{5}$$

This condition implicitly characterizes the optimal debt in the frictionless economy, which we denote as d_2^*, as a function of the parameters d_1, r, N, y. Importantly, note that in this benchmark economy, the optimal level of debt d_2^* is such that consumption is equalized in the two periods, i.e. $c_1 = c_2$.

3.5 The Transparent Economy With Political Conflict

Let us now consider an economy with political conflicts, in which the incumbent i values the utility of his party $\theta_{i,i} = \theta > \frac{1}{N+1}$. We still consider a transparent economy by assuming that the probability of an incumbent to be reelected is a constant and equal to p.

Given a level of aggregate consumption, the incumbent's utility is:

$$U^I(c) = \theta u\left(c^I\right) + (1-\theta)\, u\left(\frac{c-c^I}{N}\right), \tag{6}$$

where c^I is the value of consumption held by the incumbent party. Similarly, each opposition party's utility is:

$$U^O(c) = \frac{(1-\theta)}{N} u\left(c^I\right) + \left(1 - \frac{(1-\theta)}{N}\right) u\left(\frac{c-c^I}{N}\right),$$

since the opposition values θ his own instantaneous utility and $\frac{(1-\theta)}{N}$ the utility of the incumbent and of the other N opposition parties. When there are political conflicts, for a given level of aggregate consumption, c, the incumbent follows the optimal sharing rule that is given by maximizing the incumbent's utility in equation (6), which gives:

$$\theta u'\left(c^I\right) = \frac{(1-\theta)}{N} u'\left(\frac{c-c^I}{N}\right). \tag{7}$$

Therefore, in case of political conflicts, the incumbent maximizes the intertemporal utility with respect to $\{c_1, c_2, d_2\}$, anticipating that the incumbent at period 2 will repay the public debt, and will implement the optimal sharing rule.[19] Hence, the problem for the incumbent is then, given d_1:

$$\max_{\{c_1,c_2,d_2\}} U^I(c_1) + \beta\left[pU^I(c_2) + (1-p)\, U^O(c_2)\right]$$

$$\text{s.t. } d_{t+1} = (1+r)\, d_t + c_t - y, \text{ for } t = 1,2 \quad \text{and } d_3 = 0,$$

$$\theta u'\left(c_t^I\right) = \frac{(1-\theta)}{N} u'\left(\frac{c_t - c_t^I}{N}\right), \text{for } t = 1,2.$$

The equilibrium condition of this problem is:

$$U^{I'}(y - (1+r)\, d_1 + d_2) = \left[pU^{I'}(y-(1+r)d_2) + (1-p)\, U^{O'}(y-(1+r)d_2)\right], \tag{8}$$

[19] Suppose, instead, that the incumbent does not apply the optimal sharing rule. Then, the incumbent at period 2 could threaten the incumbent at period 1 by applying a more severe sharing to induce him not to overborrow. Such an equilibrium would not be sub-game perfect, since in the stage game the incumbent will never implement a different sharing rule. This kind of reasoning always applies with finite games.

where

$$U^{I'}(c) = \theta u'\left(c^I\right)\frac{\partial c^I}{\partial c} + \frac{(1-\theta)}{N}u'\left(c^O\right)\left(1-\frac{\partial c^I}{\partial c}\right), \tag{9}$$

$$U^{O'}(c) = \frac{(1-\theta)}{N}u'\left(c^O\right)\frac{\partial c^I}{\partial c} + \frac{1}{N}\left(1-\frac{(1-\theta)}{N}\right)u'\left(c^O\right)\left(1-\frac{\partial c^O}{\partial c}\right), \tag{10}$$

where $c^O = \frac{c-c^I}{N}$ is the amount of consumption of each opposition party. The equilibrium condition (8) defines the equilibrium level of debt in case of political conflict, $\tilde{d}_2^*$. Political conflicts affect the intertemporal decision of the incumbent. When the incumbent is deciding the optimal level of debt, she takes into account that the marginal cost of an extra unit of debt in period-1 is the weighted average of the period-2 marginal utility of being incumbent and opponent. Depending on the relative size of these two marginal utilities, political conflicts can generate more saving or more borrowing with respect to the frictionless case. Proposition (1) states the conditions for having more saving in a partisan economy with respect to the frictionless economy.

Proposition 1. ***Political Conflicts and Savings.*** *Consider the political economy model as specified above; then the following statements are equivalent:*

(a) $\tilde{d}_2^* \leq d_2^*$, *i.e. political conflicts generate saving incentives*

(b) $U^{I'}(c) \leq U^{O'}(c)$

(c) $\theta \geq \frac{\partial c^I}{\partial c}$

(d) $\frac{u''(c^O)}{u''(c^I)} \leq \left(\frac{u'(c^O)}{u'(c^I)}\right)^2$

See Appendix D.1 for the proof. This result is in contrast with Amador and Aguiar (2011), which showed that political frictions generate incentive for borrowing. The reason for their result is that they modelled political frictions using the opportunistic approach were the incumbent has *per se* larger marginal utility than the opponent. In our setting that is not generally the case. In fact, Proposition 1 states that when the marginal utility of the incumbent is lower then the marginal utility of the opponent then political conflicts induce saving incentives. This is an intuitive result: if that condition is satisfied, a unit of consumption is more valuable for the opposition than for the incumbent. Hence, a party is willing to move resources from the incumbent state to the opposition state. Given that in time $t = 1$ the decision maker is the incumbent and that there is some positive probability that at time $t = 2$ that agent will be at the opposition, she is then willing to move resources intertemporallty from $t = 1$ to $t = 2$. Notice that, as equations (9) and (10) show, the marginal utilities of the incumbent and opposition depend on the property of the utility function not only through its first derivative u', but also from its second derivative through the sharing rule $\frac{\partial c^i}{\partial c}$. In fact, by using the implicit function theorem on equation (7), it is trivial to show that:

$$\frac{\partial c^I}{\partial c} = \frac{\frac{1-\theta}{N^2} u''\left(\frac{c-c^I}{N}\right)}{\theta u''(c^I) + \frac{1-\theta}{N^2} u''\left(\frac{c-c^I}{N}\right)}. \tag{11}$$

The shape of the utility function is then a crucial determinant on the role of political frictions. We now define a general class of utility functions that have the useful property of implying a proportional optimal sharing rule.

Definition 1. **Proportional Sharing Rule.** An utility function satisfies the Proportional Sharing Rule (henceforth, PSR) property if the derivative $\frac{\partial c^I}{\partial c}$ solution of the optimal sharing rule in equation (7) is constant, i.e. if:

$$\frac{\partial c^I}{\partial c} = \psi, \quad \forall \psi \in \Re.$$

The following corollary defines the condition for a utility function to satisfy the PSR.

Corollary 2. *Consider an utility function $u(c)$ and denote with $g(\cdot)$ the inverse of its marginal utility. If for any two real positive numbers, a and x, $g(\cdot)$ satisfies the following property:*

$$g(ax) = h(a)g(x) + l(a), \tag{12}$$

where $h(\cdot)$ and $l(\cdot)$ are real-valued functions, then the utility function $u(c)$ also satisfies the PSR property.

See Appendix D.2 for the proof.

Condition (12) is quite general. In fact, it is satisfied for any utility function that belongs to the hyperbolic absolute risk aversion (HARA) utilities, as proved in the following Corollary.

Corollary 3. ***HARA utility function and PSR.*** *An utility function that belongs to the class of Hyperbolic Absolute Risk Aversion (HARA) utility functions, i.e. such that:*

$$u(c) = \frac{\sigma}{1-\sigma}\left(\frac{ac}{\sigma} + b\right)^{1-\sigma}$$

with $a > 0$ and $\frac{ac}{\sigma} + b > 0$, satisfies the PSR property.

See Appendix D.3 for the proof. As a consequence, the most common utility functions

(CRRA, logarithm, linear, quadratic, exponential) satisfy the PSR property. An interesting consequence of proposition 1 arises when considering the CRRA utility function.

Corollary 4. ***CRRA and Savings**. Consider the political economy model as specified above: if* $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$*, then:*

(a) $\frac{\partial c^I}{\partial c} = \psi = \frac{\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}{1+\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}$.

(b) $\theta \geq \psi \iff \sigma \geq 1$.

(c) $\tilde{d}_2^* \leq d_2^* \iff \sigma \geq 1$*, with* $\tilde{d}_2^* = d_2^* \iff \sigma = 1$.

See Appendix D.4 for the proof. In the case of the CRRA utility function the saving condition is always satisfied whenever $\sigma \geq 1$. When $\sigma \to 1$ (log utility case) the marginal utility of the incumbent is equal to the marginal utility of the opposition party, and by Proposition 1 the equilibrium under political uncertainty is identical to the one in the frictionless economy, for any value of p or θ. Hence, when considering logarithm instantaneous utility, political uncertainty does not affect the consumption-saving decision.

As pointed out, the incentive for an incumbent to save relies on the willingness to bring resources from its incumbent state to a possible opposition states. When the latter is less likely, the saving incentive is reduced. The next corollary formally states this feature.

Corollary 5. ***Political uncertainty and Savings**. Assuming that the utility function satisfies the PSR property and it is such that* $U^{I'}(c) \leq U^{O'}(c)$*, then* $\frac{\partial \tilde{d}_2^*}{\partial p} > 0$ *and* $\lim_{p \to 1} \tilde{d}_2^* = d_2^*$.

See Appendix D.5 for the proof.

The 2-period case that we have discussed in this section, had been already studied in Alesina and Tabellini (1990b). The authors studied the case with $\frac{1}{2} < \theta < 1$ and derived the same condition for borrowing that is presented in proposition 1 in terms of ratios of the *concavity index* defined by Debreu and Koopmans (1982). As it is stated in our Proposition 4 they argue that for the CRRA case, the borrowing condition is satisfied whenever $0 < \sigma < 1$. The problem is that this assumption makes it difficult to reconcile model predictions with data.[20] Since our final goal is to use a model that has realistic implications in the quantitative analysis, in what follows we assume that $\sigma \geq 1$. In this case, then, without any other friction, political uncertainty and political conflict do not generate borrowing incentives.

[20]The responsiveness of consumption growth to a variation of the interest rate is completely determined by $1/\sigma$ as in standard intertemporal model with CRRA utility functions. This means that with $\sigma < 1$ consumption growth is highly responsive to interest rate, an implication that the literature has found irreconcilable with the data. Furthermore, in macro finance literature $\sigma < 1$ does not provide any good result in explaining how agents face risky decisions.

Finally, the last implication of Corollary 5 states that when political uncertainty disappears, i.e. $p = 1$, the precautionary saving motives for an incumbent disappears, since it will certainly stay in power forever. In this case, political conflict does not alter the optimal decision of debt with respect to the benchmark frictionless economy.

3.6 The Non-Transparent Economy With Political Conflict

In the previous section we have pointed out that, under the commonly used parameterization of utility functions, political uncertainty alone does not generate borrowing incentives. In this section we now introduce an important feature of our model, i.e. lack of transparency, which we assume induces retrospective voting. We show that this feature is able to provide borrowing incentives and, most importantly, it interacts with political conflicts in the similar way as empirically estimated in Section 2. In what follows we modify the model presented above by assuming that the probability of being reelected is an increasing function of the aggregate consumption, $p(c)$, and we assume that that the instantaneous utility function $u(\cdot)$ satisfies the PSR property, i.e. $\frac{\partial c^I}{\partial c} = \psi$. The problem for the incumbent is, then, given d_1:

$$\max_{\{c_1, c_2, d_1\}} U^I(c_1) + \beta \left[p(c_1) U^I(c_2) + (1 - p(c_1)) U^O(c_2) \right] \tag{13}$$

$$\text{s.t. } d_{t+1} = (1 + r) d_t + c_t - y, \forall t = 1, 2 \quad \text{and } d_3 = 0, \tag{14}$$

$$\text{and } \theta u'\left(c_t^I\right) = \frac{(1-\theta)}{N} u'\left(\frac{c_t - c_t^I}{N}\right) \ \forall t = 1, 2, \tag{15}$$

The first order condition of this problem reads:

$$U^{I'}(c_1) + \beta p'(c_1) \left[U^I(c_2) - U^O(c_2) \right] = p(c_1) U^{I'}(c_2) + (1 - p(c_1)) U^{O'}(c_2) \ . \tag{16}$$

The solution of this equilibrium condition delivers the optimal level of debt in a non-transparent economy, $\hat{d}_2^*$.

Comparing the equilibrium condition above with the equilibrium condition of the economy with constant probability of re-election (equation (8)), lack of transparency adds an additional term to the marginal benefit of borrowing, since increasing debt, and therefore aggregate consumption, now increases the probability of being re-elected by $p'(c)$. A higher probability of being re-elected has a value equal to the difference in utility between the incumbent state and the opposition state at period 2. Since this difference is always positive, and since $p'(c) > 0$, this additional term increases the marginal utility of borrowing. Notice that the first order condition in (16) could not be a sufficient condition for the equilibrium. In Appendix D.6, Lemma 7, we display the sufficient condition on $p(c)$ to guarantee that the equilibrium condition (16) characterizes a global maximum.

Under those conditions, we can prove the following proposition.

Proposition 6. ***Lack of Transparency and Borrowing****. Assume conditions (25)-(26) are satisfied. Define as $\hat{d}_2^*$ the solution of the the two period model with lack of transparency that solves equation (16); define as $\tilde{d}_2^*$ the solution of the model with transparency that solves (8); define as d_2^* the solution of the frictionless benchmark model that solves equation (5), then:*

1. *Given a degree of political conflict $\theta > \frac{1}{N+1}$, a non-transparent economy has higher borrowing incentives than a transparent economy, i.e. $\tilde{d}_2^* < \hat{d}_2^*$;*
2. *If $p'(c)$ is large enough, than a non-transparent economy with political conflict has higher borrowing incentives than the benchmark frictionless economy, i.e. $d_2^* < \hat{d}_2^*$*

See Appendix D.7 for the proof. Proposition 6 is a crucial result to link political friction to borrowing incentives. In fact, when local maxima of problem (13)-(15) are ruled out, we can formally prove that lack of transparency reduces saving incentives generated by political uncertainty and can create borrowing incentive if the sensitivity of the probability of being reelected is sensitive enough to aggregate consumption.

In Appendix D.8 we investigate analytically these questions for log utility function and linear probability, i.e. when:

$$p(c) = \gamma + \alpha(c - \bar{c}) \tag{17}$$

Notice that here the parameter α incorporates the degree of lack of transparency: if $\alpha = 0$, then the reelection probability is constant and equal to γ; instead, the larger α, the strongest the reelection probability is linked to economic performances.[21]

Remark. This reduced form for the reelection probability can be rationalized with a background model as in Alt and Lassen (2006), in which government debt cannot always be observed instantaneously and from the government budget constraint, this implies that the incumbent can raise debt in order to appear more able in providing public or consumption goods. In this context one could interpret transparency as fiscal/budget transparency, which affects voters' ability to monitor government budgetary policies, or to observe and accurately assess government debt before the election.

[21] Although potentially this function could obtain values outside the $[0, 1]$ interval, in the following exercise we make sure that the realizations of the election probability lie in that interval.

Remark. Our assumption that in less transparent economies election outcomes depends more on macroeconomic performance is supported by the finding in the literature on political business cycles (henceforth, PBC). Several works have addressed the empirical plausibility of the existence of PBC; although at first evidence appeared to be weak, more recent studies have pointed out the importance of controlling for the quality of institutions. For example, Brender and Drazen (2008) analize 350 election campaigns in 74 democracies and find that strong macroeconomic performance is associated with a higher probability of reelection only in the less developed countries and in younger democracies. Similarly, while Western European high-income countries pooled studies are contradictory (see Lewis-Beck and Stegmaier (2000) for a review), economic conditions are important determinants of the vote in lower-income countries in Eastern Europe (see Pacek (1994)), Latin America (Remmer (1991)), and a broader set of developing countries (Pacek and Radcliff (1995)). In addition, Alt and Lassen (2006) highlight the difference between strength of democracy and transparency; they find that even among advanced democracies, which therefore do not vary much in terms of strength of democracy, significant opportunistic electoral cycles are conditional on the transparency of budget institutions and that in countries with less transparent institutions the political business cycle appears, whereas that is not the case in higher-transparency countries.

In the specific case of linear probability as defined in (17), we can easily check that: (i) borrowing solutions always exist; (ii) we can always characterize a threshold level for $\tilde{\alpha}$ s.t. if $\alpha > \tilde{\alpha}$ we have positive level of debt; (iii) $\tilde{\alpha}$ is independent of θ; (iv) when utility is logarithmic then $\partial d_2/\partial\theta > 0$ when $\alpha > \tilde{\alpha} = 0$.

3.7 Debt Incentives in a T-period model

Here we generalize the model by considering an economy with T large. This generalization is important since one of our goal is to study the impact of political frictions on the level of debt of the economy.

Remark. Once we move to a model with more than two periods, political uncertainty and lack of transparency leads to time inconsistency. As a consequence, it is not possible to derive a standard recursive formulation of the agent problem because when political uncertainty is present in each period, the incumbent discounts differently the utility between today and tomorrow with respect to two periods in the future, because of the compounded probability that makes more unlikely to be in power in the distant future. The existence of lack of transparency acerbates this problem as discounting depends on an endogenous variable (consumption). Since standard recursive methods in an infinite horizon are not suitable in

Table 5 – Equilibrium Level of Debt in a T-period model

		Lack of Transparency		
		No: $\alpha = 0$	Medium: $\alpha = 1$	High: $\alpha = 1.5$
Conflict	No: θ=0.5	0	0	0
	Medium: θ=0.7	-12.4	0.2	10.4
	High: θ=0.9	-35.7	7.7	58.1

Note: In this table we report the average level of debt (in percentage) in a T-period economy, with T = 1000, when assuming CRRA utility function and linear probability, for different values of degree of lack of transparency (α, x-axis) and degree of political friction, θ. Negative values denote savings.

this case, as the value function of the agent depends on time, we alternatively allow for an arbitrarily large number of periods and we solve the problem of the incumbent by backward induction by assuming that each party plays Symmetric Markov Strategy.[22]

In this section we assume that the election probability is linear, as defined in (17).[23] To show that the analytical results we have derived for a 2-period model hold even in a large-T economy, we numerically solve the model and compute the average level of debt as a function of the two main parameters of interest: the degree of political friction, θ, and the degree of transparency, α. For illustrative purpose, in this exercise we shut down fluctuations in output, so that political shocks are the only source of uncertainty. The rest of the parameters are calibrated as discussed in Section 4.1.

Table 5 shows how the average equilibrium level of debt (measured in percentage of the GDP) varies with the degree of political friction, θ, and the degree of lack of transparency, α, when considering an economy that lasts for $T = 1000$ periods. Several results are worth noting. First, not surprisingly, when political frictions are absent (i.e. $\theta = 0.5$, since we assume that there are only two parties, $N = 1$) the economy experiences no borrowing or saving, since in this case there is no incentive for the incumbent to distort voting; in other words the only uncertainty in the economy, which is political uncertainty, is irrelevant and, as a consequence, there are no incentive to save or borrow. In contrast, when political frictions arise (i.e. $\theta > 0.5$) Table 5 highlights two important features of the model.

1. Consistently with the analytical results derived for the two period model, for a given level of θ, the economy on average accumulates savings when voters live in a transparent economy, i.e. for low values of α, and the economy in average accumulate debt when lack of transparency arises (i.e. for large values of α).

[22]See Azzimonti et al. (2014) as another politico-economic equilibrium in which it is not possible to prove the existence of an invariant policy function; also in that work the quantitative analysis is conducted assuming a large number of periods T.

[23]In Appendix E we show the robustness of the results when assuming a non-linear utility function that is always bounded in the interval $[0, 1]$.

2. Consistently with the analytical results derived for the two period model, the effect described above are more pronounced when political conflicts are stronger. In fact, when θ increases, precautionary saving are even larger in a transparent economy, and borrowing incentives are stronger in a non-transparent economy.

3. Qualitatively the relation between θ, α, and debt in the model resembles the one observed in the data as described in Table 2.

4 Bringing the Model to the Data

In this section we investigate whether political conflicts and transparency are able to capture the different level of debts across countries as well as other important political economy and macroeconomics features. Specifically, our strategy is as follows. First, we select observable moments in the model that have a clear counterpart in the data. We will show that these moments are affected by the degree of transparency, α, and political conflicts θ. Then, for each country we use the prediction of our model to estimate these two parameters. We then show that these two channels are able to replicate the observed heterogeneity in debt levels and other macroeconomic fundamentals, and, importantly, that the estimated degree of transparency and political conflict are indeed highly correlated with their proxies we have used in the empirical section. We consider the same economies considered in the empirical section and listed in Appendix B.

4.1 Strategy and Calibration

First, we calibrate some parameters that remain constant across the different economies. Our goal is to investigate whether heterogeneity in transparency and political frictions alone can explain the heterogeneity in debt levels and other macroeconomic variables. Hence, we shut down possible heterogeneity in preference and on financial markets, but we allow for heterogeneity in the output process. We fixed the word interest rate $r^* = 0.07$, which correspond at an annual rate of 7%, as reported in Uribe and Yue (2006). The subjective discount rate is then pinned down such that $\beta = (1+r^*)^{-1} = 0.9346$. The coefficient of relative risk aversion, σ, is assumed to be 2. The debt elasticity of the interest rate, ξ is fixed at 0.1. The reference level of debt in the interest rate equation is assumed to be zero, which is $\bar{d} = 0$.[24]

[24]An alternative approach would be to assume that either preferences and/or financial markets are also country specific, which would imply cross sectional variation on β, σ, ξ and $\bar{d}$. As the goal of this quantitative section is to investigate whether heterogeneity in transparency and political frictions *alone* can explain the heterogeneity in debt levels and other macroeconomic variables, we have taken the stand to assume that

We consider a linear probability function as in equation (17), i.e. $p(c) = \gamma + \alpha(c - \bar{c})$, and we fixed the reference parameter $\bar{c}$ to be equal to 1; this value is identical to the unconditional mean of the exogenous endowment, in level, received by the agents in each period. Hence, if consumption in a given period is greater than the unconditional mean, the electorate is more likely to vote for the incumbent in a non-transparent economy ($\alpha > 0$).

The remaining parameters are assumed to be country-specific. The parameters that define the stochastic process for output are directly estimated from output data, by fitting an $AR(1)$ process on the deviation of the logarithm of GDP from its cubic trend, as in Garcia-Cicco et al. (2010). Hence, the deviation from the trend, in log, for country i follows: $y_t^i = \rho_i^y y_{t-1}^i + \sigma_i^y \epsilon_t^i$, where ϵ_t^i are iid, in the time dimension and cross-section dimension, disturbances. Hence, for each country, we will estimate directly from detrended GDP data the persistence of the income process, ρ_i^y, and the standard deviation of the error term, σ_i^y. Given that the utility function features risk aversion, different degrees of uncertainty in output realization imply different strength of precautionary saving motive.

Finally, there are three parameters to be estimated that are related to the two main channels introduced in our model; α_i, which measure the degree of retrospective voting, which we interpret as the degree of lack of transparency; γ_i, which is the probability of reelection of an incumbent in a transparent economy; and θ_i, which measures the degree of political conflict. We estimate these parameters by asking the model to replicate some features of the data, using a GMM-approach.

Specifically, for each country i, we estimated $\Theta_i = \{\alpha_i; \gamma_i; \theta_i\}$ as:

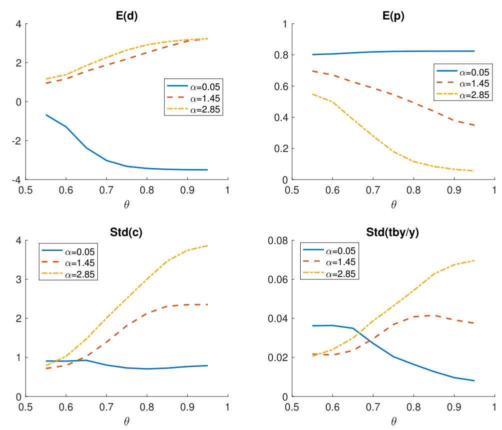
$$\Theta_i = \arg\min \left[E(Y_i) - E(Y(\Theta_i; \tilde{\Theta}_i))\right]' W_i \left[E(Y_i) - E(Y(\Theta_i; \tilde{\Theta}_i))\right], \tag{18}$$

where $E(Y_i)$ is a set of data moments, $E(Y(\Theta_i; \tilde{\Theta}_i))$ is their model counterpart, which are a function of the parameters to be estimated, Θ_i, and of the other calibrated parameters, gathered in the vector $\tilde{\Theta}_i = \left\{\rho_i^y, \sigma_i^y, \beta, \sigma, \bar{d}, r^*, \xi, \bar{c}, N\right\}$, and W_i is a weighting function. The weighting function is computed through a conventional two-step GMM procedure. The model moments are computed simulating the economy with $T = 1000$ periods, and eliminating the first and last 100 observations in order to clear the results from initial and end conditions. We include the following four moments, which are well defined in the model and that are directly observed in the data (see Appendix A for a complete description of the data source). The first moment is the average probability of reelection. This moment aims to make the model able to match the country-specific political turnover. The second moment is the average level of debt

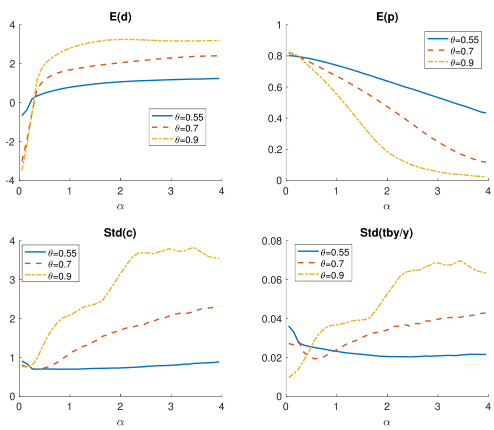
preferences and the supply equation of loans from international investor in equation (4) is not country specific.

to output ratio, which aims to make the model to match the borrowing/saving outlook of a country. The third moment is the standard deviation of consumption, which is partly due to the variation in income that are taken into account by the calibrated parameters ρ_i^y and σ_i^y and to the country borrowing/saving dynamics. The fourth moment is the standard deviation of the trade-balance-to-output ratio, which is driven mainly by the borrowing/saving dynamics. To show that these four moments are able to identify the three parameters of interest, in Figure 3 we simulate the model and display how these moments vary with θ_i (left panel) and α_i (right panel), for a given level of $\gamma_i = 0.75$, and assuming that $\rho^y = 0.75$ and $\sigma^y = 0.02$. We can observe that variations in the two parameters imply a large heterogeneity in the level of debt, as explained in the previous sections, in the reelection probability, and in the variance of consumption and trade-balance, which are not equivalent even qualitatively especially for low level of α_i. Also, our model predicts that high reelection probability can coexist with high levels of political conflict in very transparent economies; nevertheless, political instability emerges in non transparent economies: large debt accumulation reduces consumption in the long run and consequently reduces reelection probability. This result reconciles with the findings in Easterly and Levine (1997), which shows that the univariate relationship between political instability and ethnical conflict is rather ambiguous.

Figure 3 – Model Moments as function of Political Frictions and Transparency



(a) Moments and θ



(b) Moments and α

Note: In this Figure we plot the model-implied value of average debt (top-left panel), average reelection probability (top-right panel), standard deviation of consumption (bottom-left panel), and standard deviation of trade-to-output ratio (bottom-right panel), as a function of the degree of lack of transparency, θ_i(left panel) and political conflicts α_i (right panel), keeping fixed the other parameter. The other country-specific parameters are fixed as follows: $\gamma_i = 0.75$, $\rho_i^y = 0.75$, and $\sigma_i^y = 0.02$. The moments are average of simulation with length $T = 1000$.

4.2 Fit

The first question to address is whether the three estimated parameters are able to provide a reasonable match for the four target moments.

In Figure 4 we display the cross-sectional fit of the four moments. Specifically for each of the four moments (average mean reelection probability, top-left panel; mean debt-to-gdp ratio, top-right panel; standard deviation of consumption, bottom-left panel; standard deviation of trade-balance to output ratio, bottom-right panel), we plot the data value for each country in the y-axis and its model counterpart computed at the estimated parameters value. If the model was able to perfectly match the data the scatter plots would lie in the 45 degree line (displayed with a continuous blue line). The fit is extremely good for the two first moments (slope of the regression line equal to 0.92 and 0.98, and R^2 equal to 0.97 and 0.98, respectively), while the fit of the two second moments is slightly less impressive, but still satisfactory (slope of the regression line equal to 0.55 and 0.51, and R^2 equal to 0.69 and 0.72, respectively). Since the fit is overall good, we claim that variations in three parameters α_i, γ_i, and θ_i, together with the variations in the income process, are able to capture the cross-section heterogeneity in the four targeted models. Notice, that our estimation procedure attempts to match four moments with only three parameters.[25]

4.3 Hypothesis testing on the mechanism

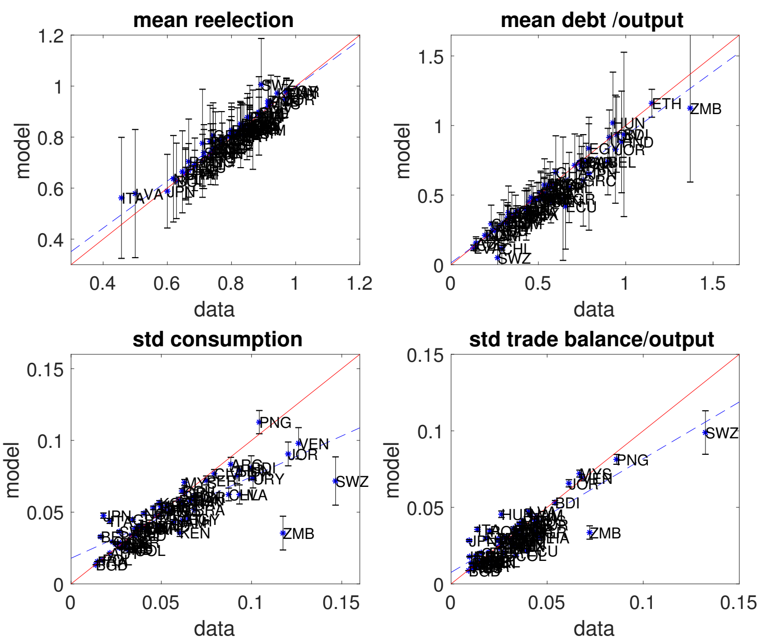
Our empirical strategy estimates the degree of transparency, $\hat{\alpha}_i$, and of political conflicts, $\hat{\theta}_i$ for a country i, only by using data on macroeconomic moments. We now investigate whether the main mechanism in our model, which is the interaction between lack of transparency and political conflict as a driver of debt incentives, is supported by the data. The GMM approach in equation (18) allows us to test the following joint hypothesis, for each country i, by computing the asymptotic distribution of the estimators:

$$\begin{aligned} H_0 &: \ \theta_i = \frac{1}{2}, \ \alpha_i = 0 \\ H_1 &: \ \theta_i > \frac{1}{2}, \ \alpha_i > 0 \end{aligned} \tag{19}$$

[25]One might wonder whether the four moments are collinear. This is not the case, as the cross correlation among the four moments is:

$$\Sigma = \begin{bmatrix} 1 & 0.15 & 0.22 & 0.23 \\ 0.15 & 1 & 0.14 & 0.02 \\ 0.22 & 0.14 & 1 & 0.81 \\ 0.23 & 0.02 & 0.81 & 1 \end{bmatrix}.$$

Figure 4 – Fit



Note: This figure plots the model-implied moments of interest, i.e. average debt (top-left panel), average reelection probability (top-right panel), standard deviation of consumption (bottom-left panel), and standard deviation of trade-to-output ratio (bottom-right panel), at the estimated parameter values the y-axis, with standard error bands, and their data counterpart in the x-axis, for each country in our sample. The red solid line is the 45 degree line. The dashed blue line is the regression line.

For all the country, the resulting F-statistic is very high and the test strongly rejects the null hypothesis.[26] Next, we investigate whether, for each country, $\theta_i = \frac{1}{2}$ and $\alpha_i = 0$, independently. These tests clarify whether the political conflict channel or the transparency channels are detected. In Table 6 we report the estimated parameters $\hat{\theta}_i$, $\hat{\alpha}_i$, and, for completeness, also $\hat{\gamma}_i$, and the associated standard error, in brackets.[27] For 44 out of 66 countries, we reject the null hypothesis of no political frictions, while for 42 countries we reject the null hypothesis of no lack of transparency. We conclude that: *(i)* no country exhibit absence of both frictions; and *(ii)* at least in two third of our sample a country displays either political conflict or lack of transparency.

4.4 Do the estimates capture transparency and political conflict?

We now investigate whether the estimated parameters $\hat{\theta}_i$ and $\hat{\alpha}_i$ do actually relate to the observed proxies of *political conflict* and *lack of transparency*, which we have defined and used in Section 2 for the cross-country regressions.

Recall that the estimation procedure in equation (18) that we have implemented does not use any information regarding the degree of transparency and political conflict of a country,

[26] Results of the F-statistic are available upon request from the authors.

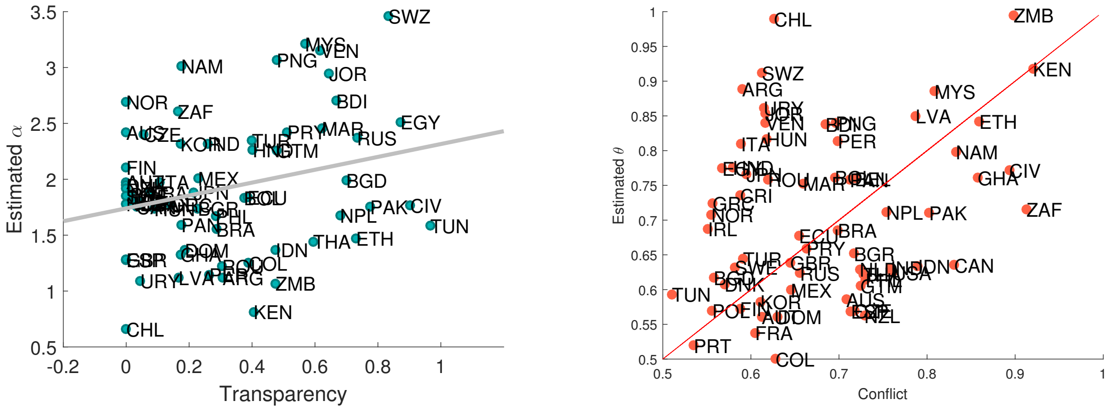
[27] For the intercept of $p(c)$ we tested the null hypothesis of $\gamma = 1$.

Table 6 – Estimated parameters

	$\hat{\theta}$	$\hat{\alpha}$	$\hat{\gamma}$		$\hat{\theta}$	$\hat{\alpha}$	$\hat{\gamma}$
ARG	0.89**	1.12***	0.89	KEN	0.92***	0.81***	1.07
	(0.17)	(0.38)	(0.09)		(0.06)	(0.12)	(0.05)
AUS	0.59***	2.42***	0.88**	KOR	0.58*	2.32***	0.8***
	(0.02)	(0.05)	(0.05)		(0.05)	(0.11)	(0.07)
AUT	0.56***	1.98***	0.85***	LVA	0.85***	1.12***	0.64***
	(0.02)	(0.13)	(0.02)		(0.03)	(0.14)	(0.11)
BGD	0.62***	1.99***	0.76***	MYS	0.89***	3.21***	1.68***
	(0.01)	(0.08)	(0.07)		(0.03)	(0.13)	(0.14)
BEL	0.76	1.79	0.92	MEX	0.6***	2.01***	0.86***
	(0.26)	(3.21)	(0.25)		(0.03)	(0.25)	(0.04)
BOL	0.76	1.84	0.76**	MAR	0.75***	2.46***	1.23***
	(0.24)	(2.32)	(0.1)		(0.02)	(0.12)	(0.05)
BRA	0.69	1.55***	0.86***	NAM	0.8***	3.02***	1.3***
	(0.12)	(0.5)	(0.04)		(0.02)	(0.06)	(0.06)
BGR	0.65	1.74	0.86	NPL	0.71***	1.68***	0.72***
	(0.24)	(3.77)	(0.1)		(0.04)	(0.38)	(0.07)
BDI	0.84***	2.7***	1.3***	NLD	0.63***	1.78*	0.9
	(0.04)	(0.12)	(0.08)		(0.02)	(1.03)	(0.07)
CAN	0.64	1.75	0.85***	NZL	0.56	1.92***	0.82***
	(0.11)	(2.18)	(0.05)		(0.04)	(0.15)	(0.03)
CHL	0.99***	0.66***	1.01	NOR	0.71***	2.69***	0.96
	(0.07)	(0.14)	(0.06)		(0.04)	(0.12)	(0.1)
COL	0.5	1.25***	0.73***	PAK	0.71	1.75	0.86***
	(0.03)	(0.08)	(0.02)		(0.22)	(2.51)	(0.02)
CRI	0.74	1.8	0.85	PAN	0.76	1.59**	0.89***
	(0.36)	(3.6)	(0.14)		(0.17)	(0.78)	(0.03)
CZE	0.57**	2.4***	0.79***	PNG	0.84***	3.07***	1.26
	(0.03)	(0.08)	(0.05)		(0.03)	(0.17)	(0.17)
DNK	0.61***	1.95***	0.87**	PRY	0.66***	2.42***	0.95
	(0.02)	(0.22)	(0.06)		(0.06)	(0.25)	(0.16)
DOM	0.56	1.37***	0.79***	PER	0.81**	1.15***	0.91
	(0.04)	(0.16)	(0.04)		(0.15)	(0.3)	(0.08)
ECU	0.68	1.84	0.74	PHL	0.61	1.67	0.89***
	(0.58)	(8.12)	(0.25)		(0.33)	(4.69)	(0.04)
EGY	0.77***	2.51***	1.28***	POL	0.57***	1.78***	0.84***
	(0.02)	(0.13)	(0.07)		(0.01)	(0.39)	(0.04)
ETH	0.84	1.47	1.11	PRT	0.52	1.87***	0.64***
	(0.24)	(1.21)	(0.07)		(0.04)	(0.19)	(0.05)
FIN	0.57***	2.11***	0.75***	ROU	0.76***	1.22***	0.74***
	(0.03)	(0.16)	(0.06)		(0.08)	(0.18)	(0.1)
FRA	0.54	1.88***	0.63***	RUS	0.62***	2.37***	0.88***
	(0.03)	(0.16)	(0.05)		(0.03)	(0.08)	(0.03)
GHA	0.76***	1.33***	0.94	ZAF	0.72***	2.61***	1.02
	(0.09)	(0.26)	(0.05)		(0.03)	(0.12)	(0.09)
GRC	0.72	1.77	0.89	ESP	0.57*	1.28***	0.83***
	(3.42)	(37.78)	(1.58)		(0.04)	(0.09)	(0.03)
GTM	0.61***	2.26***	0.68***	SWZ	0.91***	3.46***	1.83***
	(0.03)	(0.13)	(0.05)		(0.09)	(0.31)	(0.32)
HND	0.78***	2.26***	1.02	SWE	0.63***	1.85***	0.76***
	(0.02)	(0.34)	(0.1)		(0.03)	(0.53)	(0.07)
HUN	0.82	1.74	0.94	THA	0.62*	1.44***	0.64***
	(3.65)	(27.12)	(0.85)		(0.07)	(0.09)	(0.07)
IND	0.63***	2.32***	0.83**	TUN	0.59	1.58	0.95**
	(0.02)	(0.07)	(0.07)		(0.1)	(1.22)	(0.02)
IDN	0.63	1.37***	0.88***	TUR	0.64***	2.35***	0.75***
	(0.09)	(0.12)	(0.04)		(0.03)	(0.05)	(0.08)
IRL	0.69	1.81	0.81	GBR	0.64***	1.28***	0.85**
	(0.48)	(6.01)	(0.21)		(0.04)	(0.12)	(0.06)
ITA	0.81**	1.98	0.73	USA	0.62***	1.78**	0.84***
	(0.13)	(1.61)	(0.24)		(0.03)	(0.82)	(0.04)
CIV	0.77	1.77	1.04	URY	0.86*	1.09**	0.92
	(0.22)	(2.32)	(0.17)		(0.21)	(0.44)	(0.1)
JPN	0.77*	1.88	0.73*	VEN	0.84***	3.15***	1.46***
	(0.15)	(1.81)	(0.15)		(0.02)	(0.09)	(0.1)
JOR	0.85***	2.95***	1.53***	ZMB	1***	1.07***	1.16**
	(0.03)	(0.2)	(0.14)		(0.11)	(0.39)	(0.07)

Note: In this table we report estimated parameter values of $\hat{\theta}_i$, $\hat{\alpha}_i$, and $\hat{\gamma}_i$. Standard errors are reported in brackets. We denote with *** significance at 1%, with ** significance at 5%, and with * significance at 10%. Specifically, we tested the following null hypothesis $\theta = 0.5$, $\alpha = 0$, $\gamma = 1$.

Figure 5 – Scatterplot of estimated parameters and proxies of transparency and conflict



(a) Estimated α vs Trasparency (b) Estimated θ vs Conflict

Note: In this Figure we plot the relationship between our estimates of political frictions (y-axis) and their data proxies (x-axis). In the left panel we plot the estimated degree of transparency ($\hat{\alpha}_i$) and the proxy $Transp_i$ as defined in section 2. In the right panel we plot the estimated degree of political conflict ($\hat{\theta}$) and the proxy $Confl_i$ as defined in section 2. The solid lines are regression lines.

but it only employs the relationship between re-election probabilities, levels of debt, and consumption and trade balance variances. Therefore, if we find a positive relationship between the two estimates $\hat{\theta}_i$ and $\hat{\alpha}_i$ and the observed proxies of *political conflict* and *lack of transparency*, we can conclude that our simple model is able to attribute cross-country variations of debt to the interaction between transparency and political conflict.

A first natural step to explore whether the estimated parameters $\hat{\theta}_i$ and $\hat{\alpha}_i$ positive correlate with the observed proxies of *political conflict* and *lack of transparency*, is to draw a scatter plot of the model estimates and their proxies, for any given country. In Figure 5a and 5b we plot, on the x-axis, the empirical counterpart of θ and α defined in Section 2, and on the y-axis we plot the estimated $\hat{\theta}_i$ and $\hat{\alpha}_i$. The correlations between model estimates and proxies are positive and equal to 0.26 and 0.27 for political conflicts and transparency, respectively.

Possibile explanation for imperfect fit Although the positive relationship between data and estimates is comforting, nevertheless it is not possible to ignore the evidence that there are disturbances around the linear relationship. The imperfect fitting may arise for two different reasons:

1. **Specification Error:** The model considered in this paper is a rather stylized model of consumption smoothing, in which output is exogenous (i.e. no production), financial markets are competitive, debt contracts are fully enforceable, there are only two possible shocks (to domestic output and to reelection probability) so other relevant internal or external sources of risk are ignored. Whenever these missing features are actually relevant in determining the empirical moments that we have employed in our estimation

strategy (i.e. re-election probability, level of debt, and consumption and trade balance variances), then the estimated parameters $\{\hat{\Theta}_i\}$ may differ from their real value. For example, suppose that debt to GDP is larger in country i than in country j because of different demographic structures that result in different costs of the pension system. Since this element is not present in our model, country i would result as more politically frictioned compared to country j.

2. **Measurement Error:** Another potential source of error comes from the unobservability of the real structural parameters. The proxies for lack of transparency and political conflicts proposed in Section 2 are only imperfect measures of the real institutional frictions. For example, to proxy political conflict we averaged different measures of fractionalization following the literature. As explained in Section 2, the existence of fractionalization might not necessarily imply that a conflict between parties exists. Observing more accurate measures of conflict would reduce the measurement error arising from comparing the structural parameter θ implied and its data proxies. Similarly, we do not observe the degree of lack of transparency, which relates to the degree of retrospective voting in our model, in each country but only possible determinants of the existence of this phenomenon.

Given the argument above, the imperfect fitting resulting in the scatters of Figure 5a and 5b may result from estimating a too stylized model and from comparing the estimates to imprecise proxies. Removing these sources of the errors is not an easy task and it would ideally require developing a richer model or observing different data. Nevertheless, in what follows we try to correct for these possible errors and to investigate whether, when addressing them, the relationship between the data and the estimates becomes stronger or weaker. To address this point we proceed by adding potential omitted factors in the regression of $\hat{\Theta}$, i.e. the structurally estimated parameters of interest, on their proxies from the data, and then testing whether Specification errors and Measurement errors alter the positive relationship between estimated parameters and data proxies. To address the Specification error, we include the same control variables that have used to test the cross section of debt in equation (1). To address the Measurement error we included alternative proxies of conflict and transparency that could help in reaching a more accurate measure of the proxies. Hence, we run the following regressions:

$$\hat{\alpha}_i = \gamma_0 + \gamma_1 Transp_i + \gamma_s X_i^s + \gamma_m Z_i^{m,\alpha} + \eta_i; \tag{20}$$

$$\hat{\theta}_i = \psi_0 + \psi_1 Conflict_i + \psi_s X_i^s + \psi_m Z_i^{m,\theta} + \nu_i; \tag{21}$$

where $Conflict_i$ and $Transp_i$ are the proxies defined in Section 2, X_i^s are the control variables used in the regression (1) and that aim to capture the Specification error, $Z^{m,\alpha}$ and $Z^{m,\theta}$ are control variables that aim to capture the Measurement errors for α and θ, respectively, and η_i and ν_i are *iid* disturbances. Explanatory variables are included in the model as averages in the period available.

In Table 7 we present the results for the two regressions. Regarding transparency, left panel, the first column displays the results for the univariate regression corresponding to the solid regression line in Figure 5a: as expected the coefficient is positive and strongly significant, although the fit is not excellent, since the R^2 is below 0.1. In column 2 (Spec.) we address the Specification error by including a selection of most significant control variables among the one used in regression (1). Recall that these control variables aim to capture possible determinants of debt levels that are not included in our model. Accounting for the Specification error improves quite substantially the fit, since the R^2 increases to 0.35, but, importantly, it does not alter the significant and strong positive relationship between the estimated degree of lack of transparency, and its data counterpart. In column 3 (Meas.) we analyze the role of an alternative interpretation of lack of transparency, that is lack of sophistication, to reduce potential measurement error. We have included the two different variables that capture lack fo sophistication, as described in section 2: *Lack of Education* and *Lack of Social Globalization*. Only the second variable is significant and the fit increases only marginally, but the significance disappear when we include all the controls as displayed in column 4 (Complete). Notice, that even when addressing the Measurement error and in the complete regression, the statistically significant positive relationship between $\hat{\alpha}$, and the proxy of lack of transparency still holds.

The right panel displays the results for the regression for political friction in equation (21). As before, in the first column (Univariate) we present univariate regression of $\hat{\theta}$ on $Conflict$. As expected the slope is positive and significant. In the second column (Spec.) we present multivariate regression with the same controls included in Table 7. In contrast with the α case, the majority of controls that account for the the Specification error are not significant; furthermore, the relation between the estimate $\hat{\theta}$ and the proxy of political conflict becomes not significant, albeit still positive. In column 3 (Meas.) we add only controls for the measurement error, i.e. a measure of dictatorship (No Party allowed) aimed to capture a degree of political friction that is not embodied in fractionalization, the Gini index,[28] as a measure of economic inequality, and political killings, which is a measure of

[28]Remember that, in our model, larger θ implies larger distribution of consumption to the incumbent's party, which results in greater inequality.

realized conflict. We find that measurement controls are strongly significant and improve substantially the fit. Importantly, the significant positive relationship between estimated parameters and our benchmark proxies holds. The same conclusion applies when estimating the complete regression.

To summarize, we found that the estimated institutional parameters in our model, i.e. political conflict and lack of transparency, are positively correlated with the proxies that have been found to explain the cross section of debt-to-gdp across countries. The positive relationship holds when controlling for possible specification errors of the model and measurement errors in the proxy. Our preliminary analysis supports the idea that a less stylized model would probably help in improving the link, but we nevertheless found support that indeed lack of transparency and political conflict can be an important determinant of observed heterogeneity of debt levels across countries.

Table 7 – Estimated parameters, Trasparency and Political Conflict

	Dependent var: $\hat{\alpha}$				Dependent var: $\hat{\theta}$			
	Univariate	Spec.	Meas.	Complete	Univariate	Spec.	Meas.	Complete
Constant	1.74**	-1.21	2.01***	-2.05	0.49***	0.67**	0.26**	0.10
	(16.39)	(-1.18)	(17.13)	(-1.41)	(5.37)	(2.66)	(2.22)	(0.26)
Lack-of-Transp.	0.58**	0.79**	1.11**	0.68*				
	(2.14)	(2.09)	(2.59)	(1.70)				
Political Conflict					0.30**	0.20	0.30**	0.33***
					(2.29)	(1.50)	(2.05)	(2.71)
Energy		0.38***		0.38***		0.01		0.03**
		(4.46)		(4.45)		(0.79)		(2.04)
Business		0.39**		0.38*		0.04		0.05
		(2.22)		(1.80)		(1.08)		(1.40)
GDP per capita		0.23**		0.31**		-0.02		-0.01
		(2.34)		(2.11)		(-1.09)		(-0.20)
Majoritarian		0.32*		0.37**		-0.01		-0.00
		(1.89)		(2.13)		(-0.23)		(-0.11)
Openness		0.60***		0.64***		0.07*		0.02
		(3.15)		(2.76)		(1.96)		(0.41)
Lack of Social Glob			-0.98**	0.10				0.17
			(-2.47)	(0.21)				(1.59)
Lack of Educ			0.08	0.22				-0.09
			(0.25)	(0.45)				(-1.60)
No Parties Allow.				0.15			0.23**	0.20***
				(0.43)			(2.22)	(3.02)
Gini index				0.12			0.37***	0.45***
				(0.09)			(3.47)	(3.43)
Political killings				-0.07			0.04*	0.10***
				(-0.47)			(1.79)	(3.43)
R^2	0.07	0.35	0.17	0.37	0.06	0.22	0.31	0.43
$\bar{R}^2$	0.06	0.28	0.13	0.24	0.05	0.15	0.26	0.31
N	66	66	66	66	66	66	66	66

Note: This table presents the results of regression (20) (left panel) and for (21) (right panel). The univariate regression displays the link between estimated degree of lack-of transparency, $\hat{\alpha}_i$ and its proxy observed in the data, $Transp_i$ (left panel) and $\hat{\theta}_i$ and its proxy observed in the data, $Confl_i$ (right panel). The regression labelled Spec includes control variables X_i^s that capture the Specification error. The regression labelled Meas. includes control variables $Z_i^{m,\theta}$ that capture the Measurement error. The final regression is the complete regression. For each country, all variables are calculated as sample average.

5 Conclusion

In this paper we study the relationship between cross-country sovereign debt, lack of transparency and political conflicts. Our first set of results is empirical. Whereas these two variables, *per-se*, are not significant determinants of observed debt levels across countries, their interaction is a key factor to explain debt-levels heterogeneity. In fact, whereas the simple regression of debt levels on political conflict and lack of transparency yields insignificant coefficients, their interaction term is positive and significant. This implies that if political conflict increases in a transparent economy (low lack of transparency values), its effect on debt is negative (which means it incentivizes saving); on the contrary, in a non-transparent economy (high lack of transparency values) large political conflicts induce borrowing (more debt).

Then, we propose a model that rationalizes these findings. We incorporate political conflicts and transparency into a conventional open-economy real business cycle model. Regarding political conflict, similarly to Alesina and Tabellini (1990b), parties have preferences over distribution across different groups and decide the allocation of consumption according to these preferences. Regarding lack of transparency, we assume that in more non-transparent economies, the probability of an incumbent to be re-elected is more strongly a function of current economic conditions. This model can generate the empirical finding that in a transparent economy, political conflict generates savings, since an incumbent has a precautionary saving motive driven by political uncertainty, while with lack of transparency it incentivizes borrowing, since a higher amount of resources in the economy increases re-election probability.

We then use the theoretical prediction of our model about macroeconomic aggregates to estimate the two frictions. Using a GMM approach, our strategy yields a cross section set of estimates for the two parameters of interest, the degree of political conflict and lack of transparency. Notice that we use only observed macroeconomic moments to estimate these frictions, without using any information about the actual degree of these frictions. Hence, the second natural step is to investigate how our estimates correlate, in the cross-section, with observed proxies of political conflict and lack of transparency. Our finding can be summarized as follows. First, the model strongly supports the existence of these frictions and the estimated frictions positively and significantly relate to their data counterparts. Third, once one takes into account possible sources of bias, the positive relationship becomes even stronger. Hence, we are confident that the mechanism proposed in our model can rationalize the empirical importance of the interaction between political conflict and lack of transparency as observed in the data.

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A Appendix: Data Source

Institutional variables come from different sources that are collected in the Quality of Government dataset Teorell et al. (2011).

A.1 Debt-to-GDP

Debt to GDP data has been collected from Reinhart and Rogoff (2010) and Jaimovich and Panizza (2010). From Reinhart and Rogoff (2010) we took debt to GDP measured as the share of total gross general public debt (domestic and external) over gross domestic product, last year available 2009.[29] Country coverage has been extended by using the dataset of Jaimovich and Panizza (2010) at the cost of fewer observation in the time-dimension (until 2005), where the debt data refers to gross central (as opposite to general) government debt and for this reason it is not fully comparable with the data in Reinhart and Rogoff (2010). Gross domestic product is extracted from the World Bank dataset, is calculated at constant local currency prices. In fact, from this dataset we can also include the following countries: Bangladesh, Burundi, Czech Republic, Ethiopia, Jordan, Latvia, Namibia, Nepal, Pakistan, Papua New Guinea, Swaziland.

A.2 Transparency proxies

- *Functioning of Government (FOG)*: This variable examines to what extent the freely elected head of government and a national legislative representative determine the policies of the government; if the government is free from pervasive corruption; and if the government is accountable to the electorate between elections and operates with openness and transparency. Countries are graded from the worst to the best.
- *Freedom of Expression and Belief (FEB)*: This variable measures the freedom and independence of the media and other cultural expressions; the freedom of religious groups to practice their faith and express themselves; the academic freedom and freedom from extensive political indoctrination in the educational system; and the ability of the people to engage in private (political) discussions without fear of harassment or arrest by the authorities. Countries are graded from the worst to the best.

The source for the two variables is Freedom House. https://freedomhouse.org. Other proxies from this source have been used to define an alternative transparency index that has been used in regression (12) of Table 3. The available sample for these variables is 2005-2008, see Table A.7.

A.3 Political conflict proxies

- *Ethnic, linguistic and religious fractionalization*: Fractionalization expresses the probability that two randomly selected individuals from the population will not belong to the same ethnic/linguistic/religious group. Time coverage differs across countries. Source Alesina et al. (2003).

[29] We made few exceptions due to data availability. In Tunisia we choose total non-financial public sector debt over GDP, while for UK we choose net central public debt over GDP.

A.4 Control Variables used in Section 2

- *Credit*: domestic credit provided by the banking sector. Source World Development Indicators (WDI)
- *GPDpc*: GDP per capita (PPP, constant 2005 international $) . Source WDI
- *GDP growth*: annual growth rate of GDP per capita. Source WDI
- *Openness*: sum of export and imports over GDP. Source Penn world tables
- *Majoritarian*: fraction of years in which the country had majoritarian system. Source Norris (2009)
- *Energy*: per-capita energy production (kt of oil equivalent). Source WDI
- *Business*: variable easiness of doing business. Source WDI
- *Pop>65*: share of the population over 65 years old. Source WDI

Lack of sophistication is the average of two different proxies:

- *Lack of Education*: (inverse of) number of students at universities or other higher education institutions per 100000 inhabitants. Source: Index of Power resources Vanhanen (2004)
- *Lack of Social Globalization*: it is measured by three categories of indicators; (i) personal contacts, such as telephone traffic and tourism; (ii) information flows, e.g. number of Internet users; and (iii) cultural proximity, e.g. trade in books and number of Ikea warehouses per capita. Source: KOF Globalisation Index, Dreher (2006)

A.5 Data used for GMM estimation

Output is GDP per capita in costant local currency. Consumption is calculated by multiplying GDP per capita and final consumption expenditure in percentage of GDP. Trade balance is calculated as the difference between output and consumption. Consumption and output are detrended using cubic polynomial. The source of macroeconomic data is WDI. Mean re-election probability is calculated as the average number of years in office of the chief executive, from the Database of Political Institutions (Beck et al. (2001) and Keefer (2009)).

A.6 Data for the Measurement Error regression

- *No Parties Allowed*: For a single year the index takes value 1 if parties are not allowed. Source: Institutions and Elections Project Regan and Clark (2010).
- *Gini Index*: Source WDI
- *Political Killings and Imprisonment*: These proxies measure the frequency of political killings and imprisonment. Source Human Rights Dataset Cingranelli and Richards (2010)

A.7 Sample Available for the Analisys

Table 8 – Sample available for each country and each variable

country	Debt/GDP	Lack Transp.	Pol. Conflict	Credit	Energy	Business	GDP p.c. (PPP)	GDP growth	Majoritarian
ARG	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
AUS	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
AUT	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
BDI	75-05	05-08	75-05	75-05	75-05	08-09	80-05	75-05	75-04
BEL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
BGD	90-05	05-08	90-05	90-05	90-05	08-09	90-05	90-05	90-04
BGR	81-09	05-08	81-09	91-09	81-09	08-09	81-09	81-09	81-04
BOL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
BRA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
CAN	75-09	05-08	75-09	75-08	75-09	08-09	80-09	75-09	75-04
CHL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
CIV	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
COL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
CRI	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
CZE	93-05	05-08	93-05	93-05	93-05	08-09	93-05	93-05	93-04
DNK	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
DOM	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ECU	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
EGY	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ESP	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ETH	93-05	05-08	93-05	93-05	93-05	08-09	93-05	93-05	93-04
FIN	76-09	05-08	76-09	76-09	76-09	08-09	80-09	76-09	76-04
FRA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
GBR	75-07	05-08	75-07	75-07	75-07	08-09	80-07	75-07	75-04
GHA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
GRC	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
GTM	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
HND	80-09	05-08	80-09	80-09	80-09	08-09	80-09	80-09	80-04
HUN	91-09	05-08	91-09	91-09	91-09	08-09	91-09	91-09	91-04
IDN	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
IND	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
IRL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ITA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
JOR	76-05	05-08	76-05	76-05	76-05	08-09	80-05	76-05	76-04
JPN	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
KEN	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
KOR	76-09	05-08	76-09	76-09	76-09	08-09	80-09	76-09	76-04
LVA	94-05	05-08	94-05	94-05	94-05	08-09	94-05	94-05	94-04
MAR	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
MEX	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
MYS	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
NAM	91-05	05-08	91-05	91-05	91-05	08-09	91-05	91-05	91-04
NLD	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
NOR	75-09	05-08	75-09	75-06	75-09	08-09	80-09	75-09	75-04
NPL	85-05	05-08	85-05	85-05	85-05	08-09	85-05	85-05	85-04
NZL	77-09	05-08	77-09	77-09	77-09	08-09	80-09	78-09	77-04
PAK	75-05	05-08	75-05	75-05	75-05	08-09	80-05	75-05	75-04
PAN	80-09	05-08	80-09	80-09	80-09	08-09	80-09	80-09	80-04
PER	80-09	05-08	80-09	80-09	80-09	08-09	80-09	80-09	80-04
PHL	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
PNG	75-05	05-08	75-05	75-05	75-05	08-09	80-05	75-05	75-04
POL	90-09	05-08	90-09	90-09	90-09	08-09	90-09	91-09	90-04
PRT	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
PRY	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ROU	92-09	05-08	92-09	92-09	92-09	08-09	92-09	92-09	92-04
RUS	92-09	05-08	92-09	93-09	92-09	08-09	92-09	92-09	92-04
SWE	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
SWZ	78-05	05-08	78-05	78-05	78-05	08-09	80-05	78-05	78-04
THA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
TUN	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
TUR	77-09	05-08	77-09	77-09	77-09	08-09	80-09	77-09	77-04
URY	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
USA	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
VEN	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ZAF	75-09	05-08	75-09	75-09	75-09	08-09	80-09	75-09	75-04
ZMB	75-09	05-08	75-09	75-09	80-09	08-09	80-09	75-09	75-04

country	Openess	Pop>65	Lack Educ.	Lack Soc.Glob.	Gini	No Parties Allow.	Pol. Killings	Re-election	GDP p.c.(LC)
ARG	75-07	75-09	68-98	70-06	86-06	72-05	81-08	75-09	75-09
AUS	75-07	75-09	68-98	70-06	94-94	72-05	81-08	75-09	75-09
AUT	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
BDI	75-05	75-05	68-98	70-06	92-06	72-05	81-08	75-05	75-05
BEL	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
BGD	90-05	90-05	78-98	70-06	86-05	72-05	81-08	90-05	90-05
BGR	81-07	81-09	68-98	70-06	89-03	72-05	81-08	81-09	81-09
BOL	75-07	75-09	68-98	70-06	91-07	72-05	81-08	75-09	75-09
BRA	75-07	75-09	68-98	70-06	81-07	72-05	81-08	75-09	75-09
CAN	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
CHL	75-07	75-09	68-98	70-06	87-06	72-05	81-08	75-09	75-09
CIV	75-07	75-09	68-98	70-06	85-02	72-05	81-08	75-09	75-09
COL	75-07	75-09	68-98	70-06	88-06	72-05	81-08	75-09	75-09
CRI	75-07	75-09	68-98	70-06	81-07	72-05	81-08	75-09	75-09
CZE	93-05	93-05	98-98	93-06	88-96	93-05	93-08	93-05	93-05
DNK	75-07	75-09	68-98	70-06	97-97	72-05	81-08	75-09	75-09
DOM	75-07	75-09	68-98	70-06	86-07	72-05	81-08	75-09	75-09
ECU	75-07	75-09	68-98	70-06	87-07	72-05	81-08	75-09	75-09
EGY	75-07	75-09	68-98	70-06	91-05	72-05	81-08	75-09	75-09
ESP	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
ETH	93-05	93-05	98-98	70-06	82-05	93-05	93-08	93-05	93-05
FIN	76-07	76-09	68-98	70-06	00-00	72-05	81-08	76-09	76-09
FRA	75-07	75-09	68-98	70-06	95-95	72-05	81-08	75-09	75-09
GBR	75-07	75-07	68-98	70-06	99-99	72-05	81-08	75-07	75-07
GHA	75-07	75-09	68-98	70-06	88-06	72-05	82-08	75-09	75-09
GRC	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
GTM	75-07	75-09	68-98	70-06	87-06	72-05	81-08	75-09	75-09
HND	80-07	80-09	68-98	70-06	86-06	72-05	81-08	80-09	80-09
HUN	91-07	91-09	68-98	70-06	87-04	72-05	81-08	91-09	91-09
IDN	75-07	75-09	68-98	70-06	05-07	72-05	81-08	75-09	75-09
IND	75-07	75-09	68-98	70-06	05-05	72-05	81-08	75-09	75-09
IRL	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
ITA	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
JOR	76-05	76-05	68-98	70-06	87-06	72-05	81-08	76-05	76-05
JPN	75-07	75-09	68-98	70-06	93-93	72-05	81-08	75-09	75-09
KEN	75-07	75-09	68-98	70-06	92-05	72-05	81-08	75-09	75-09
KOR	76-07	76-09	68-98	70-06	98-98	72-05	81-08	76-09	76-09
LVA	94-05	94-05	98-98	91-06	88-07	92-05	92-08	94-05	94-05
MAR	75-07	75-09	68-98	70-06	85-07	72-05	81-08	75-09	75-09
MEX	75-07	75-09	68-98	70-06	84-08	72-05	81-08	75-09	75-09
MYS	75-07	75-09	68-98	70-06	84-04	72-05	81-08	75-09	75-09
NAM	91-05	91-05	98-98	70-06	93-93	91-05	81-08	91-05	91-05
NLD	75-07	75-09	68-98	70-06	99-99	72-05	81-08	75-09	75-09
NOR	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
NPL	85-05	85-05	68-98	70-06	96-04	72-05	81-08	85-05	85-05
NZL	77-07	77-09	68-98	70-06	97-97	72-05	81-08	77-09	77-09
PAK	75-05	75-05	78-98	70-06	87-05	72-05	81-08	75-05	75-05
PAN	80-07	80-09	68-98	70-06	79-06	72-05	81-08	80-09	80-09
PER	80-07	80-09	68-98	70-06	86-07	72-05	81-08	80-09	80-09
PHL	75-07	75-09	68-98	70-06	85-06	72-05	81-08	75-09	75-09
PNG	75-05	75-05	88-98	70-06	96-96	76-05	81-08	75-05	75-05
POL	90-07	90-09	68-98	70-06	85-05	72-05	81-08	90-09	90-09
PRT	75-07	75-09	68-98	70-06	97-97	72-05	81-08	75-09	75-09
PRY	75-07	75-09	68-98	70-06	90-07	72-05	81-08	75-09	75-09
ROU	92-07	92-09	68-98	70-06	89-07	72-05	81-08	92-09	92-09
RUS	92-07	92-09	98-98	90-06	88-07	92-05	92-08	92-09	92-09
SWE	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
SWZ	78-05	78-05	88-98	70-06	95-01	72-05	81-08	78-05	78-05
THA	75-07	75-09	68-98	70-06	81-04	72-05	81-08	75-09	75-09
TUN	75-07	75-09	68-98	70-06	85-00	72-05	81-08	75-09	75-09
TUR	77-07	77-09	68-98	70-06	87-06	72-05	81-08	77-09	77-09
URY	75-07	75-09	68-98	70-06	89-07	72-05	81-08	75-09	75-09
USA	75-07	75-09	68-98	70-06	00-00	72-05	81-08	75-09	75-09
VEN	75-07	75-09	68-98	70-06	81-06	72-05	81-08	75-09	75-09
ZAF	75-07	75-09	68-98	70-06	93-00	72-05	81-08	75-09	75-09
ZMB	75-07	75-09	68-98	70-06	91-04	72-05	81-08	75-09	75-09

Note: GDP per capita LC (local currency) is used for GMM estimation together with Trade balance and Consumption, whose sample size coincides with GDP.

B Appendix: List of Countries

We collect public data from different sources of 66 economies listed in Table 9. Selected countries are strongly heterogenous in terms of economic development: we have included OECD economies, emerging economies and developing economies. The choice of which country to include in the analysis that follows has been driven mainly by the existence of data on government debt over GDP.

Table 9 – List of Countries

Argentina	Greece	Pakistan
Australia	Guatemala	Panama
Austria	Honduras	Papa New Guinea
Bangladesh	Hungary	Paraguay
Belgium	India	Peru
Bolivia	Indonesia	Philippines
Brazil	Ireland	Poland
Bulgaria	Italy	Portugal
Burundi	Ivory Coast	Romania
Canada	Japan	Russia
Chile	Jordan	South Africa
Colombia	Kenya	Spain
Costa Rica	Korea	Swaziland
Czech Republic	Latvia	Sweden
Denmark	Malaysia	Thailand
Dominican Republic	Mexico	Tunisia
Ecuador	Morocco	Turkey
Egypt	Namibia	United Kingdom
Ethiopia	Nepal	United States
Finland	Netherland	Uruguay
France	New Zealand	Venezuela
Ghana	Norway	Zambia

C Appendix: Equilibrium

We describe the game as follows. We define the state vector $k \in K \in \mathbb{R}^4$ where $k_t = (t, d_t, y_t, \omega_t)$,[30] and $\omega_t \in \Re^{N+1}$ is a vector of indices s.t. $w_{i,t} = 1$ if i is the incumbent at period t and 0 otherwise $\forall i = 1, .., N+1$. Output y_t evolves exogenously, d_t is the level of debt inherited from past period, and ω_t is determined by the endogenous political markov process.

In this dynamic game, at each stage t of the game, the incumbent decides an action $a_{it} \in A^i(k_t)$ where $a_{it} = \left(d_{t+1}, c_t^{i,i}, \left\{c_t^{i,j}\right\}_{i \neq j}\right)$ if $\omega_{it} = 1$ and subject to the budget constraint in (3); instead the action profile of the opponents at t is empty: $a_{j,t} = A^j(k_t) = \emptyset$. Define an history $h^t \in \mathcal{H}^t$ as $h^t = (a_0, k_0, \ldots, a_{t-1}, k_{t-1})$. A pure strategy for party i as incumbent I at time t is a function

$$\sigma_{i,t} : \quad \mathcal{H}^t \times K \to A_t$$

[30]The time index t enters in the state representation because we are focusing on finite horizon

i.e. a mapping from the entire history and the current state space to each party actions at time t. We define as $\sigma_i = (\sigma_{i,1}, \dots, \sigma_{i,T})$ the strategy profile of party i in the finite game, and $\sigma_i[t] = (\sigma_{i,t}, \dots, \sigma_{i,T})$ the continuation strategy at time t. To be general let's define the intertemporal utility of party i in t as a function of the continuation strategy $W(\sigma_i[t], \sigma_{-i}[t])$. Defining S_i the set of all feasible σ_i, the strategy space of the infinite game is $S = \prod_{i=1}^{N+1} S_i$. We define the best response correspondence as:

$$BR(\sigma_i[t]|h^{t-1}, k_t) = \{\sigma_i[t] \in S_i[t]\},$$

such that

$$\sigma_i[t] \text{ maximizes } W(\sigma_i[t], \sigma_{-i}[t]),$$

given $\sigma_{-i}[t] \in S_{-i}[t]$.

A Sub-game Perfect Equilibrium of this game is defined as follows:

Definition 2. A **Sub-game Perfect Equilibrium** is a strategy profile $\sigma^* = (\sigma_1^*, \dots, \sigma_{N+1}^*) \in S$ s.t. $\sigma_i^*[t] \in BR(\sigma_i[t]|h^{t-1}, k_t)$ for all (k_t, h^{t-1}), for all t and i.

In the rest of the paper we consider the more specific class of Markov Perfect Equilibria (MPE), where we restrict the strategies to be based only on *payoff-relevant* state, and not on the entire history of the game. In particular a Markov strategy is a mapping $\sigma \in \hat{S} \subset S$ s.t. $\sigma_i(k, h^{t-1}) = \sigma_i(k) \quad \forall h^{t-1} \in \mathcal{H}^{t-1}$.

Given the assumption of no discrimination and given that borrowing is completely independent from consumption allocation, it is natural to restrict our attention to the class of Symmetric MPE. In such a case the consumption level decided by the incumbent doesn't change with her identity, furthermore there is no discrimination between different groups at the opposition. As discussed in section 3.1, in such a case we can then define the instantaneous utility evaluated in $c^*(c)$ as $U^I(c_t) = \mathcal{U}^{i,i}(c_t^*)$ and $U^O(c_t) = \mathcal{U}^{i,r}(c_t^*)$. Defining as $\bar{p}_{t,s}$ the conditional probability for the party being in power at t to be in power also in s, the discounted utility is defined as

$$W(\sigma[t]) = \mathbb{E}_t \left[\sum_{s=t}^{T} \beta^t \left\{ \bar{p}_{t,s} U^I(c_t) + (1 - \bar{p}_{t,s}) U^O(c_t) \right\} \right] \tag{22}$$

Definition 3. A **Symmetric Markov Perfect Equilibrium** of this game is a strategy profile $\sigma^* = (\sigma_1^*, \dots, \sigma_{N+1}^*) \in \hat{S}$ s.t.

1. $\sigma_i^*[t] \in BR(\sigma_i[t]|k_t)$ for all k_t, for all t and i,
2. $\forall k, \tilde{k} \in K$ s.t. $k = (t, d, y, \omega)$ and $\tilde{k} = (t, d, y, \tilde{\omega})$, where $\omega \neq \tilde{\omega}$, $\Rightarrow$ $\sigma_{i,t}(k) = \sigma_{j,t}(\tilde{k}) \in \hat{S}$ where $\omega_i = \tilde{\omega}_j = 1$.

D Appendix: Proofs

D.1 Proof of Proposition 1

Proof. • Part 1: $(a \Leftrightarrow c)$. Using equations (9) and (10), the RHS of the Euler equation in (8), can be written as:

$$\begin{bmatrix} pU^{I'}(y-(1+r)d_2)+ \\ +(1-p)\,U^{O'}(y-(1+r)d_2) \end{bmatrix} = \begin{Bmatrix} p\left(\theta u'\left(c_2^I\right)\frac{\partial c^I(c_2)}{\partial c}+\frac{(1-\theta)}{N}u'\left(c_2^O\right)\left(1-\frac{\partial c^I(c_2)}{\partial c}\right)\right)+ \\ (1-p)\left(\frac{1}{N}\left(1-\frac{1-\theta}{N}\right)u'\left(c_2^O\right)\left(1-\frac{\partial c^I(c_2)}{\partial c}\right)+\frac{(1-\theta)}{N}u'\left(c_2^I\right)\frac{\partial c^I(c_2)}{\partial c}\right) \end{Bmatrix}$$

$$= \frac{\partial c^I(c_2)}{\partial c}\gamma u'\left(c_2^I\right)+\left(1-\frac{\partial c^I(c_2)}{\partial c}\right)\left(\frac{1-\gamma}{N}\right)u'\left(c_2^O\right),$$

where we have defined $\gamma=\left(p\theta+(1-p)\frac{1-\theta}{N}\right)$. Since, $\theta \geq (N+1)^{-1}$, then $\gamma \leq \theta$.

Similarly, the LHS of the Euler equation in (8) is:

$$U^{I'}(y-(1+r)\,d_1+d_2)=\frac{\partial c^I(c_1)}{\partial c}\theta u'\left(c_1^I\right)+\left(1-\frac{\partial c^I(c_1)}{\partial c}\right)\frac{(1-\theta)}{N}u'\left(c_1^O\right).$$

Notice that $\frac{\partial c^I(c)}{\partial c}$ can be derived by applying the implicit function theorem on the optimal sharing rule in equation (7), which gives:

$$\psi(c)=\frac{\partial c^I(c)}{\partial c}=\frac{\frac{1-\theta}{N^2}u''\left(\frac{c-c^I}{N}\right)}{\theta u''(c^I)+\frac{1-\theta}{N^2}u''\left(\frac{c-c^I}{N}\right)}. \tag{23}$$

From this expression it is clear that $0 \leq \frac{\partial c^I}{\partial c} \leq 1$. In the following, we omit to make explicit the dependency of ψ from aggregate consumption. Let's now evaluate the Euler Equation above at d_2^*, which is the solution of the benchmark (transparent and no-conflict) economy, i.e.

$$U^{I'}(y-(1+r)\,d_1+d_2^*)=\begin{bmatrix} pU^{I'}(y-(1+r)d_2^*)+ \\ +(1-p)\,U^{O'}(y-(1+r)d_2^*) \end{bmatrix}$$

Recall that d_2^* implies that $c_1=c_2$, and, therefore, $\psi(c_1)=\psi(c_2)$, $c_1^I=c_2^I$, and $c_1^O=c_2^O$. Therefore, we can use the expressions for the LHS and RHS derived above and we can then eliminate the time subscripts. Since the utility function is concave, then we have that political conflict implies incentive to save (i.e. $\tilde{d}_2^* \leq d_2^*$), if and only if:

$$\psi\gamma u'\left(c^I\right)+(1-\psi)\frac{(1-\gamma)}{N}u'\left(c^O\right) \geq \psi\theta u'\left(c^I\right)+(1-\psi)\frac{(1-\theta)}{N}u'\left(c^O\right),$$

which can be rearranged as:

$$\underbrace{(\theta-\gamma)}_{\geq 0}\left((1-\psi)u'\left(c^O\right)-N\psi u'\left(c^I\right)\right) \geq 0. \tag{24}$$

By the optimal sharing rule in (7), we also have that: $u'\left(c^O\right) = \frac{N\theta}{1-\theta} u'\left(c^I\right)$. Hence, :

$$\left(\theta - \gamma\right) u'\left(c^I\right) N \left((1-\psi)\frac{\theta}{1-\theta} - \psi \right) \geq 0.$$

This inequality is satisfied if and only if $\theta > \psi$.

- Part 2: ($c \Leftrightarrow b$). Statement b is:

$$U^{I'}(c) \leq U^{O'}(c)$$

Using the definition of ψ and equations (9) and (10), it becomes:

$$\theta u'(c^I)\psi + \frac{1-\theta}{N} u'\left(c^O\right)(1-\psi) - \left(\frac{1-\theta}{N} u'(c^I)\psi + \frac{1}{N}\left(1 - \frac{1-\theta}{N}\right) u'\left(c^O\right)(1-\psi) \right) \leq 0$$

$$\frac{N\theta - 1 + \theta}{N}\left[N\psi u'(c^I) - (1-\psi)u'(c^O)\right] \leq 0$$

Since $\theta \geq (N+1)^{-1}$, the condition is satisfied if the term in squared brackets is negative. Notice that this condition is equivalent to the one used in (24). Hence, as before, by using the optimal sharing rule in (7) we have that the condition is satisfied if and only if $\theta \geq \psi$.

- Part 3: ($c \Leftrightarrow d$). Condition c states that: $\theta \geq \frac{\partial c^I}{\partial c}$. Applying the implicit function theorem on the optimal sharing rule in equation (7), that condition is:

$$\theta \geq \frac{\partial c^I}{\partial c} = \frac{\frac{1-\theta}{N^2} u''\left(\frac{c-c^I}{N}\right)}{\theta u''(c^I) + \frac{1-\theta}{N^2} u''\left(\frac{c-c^I}{N}\right)}.$$

Using the definition: $c^O = \frac{c-c^I}{N}$ and the fact that $u''(\circ) < 0$, the condition becomes:

$$u''(c^I) \leq \left(\frac{1-\theta}{N\theta}\right)^2 u''(c^O).$$

The optimal sharing rule in (7) implies that:

$$\frac{1-\theta}{N\theta} = \frac{u'(c^I)}{u'(c^O)}.$$

Substituting into the equation above, and again considering that $u''(\circ) < 0$, then we have:

$$\frac{u''(c^O)}{u''(c^I)} \leq \left(\frac{u'(c^O)}{u'(c^I)}\right)^2$$

□

D.2 Proof of Corollary 2

Proof. Consider the optimal sharing rule in equation (7). Applying the inverse of the marginal utility function to both sides of the equation, we have:

$$u'^{-1}\left(\theta u'\left(c^I\right)\right) = u'^{-1}\left(\frac{(1-\theta)}{N}u'\left(\frac{c-c^I}{N}\right)\right).$$

Assuming that condition (12) is satisfied, we have:

$$h\left(\theta\right)u'^{-1}\left(u'\left(c^I\right)\right) + l\left(\theta\right) = h\left(\frac{(1-\theta)}{N}\right)u'^{-1}\left(u'\left(\frac{c-c^I}{N}\right)\right) + l\left(\frac{(1-\theta)}{N}\right).$$

Labelling some terms for convenience, we obtain:

$$\underbrace{h\left(\theta\right)}_{\kappa_1}c^I + \underbrace{l\left(\theta\right)}_{\iota_1} = \underbrace{h\left(\frac{(1-\theta)}{N}\right)}_{\kappa_2}\frac{c-c^I}{N} + \underbrace{l\left(\frac{(1-\theta)}{N}\right)}_{\iota_2}.$$

Solving for c^I, we have:

$$c^I = \frac{\kappa_2}{N\kappa_1+\kappa_2}c + \frac{N(\iota_2-\iota_1)}{N\kappa_1+\kappa_2}.$$

It follows that:

$$\frac{\partial c^I}{\partial c} = \frac{\kappa_2}{N\kappa_1+\kappa_2} = \psi.$$

Since ψ is only a function of parameters of the model, then the utility function $u(c)$ satisfies the PSR property.

□

D.3 Proof of Corollary 3

Proof. According to corollary 2, we only need to test condition 12 on the marginal utility of the HARA utility functions, i.e.

$$u'(c) = a\left(\frac{ac}{\sigma}+b\right)^{-\sigma}.$$

In particular the inverse of the marginal utility of HARA utility can be written as:

$$c = g(\bar{u}) = \bar{u}^{-\frac{1}{\sigma}}\underbrace{\sigma a^{\frac{1-\sigma}{\sigma}}}_{r} - \underbrace{b\sigma a^{-1}}_{s} = \bar{u}^{-\frac{1}{\sigma}}r - s.$$

We can now show that property (12) holds:

$$g(\epsilon\bar{u}) = \epsilon^{-\frac{1}{\sigma}}\bar{u}^{-\frac{1}{\sigma}}r - s = \epsilon^{-\frac{1}{\sigma}}\bar{u}^{-\frac{1}{\sigma}}r - s + \epsilon^{-\frac{1}{\sigma}}s - \epsilon^{-\frac{1}{\sigma}}s = \underbrace{\epsilon^{-\frac{1}{\sigma}}}_{h(\epsilon)}\underbrace{(\bar{u}^{-\frac{1}{\sigma}}r - s)}_{g(\bar{u})} + \underbrace{s\left(\epsilon^{-\frac{1}{\sigma}}-1\right)}_{l(\epsilon)}.$$

Hence, any HARA utility function satisfies the PSR property. □

D.4 Proof of Corollary 4

Proof.

- Part (a). Let us begin with part (a) of the corollary. In case of CRRA utility, it can be easily checked that the sharing rule is the following $c^I = \psi c$. In fact, by using equation (23) considering that $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ and by using the optimal sharing rule in (7), we have that $c^I = \psi c$, with:

$$\psi = \frac{\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}{1 + \left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}.$$

- Part (b). The inequality $\theta \geq \psi = \frac{\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}{1+\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{\sigma}} N^{\frac{1-\sigma}{\sigma}}}$ is satisfied for:

$$1 - \left(\frac{N\theta}{1-\theta}\right)^{\frac{1-\sigma}{\sigma}} \geq 0.$$

  which holds for $\sigma \geq 1$ and is satisfied with strictly inequality for $\sigma > 1$. Notice that in the log case ($\sigma = 1$), we have equality, i.e. $\theta = \psi$.

- Part (c). The result follows from part (b) above and from parts (a) and (c) of Proposition 1.

□

D.5 Proof of Corollary 5

Proof. At the optimal level of debt $\tilde{d}_2^*$, the Euler equation in (8) is satisfied, i.e.:

$$\theta\psi u'\left(c^I(y+\tilde{d}_2^*+d_1)\right) + (1-\psi)\frac{1-\theta}{N}u'\left(c^O(y+\tilde{d}_2^*+d_1)\right) = \psi\gamma u'\left(c^I(y-\tilde{d}_2^*(1+r))\right) + (1-\psi)\,\frac{(1-\gamma)}{N}u'\left(c^O(y-\tilde{d}_2^*(1+r))\right),$$

where we have used the expression for the Euler equation as derived in the proof D.1, and the definition of $\gamma = \left(p\theta + (1-p)\frac{1-\theta}{N}\right)$. Differentiating both sides for p, considering that by assumption ψ is a constant, we have:

$$\left[\theta\psi u''\left(c_1^I\right) + (1-\psi)\frac{1-\theta}{N}u''\left(c_1^O\right)\right]\frac{\partial\tilde{d}_2}{\partial p} = \frac{\partial\gamma}{\partial p}\left(\psi u'\left(c_2^I\right) - \frac{1-\psi}{N}u'\left(c_2^O\right)\right) - (1+r)\frac{\partial\tilde{d}_2}{\partial p}\left(\psi\gamma u''\left(c_2^I\right) + (1-\psi)\frac{1-\gamma}{N}u''\left(c_2^O\right)\right),$$

which gives:

$$\frac{\partial\tilde{d}_2}{\partial p} = \frac{\frac{\partial\gamma}{\partial p}\left(\psi u'\left(c_2^I\right) - \frac{1-\psi}{N}u'\left(c_2^O\right)\right)}{\left[\theta\psi u''\left(c_1^I\right) + (1-\psi)\frac{1-\theta}{N}u''\left(c_1^O\right)\right] + (1+r)\left(\psi\gamma u''\left(c_2^I\right) + (1-\psi)\frac{1-\gamma}{N}u''\left(c_2^O\right)\right)}$$

The denominator is negative because of the concavity of the utility function. Also, the first term in the numerator is positive, $\frac{\partial\gamma}{\partial p} > 0$, whenever $\theta > (N+1)^{-1}$. The term in brackets at the numerator is negative whenever $\theta > \psi$, as can be easily seen by optimal sharing rule in (7). By assumption, $U^{I'}(c) \leq U^{O'}(c)$, which indeed implies that $\theta > \psi$, by Proposition 1. Hence, $\frac{\partial\tilde{d}_2}{\partial p} < 0$, which means that an increase in p reduces saving incentive. Finally, notice that if $p = 1$, then $\gamma = \theta$, which is independent of p. Therefore $\frac{\partial\tilde{d}_2}{\partial p}|_{p=1} = 0$, and the Euler equation of the problem coincides with the Euler equation of the frictionless economy in 5. □

D.6 Sufficient conditions for the solution of FOC to be a global maximum

In this section we provides the sufficient conditions on the probability function $p(c)$ such that the equilibrium condition in (16) characterizes a unique global maximum.

Lemma 7. Assuming that the utility function satisfies the PSR property and the conditions of Proposition 1. Then, if $\forall d_2$

$$p'(c_1) < A_1(c_2) \tag{25}$$

$$p''(c_1) < A_2(c_1, c_2) \tag{26}$$

then the solution of the Euler Equation in equation (16) is a global solution of the problem (13)-(15). Here, $c_1 = y + d_2 - (1+r)\,d_1$, $c_2 = y - (1+r)\,d_2$, $\tau = (N\theta - 1 + \theta)/N$, *and* $A_1(c_2)$, $A_2(c_1, c_2)$ *are:*

$$A_1(c_2) = (1+r)\frac{\theta\psi^2 u''(\psi c_2) + (1-\theta)\left(\frac{1-\psi}{N}\right)^2 u''\left(\frac{1-\psi}{N}c_2\right)}{\tau\left[\psi u'(\psi c_2) - \frac{1-\psi}{N}u'\left(\frac{1-\psi}{N}c_2\right)\right]} > 0.$$

$$\begin{aligned} A_2(c_1, c_2) = &-\frac{\theta\psi^2\left[u''(\psi c_1) + (1+r)u''(\psi c_2)\right]}{\beta\tau\left(u(\psi c_2) - u\left(\frac{1-\psi}{N}c_2\right)\right)} - \\ &-\frac{(1-\theta)\left(\frac{1-\psi}{N}\right)^2\left[(1+r)(1-\theta)\left(\frac{1-\psi}{N}\right)^2 u''\left(\frac{1-\psi}{N}c_2\right) + (1-\theta)\left(\frac{1-\psi}{N}\right)^2 u''\left(\frac{1-\psi}{N}c_1\right)\right]}{\beta\tau\left(u(\psi c_2) - u\left(\frac{1-\psi}{N}c_2\right)\right)} \end{aligned}$$

Proof. A sufficient condition for the solution of FOC to be a global maximum is that the RHS of the Euler equation in 16 is increasing in d_2 and the LHS decreasing in d_2. Notice that $U^{I'}(c) - U^{O'}(c) = \tau\left(u'(\psi c_1) - u'\left(\frac{1-\psi}{N}c_1\right)\right)$, where $\tau = (N\theta - 1 + \theta)/N$. Differentiating the RHS for d_2:

$$\frac{\partial RHS}{\partial d_2} = -(1+r)\left[\theta\psi^2 u''(\psi c_2) + (1-\theta)\left(\frac{1-\psi}{N}\right)^2 u''\left(\frac{1-\psi}{N}c_2\right)\right] + \underbrace{\tau p'(c_1)}_{\gamma'(c_1)}\left[\psi u'(\psi c_2) - \frac{1-\psi}{N}u'\left(\frac{1-\psi}{N}c_2\right)\right] > 0$$

Notice that the first term in squared brackets is negative because of the concavity of the utility function. Also, the second term in squared bracket is negative when $\theta > \psi$, as directly implied by optimal sharing rule in (7). Solving for $p'(c_1)$, we obtain the condition in (25). Differentiating the LHS of the Euler equation for d_2:

$$\begin{aligned} \frac{\partial LHS}{\partial d_2} =& \theta\psi^2 u''(\psi c_1) + (1-\theta)\left(\frac{1-\psi}{N}\right)^2 u''\left(\frac{1-\psi}{N}c_1\right) + \\ &+ \tau p'(c_1)\left[\psi u(\psi c_2) - \frac{1-\psi}{N}u\left(\frac{1-\psi}{N}c_2\right)\right] + \beta\tau p''(c_1)\left[u(\psi c_2) - u\left(\frac{1-\psi}{N}c_2\right)\right] < 0 \end{aligned}$$

Rearranging terms and using (25) to determine an upper bound for $p'(c_1)$, we obtain the condition (26). □

D.7 Proof of Proposition 6

Proof. Part 1. If conditions (25) and (26) are satisfied, the unique equilibrium $\hat{d}_2^*$ in a non-transparent economy is given by equating the LHS and RHS of the Euler equation in (16). In a transparent economy, the equilibrium $\tilde{d}_2^*$ is given by (8). Comparing the two conditions, notice that the right-hand sides are identical; hence, the marginal utility of savings is unchanged in the two case. Instead, the left-hand side of (16) has an additional term, which is: $\beta p'(c_1)\left[U^I(c_2) - U^O(c_2)\right]$. With a strictly positive degree of political conflict, i.e. $\theta > \frac{1}{N+1}$, that term is strictly positive if $p'(c_1) > 0$. That means that with a positive degree of lack of transparency, the marginal utility of consuming is larger than in a transparent economy. Therefore, it follows that $\tilde{d}_2^* > \hat{d}_2^*$.

Part 2. Now consider the solution d_2^* of the frictionless benchmark model that solves equation (5). Recall that d_2^* implies that $c_1 = c_2$, and, therefore, $\psi(c_1) = \psi(c_2)$, $c_1^I = c_2^I$, and $c_1^O = c_2^O$. Then, defining z the difference between RHS and LHS evaluated at d_2^*. z represents the difference between saving incentives and consuming incentives. Eliminating the time subscripts, we have:

$$z = \left(\theta - \gamma\left(c^I\right)\right) N \left[(1-\psi)\frac{\theta}{(1-\theta)} - \psi\right] u'\left(c^I\right) - p'(c)\left(\frac{N\theta - 1 + \theta}{N}\right)\left[u\left(c^I\right) - u\left(c^O\right)\right].$$

Differentiating, we have that $\frac{\partial z}{\partial p'(c)} < 0$. Since z is monotone, for a large enough $p'(c)$ then $z < 0$, which means that the solution in a non-transparent economy with political conflict implies larger borrowing incentives than the one in the frictionless economy.

□

D.8 The log-utility case with linear probability

In the log utility case we have already seen that there is no saving incentive for any level of θ when the probability of being re-elected is exogenous. Indeed in this case $\psi = \theta$ and $U^{I'}(c) = U^{O'}(c) = 1/c$. It is easy to notice also that $U^I(c) - U^O(c) = \tau(2\theta - 1)\left[\log\theta - \log(1-\theta)\right]$. The Euler Equation (16) becomes:

$$(y + d_1)^{-1} + p'(d_1)\beta\tau(2\theta - 1)\left[\log\theta - \log(1-\theta)\right] = (y - d_1(1+r))^{-1}.$$

In the linear probability case, i.e. $p'(d_1) = \alpha$, the optimal level of debt solves:

$$\frac{(y + d_1)}{(y - d_1(1+r))} = 1 + (y + d_1)\alpha\beta\tau\left[\log\theta - \log(1-\theta)\right] \tag{27}$$

In a non-transparent economy, $\alpha > 0$, the RHS of this equation is always greater than 1. Then $\tilde{d}_1$ that satisfies (27) is always positive. This implies that as far as $\alpha > 0$ we have borrowing in this economy. Therefore, the threshold level of $p'(c)$ that implies borrowing incentives with respect to the frictionless case is zero, in the log-utility case. We can also prove a more general statement: with CRRA utility function and with linear reelection probability, the threshold level for α, $\bar{\alpha}$ s.t. when $\alpha > \bar{\alpha}$ we have borrowing incentives with respect to the frictionless economy is independent from θ. In the body we showed numerically that this result is robust also to a more general form of probability function .

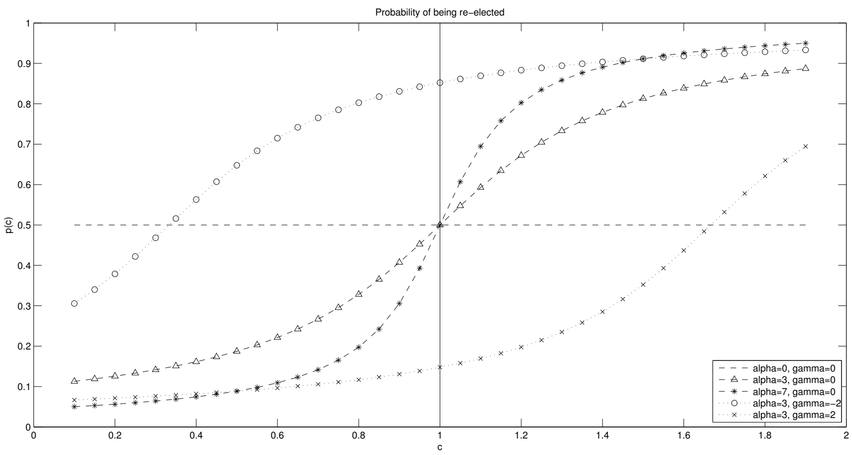
E Appendix: Equilibrium Debt and Non-linear Probability

Here we consider the following non-linear probability function: We assume that the probability of being re-elected is represented by the following functional form:

$$p(c) = \text{atan}\left(\frac{\alpha(c - \bar{c}) + \gamma}{\pi}\right) + \frac{1}{2}. \tag{28}$$

Figure 6 visualizes this probability function for different parameter values. Here, α affects the sensitivity (slope) of the probability function, whereas γ determines its level. By increasing α the probability becomes steeper around the flex. When α is very large the probability function is close to a step function. If γ is zero, the function is centered in $\bar{c}$. Adopting the function in (28) we assume that voters are more sensitive to economic conditions at the flex point. The flex point of the curve is shifted to the left (right) with respect to $\bar{c}$ when $\gamma > 0 (< 0)$. This function is bounded between 0 and 1 for any realization of consumption. The calibration of the model is as presented in section 3.7. In Figure 7 we plot the equilibrium level of debt for different combinations of θ and α in a 2-period model with CRRA utility function. In Table 10 we report the average equilibrium level of debt for different combinations of θ and α in a T-period model (with T=2250).

Figure 6 – Non-linear Probability function



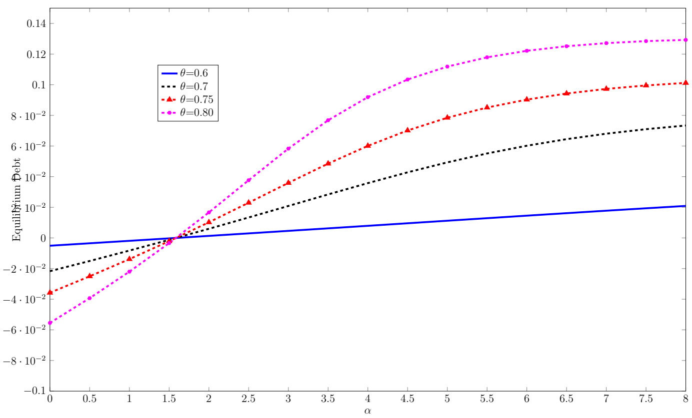
Note: In this figure we display of the probability function in equation (28) for different pairs of sensitivity (α) and the level parameter (γ).

Table 10 – Equilibrium Level of Debt in a T-period economy: Non-linear Probability

		Lack of Transparency		
		No: $\alpha = 0$	Medium: $\alpha = 1$	High: $\alpha = 5$
Conflict	No: θ=0.5	0	0	0
	Medium: θ=0.7	-4.3	-0.2	23.3
	High: θ=0.9	-4.8	-1.2	256.7

Note: In this table we report the average level of debt (in percentage) in a T-period economy, with $T = 2250$, when assuming CRRA utility function and non-linear probability, for different values of degree of retrospective voting (α, x-axis) and degree of political friction, θ. Negative values denote savings.

Figure 7 – Equilibrium Debt, Retrospective Voting, and Political Friction: Non-linear Probability



Note: This figure plots the equilibrium level of debt in a 2-period economy when assuming CRRA utility function and non-linear probability, for different values of degree of retrospective voting (α, x-axis) and degree of political friction, θ. The blue-solid line is associated to a low degree of political friction (θ=0.6), the black-dotted line and the red-triangle-marked line are associated to moderate degrees of political friction ((θ=0.7 and 0.8, respectively), and the pink-circle-marked line is associated to a high degree of political friction (θ=0.8).

Political Cost of Default and Business Cycle in Emerging Countries*

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Abstract

Sovereign default models successfully explain business cycle in emerging economies by matching the stylized facts of main economic aggregates in normal and default periods but they usually fail to reproduce both the large levels of debt and spread observed in the data. We introduce political uncertainty in the standard default model of Arellano (2008): the incumbent has an exogenous probability of not being reelected in the next period, but in the cases when she decides to default, there is a larger probability of losing power. After estimation of the relevant parameters by targeting key business cycle moments, the model generates realistic levels of debt to GDP and spread without affecting the performance on the other business cycle moments. The estimated political cost of default from the model is shown as being consistent with the decline in confidence in the Argentinian government documented around its 2001 default event.

JEL Classification: F3 - F41 - D72 - P16 - E32

Keywords: Public debt, Political uncertainty, Small open economy, Sovereign Default

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1 Introduction

Stylized facts about business cycles and sovereign defaults in emerging economies have been established by the literature. More recently, quantitative models where default decisions are endogenously determined have been proposed to replicate the patterns observed in the data. This class of models usually relies on the existence of external factors that make default a costly decision. However, there is limited support for theories that explain the feasibility of sovereign debt based on external factors such as sanctions or exclusion from international markets, as in Arellano (2008), and more support for explanations based on internal factors (Panizza et al. (2009)). Moreover, there is growing agreement that default events in many emerging economies have been triggered by political motives (Balkan (1992), Cuadra and Sapriza (2008), Hatchondo et al. (2009), Hatchondo and Martinez (2010), Panizza et al. (2009)). In this paper we present a quantitative model of default incorporating political uncertainty to account for these facts, which closely matches the relevant business cycle statistics, the level of debt to GDP, probability of default and sovereign spread that we observe in the data.

Empirical papers have estimated the cost of default for a country based on external factors. According to Gelos et al. (2008), exclusion from capital markets, measured by bond issuance, lasted an average of 4 years following default events during the 80's, but this duration dropped to 0.3 years during the 90's. Richmond and Dias (2009) measured exclusion from positive net transfers and found that exiting from default took an average of 5.5 years during the 80's, 4.1 years during the 90's and 2.5 years after 2000. These results show that market exclusion may no longer represent the main cost of default. Mendoza and Yue (2012) calibrate re-entry probability according to the estimates by Richmond and Dias (2009), implying 3 years of exclusion from capital markets on average. Exclusion from capital markets is costly for governments because of the inability to smooth consumption, but according to Aguiar and Gopinath (2007), Lucas (1987) and Otrok (2001) the welfare cost of business cycle is relatively small. In addition, traditional models of sovereign default assume that output drops in default periods, but they do not address the simultaneity issue that defaults occur more often during recessions. Hébert and Schreger (2017) identifies the causal effect of sovereign default on the equity returns of Argentine firms by exploiting changes in the probability of Argentine sovereign default induced by legal rulings.

We argue that political motive are a driver of debt repayment in some cases.

Politicians in several economies seem to have postponed unavoidable defaults for a long time in order to avoid replacement in office. Looking at post-election results, there seems to be clear evidence that the incumbent loses political support after a default. The literature on the estimation of the political cost of default is not large. Borensztein and Panizza (2009) calculated the loss of vote share for the ruling party after a default across a range of countries, finding that the incumbent losts an average of 16% of electoral support after the decision.

There is better evidence on the political cost of currency devaluation. Cooper (1971) showed that devaluations more than double the probability of a political crisis and a government change within the next 12 months. Frankel (2005) updated the results of Cooper (1971) and found that in the period from 1971 to 2003, devaluations increased the probability of a change of chief executive in the following 12 months from 20 to 29%.

In this paper we present a model of sovereign default with political uncertainty. When the government faces an exogenous political shock, this can potentially result in substitution the incumbent. In the case of default the probability of an adverse political event rises, making default more costly from a political point of view since the incumbent can ''fall" at the opposition where she benefits of lower intertemporal utility.

The existence of political uncertainty itself produces borrowing incentive as discussed in the political economy literature (Alesina and Tabellini (1990), Amador (2004), Amador and Aguiar (2011), Pancrazi and Prosperi (2016)). However, previous papers have not considered the enforceability of debt contracts.

The model presented in this paper is calibrated to Argentina, where we show that it matches debt levels observed in reality, in contrast with the inability of previous papers in this regard. This paper is closely related to Amador (2004) which shows that because of borrowing incentives generated by political uncertainty, the replication strategy central to Bulow and Rogoff (1989) is not efficient. Cuadra and Sapriza (2008) introduce political friction in a small open economy model of sovereign debt and default. However, in their model, political uncertainty does not increase in default periods and as a result they cannot generate large levels of debt in equilibrium. In this paper we focus on the quantitative implications of political uncertainty and argue that the loss of political support that the incumbent might face in case of default is a crucial ingredient to explain business cycle statistics and government debt.

Since we calibrate our model based on the Argentinian economy, it is important to understand whether political factors played an important role in recent Argentinian defaults. During the last 60 years several episodes of political instability and debt crisis have occurred in the country. In figure 1 we represent business cycle movement measured as the percentage deviation from a linear trend of GDP per capita[1], against domestic and external debt crisis bars starting from 1975 as identified by Reinhart and Rogoff (2010) and political events defined as a change in p olitical leader or party[2].

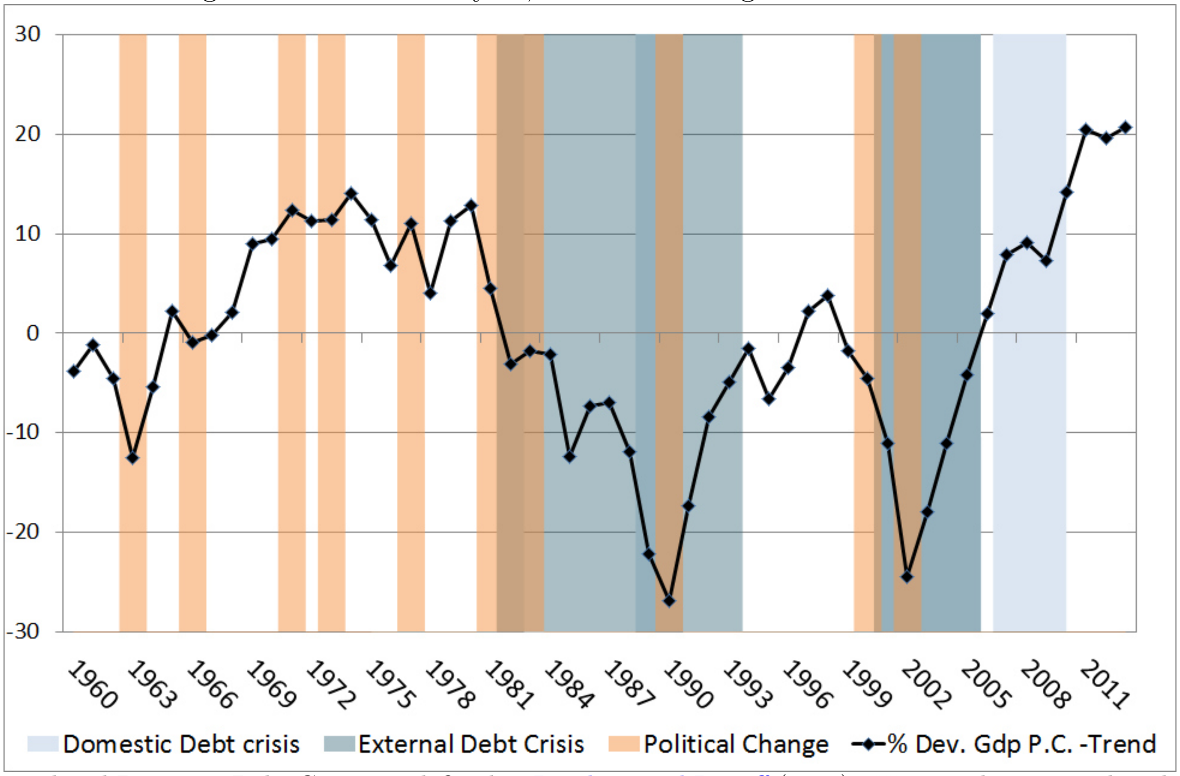
Several things can be observed from this graph. First, there is strong coincidence between political events, debt crise and recessions. Second, political changes occurred more frequently in the first part of the sample when several governments alternated in power with the support of the military. In the second part of the sample, government changes occurred less frequently and in coincidence with defaults and recessions. This strongly suggests that there may be a link between default and political events in Argentina.

There is also anecdotal evidence that during the 2001 Argentinian debt crise, the government was reluctant to restructure the debt and devalue the peso. This was particularly relevant for domestic reasons since many Argentinians borrowed in US dollars during that period. Blustein (2006) reported that Wall Street bankers had to persuade the policymaking authorities to initiate debt restructuring. In the presidential campaign of 1999, the two main candidates, Duhalde and de la Rua, expressed opposing positions as to whether the future government should declare a moratorium on its foreign debt. Economist (1999) wrote that ‘’while Eduardo Duhalde, his Peronist opponent, has made rash public-spending promises, and suggested that Argentina should default on its foreign debt, it has been Mr. de la Rua who has responsibly promised to maintain the main trust of current economic policies, including convertibility”. This policy stance was

[1]Output data are constant prices in local currency and are taken from World Bank.

[2]See section 4 for the full definition of political events.

Figure 1: Business Cycle, Political Changes and Debt Crisis



External and Domestic Debt Crisis are defined in Reinhart and Rogoff (2010). We use a linear trend to define deviation of gdp per capita from trend. Political Events are defined in section 4.

reinforced by de la Ruas statement that ‘'... there'll be no default and no devaluation. Our effort is to reactivate the internal market, which needs lower interest rates. It could be necessary to lower the costs of the debt, but we will comply with our obligations" (Economist (2001)).

The paper is organized as follows. In section 2 we present a toy model of default and political uncertainty showing how political uncertainty can increase the incentive to default even when debt contracts are not enforceable. In section 3 we present the extended infinite horizon model and the main theoretical results. In section 4 we present the data used for model estimation, the solution method, model simulation and estimation output with and without assuming risk aversion of international investors. In the same section we perform hypothesis tests on the parameters and test the model against a restricted version corresponding to the Arellano (2008) model. In section 5 we validate the model on the political side, showing that political uncertainty is in line with political turnover from electoral data and decline in confidence in the Argentinian government around the country's default event of 2001.

2 A Toy Model of Political Default

In this section we demonstrate, using a simple toy model that political uncertainty in normal times does not increase debt to GDP in equilibrium when repayment is not enforceable, but it does when re-election probability decreases in the case of default. Consider a 2 periods economy where the incumbent during period 1 has to decide the amount of borrowing for next period, b'. She benefits from a constant stream of output y and initial assets $b_0 = 0$. The agent can default on her debt. After a default decision is taken, a political shock may occur: the agent is reappointed with probability γ in case of repayment, and probability $\gamma - \psi$ in case of default. In case of default and reappointment of the agent, she consumes output y^{def}. If the agent is not reappointed, she gets utility $\tilde{W}$. Interest rates are endogenously determined in the model according to default incentives. The agent discounts period 2 utility at rate β. The intertemporal problem of the agent is the following:

$$\max_{b'} \quad u(c)+\beta \left\{(1-\mathcal{I}_{Def}(b'))\left(\gamma u(c') + (1-\gamma)\tilde{W}\right) + \mathcal{I}_{Def}(b')\left((\gamma-\psi)u(y^{def}) + (1-\gamma-\psi)\tilde{W}\right)\right\} \tag{1}$$

$$c = y - q(b')b' \qquad c' = y + b'$$

where $\mathcal{I}_{Def}(b')$ is an indicator function that determines whether the agent defaults or not. The agent repays the debt in period 2 if the utility in period 2 in case of repayment is larger than the utility in case of default.

$$\gamma u(c') + (1-\gamma)\tilde{W} \geq (\gamma-\psi)u(y^{def}) + (1-\gamma+\psi)\tilde{W}$$

$$u(y+b') \geq \frac{\gamma-\psi}{\gamma}u(y^{def}) + \frac{\psi}{\gamma}\tilde{W} \tag{2}$$

When this inequality is binding, we can determine a threshold level $\tilde{b}$ such that if $b < \tilde{b}$ the agent defaults. If not, she repays. The agent chooses b' to maximize intertemporal utility considering incentive compatibility constraint. Investors are risk neutral and we assume without loss of generality that they discount future periods at the same rate as the incumbent; this implies that the stochastic discount factor is $m(y) = \beta$. For the sake of presenting our results, we shut down any borrowing or saving incentive that derives from assuming different discount factors between the domestic and foreign agents, which is not a relevant complication for this simple setting. Defining b^* as the solution of the maximization problem, the price of the bond is:

$$q(b) = \begin{cases} \beta & b^* \geq \tilde{b} \\ 0 & b^* < \tilde{b} \end{cases}$$

If $b^* \geq \tilde{b}$, b^* is the solution of the following equation:

$$-q(b^*)u'(y - q(b^*)b^*) = \gamma\beta u'(y + b^*) \Leftrightarrow u'(y - \beta b^*) = \gamma u'(y + b^*) \tag{3}$$

If $b^* < \tilde{b} < 0$ we have that:

$$u'(y - q(\tilde{b})\tilde{b}) > \gamma u'(y + \tilde{b}) \tag{4}$$

Let's now consider 3 possible cases:

2.1 Case 1: Never Default

Suppose for simplicity that the output cost of default is large, $y^{def} = 0$ and $\tilde{W} = 0$, this implies that $\tilde{b} = -y$. In this case, the agent always repays, except for the cases when the agent borrows the full amount of her endowment. The amount of borrowing is determined by 3. Notice that if $\gamma = 1$, the optimal amount of borrowing is 0, while if $\gamma < 1$, $u'(y - q(b^*)b^*) < u'(y + b^*)$ that implies $b^* < 0$. The reason for this is that political uncertainty makes the agent more impatient, since in period 2 she does not bear the cost of extra borrowing with probability $1 - \gamma$. This is a standard effect of political uncertainty on borrowing incentive.

2.2 Case 2: No political cost of default

Suppose there is no output cost of default $y^{def} = y$ and no political cost of default $\psi = 0$. Since the right hand side of 2 is now simply $u(y)$, it is straightforward to check that repayment set requires the amount of assets to be positive in equilibrium, $\tilde{b} \geq 0$. When $\gamma < 1$, optimal borrowing b^* from 3 is negative, but this would contradict incentive compatibility. As a result, the existence of political uncertainty in a context where agents can default does not imply larger level of debt in equilibrium, because markets anticipate default in the following period.

2.3 Case 3: Political Cost of Default

Suppose now $0 < \psi < \gamma$ and $y^{def} = y$. It is easy to check that $\tilde{b} < 0$ as far as $u(y^{def}) > \tilde{W}$. To verify this we only need to check that under the previous condition, the inequality 2 is strict when $b = 0$. As shown:

$$u(y) = u(y^{def}) > \frac{\gamma - \psi}{\gamma} u(y^{def}) + \frac{\psi}{\gamma} \tilde{W}$$

$$\frac{\psi}{\gamma} \left(u(y) - \tilde{W} \right) > 0$$

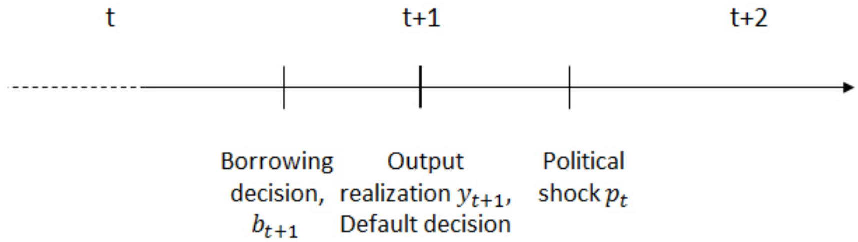
This implies that the existence of political uncertainty produces large borrowing levels only if default has a negative impact on the probability of remaining in power next period.

In the next section, we present an infinite horizon model and we show that the same results hold in a more complex economy.

3 The Model

Consider a small open economy with a stochastic stream of income. We assume that the government trades bonds with foreign creditors which are not enforceable and the government can choose to default on its debt at any time. There are n types of agents who can represent incumbents in government with homogeneous preferences. At each point in time, one of these agents is appointed, makes consumption decisions for herself and raise debt which is paid by the government in power in the subsequent period. After consumption and borrowing decisions are taken, the government observes income shock for the next period and decides whether to default or not. After a default decision, a political shock occurs. The probability of mantaining power during next period p is equal to γ if the government does not default and is equal to $\gamma - \psi$ in a default state. If the

Figure 2: Timeline in the Political Default Model



government is replaced, the other agents in the economy have equal probability to be appointed. We assume that $n \to \infty$, that implying the opposition state is an absorbing state.

This is the new feature of the model compared with previous literature; the cost of default for the government comes from the lower probability of being re-elected during the next period. This is a cost only if the agent has lower utility in the opposition state. We assume that the agent gains an intertemporal utility $\tilde{W}$ in the opposition state. For the sake of simplicity we have not explicitly modelled the cost of being in the opposition. The timeline of the events in our economy is summarized in figure 2.

Together with the novel source of default cost, as in Arellano (2008) we also assume that if the government defaults, it is temporarily excluded from international capital markets and incurs direct output costs. As in Arellano (2008) we further assume that when the government defaults, the debt is erased from the budget constraint and the agent cannot access to further borrowing while the economy is in default state. This implies that the incumbent consumes her entire output in default state, $c = y^{def}$. We assume that the output cost is greater when the output is large.

$$y^{def} = \begin{cases} \hat{y} & y \geq \hat{y} \\ y & y \leq \hat{y} \end{cases}$$

Exclusion from capital markets is determined by a random shock. The country can exit from default at the beginning of each period[3] with probability μ.

The price of each bond available to the government reflects the likelihood of default events, such that creditors break even in expected value. When in power, agents maximize expected utility

[3]Notice that political cost of default also depends on μ, since we assume that probability of re-election is lower until the economy is in default state.

and they discount future at rate $\beta < 1$. The utility function $u(c)$ is increasing and concave and the stochastic output, y, follows a Markov chain with transition $f(y', y)$. The price of a bond is $q(b', y)$, where b' is the value of the asset. The budget constraint is

$$c + q(b', y)b' = y + b$$

Lenders are risk averse and price sovereign bonds in the following way

$$q(b, y) = \int_{A(b')} m(y')f(y', y)dy$$

where $A(b')$ is the repayment set (see below). We assume that the agent has the discount factor $m(y') = 1/(1 + r) - \lambda\epsilon_{t+1}$. When $\lambda = 0$, the agent is risk neutral and the price of the bond is simply

$$q(b', y) = \frac{1 - P(b', y)}{1 + r}$$

where $P(b', y)$ is the endogenous probability of default.

We can write the model in a recursive form. Define $V^c(b, y)$ as the value function for the government in case of repayment. This value function satisfies

$$V^c(b, y) = \max_{b'} \quad u(y - q(b', y)b' + b) + \beta \int V^o(b', y')f(y', y)dy \tag{5}$$

We define the value of the option to default as

$$V^0(b, y) = \max \left\{V^{nd}(b, y), V^d(y)\right\} \tag{6}$$

where $V^{nd}(b, y)$ is the value of not defaulting after observing output y and before observing a political shock, while $V^d(y)$ is the same object in case of default:

$$V^{nd}(b, y) = \gamma V^c(b, y) + (1 - \gamma)\tilde{W} \tag{7}$$

$$V^d(y) = (\gamma - \psi)\left(u(y^{def}) + \beta\left(\mu \int V^c(0,y')f(y',y)dy' + \right.\right.$$
$$\left.\left. +(1-\mu)\int V^d(y')f(y',y)dy'\right)\right) + (1-\gamma+\psi)\tilde{W} \quad (8)$$

From these definitions we can further define a repayment set $A(b)$ and a default set $B(b)$ such that:

$$A(b) = \left\{y \in Y | V^{nd}(b,y) \geq V^d(y)\right\}$$

$$B(b) = \left\{y \in Y | V^{nd}(b,y) < V^d(y)\right\}$$

Repayment set $A(b)$ and default set $B(b)$ are the sets of all output realizations, that for a specific asset position b are consistent with repayment or default decision.

As in the toy model presented in section 2 most of the results rely on assuming that in the opposition state the agent gets the lowest utility level.

Assumption 1 *At the opposition state the agent benefits from a constant lifetime utility $\tilde{W} \in \Re$, where $\tilde{W} < V^{nd}(b,y)\, \tilde{W} < V^d(y) \quad \forall b, y$*

As in Arellano (2008) we can state some important results (proofs in the appendix).

Proposition 2 *For all $b_1 \leq b_2$, if default is optimal for b_2, in some states y, then default will be optimal for b_1 for the same states y*

More results can be derived formally by making additional assumptions. Suppose output shocks are i.i.d. We also assume $y^{def} = y$, that there is no output loss in case of default and that a default state is an absorbing state ($\mu = 1$).

Proposition 3 *Output shocks are iid. If, for some value of b, the default set is nonempty, then there are no contracts available $\{q(b'), b'\}$ such that the economy can experience capital inflows, $b - q(b')b' > 0$*

Proposition 4 *Output shocks are iid. Default incentives are stronger with lower endowment. $\forall y_1 \leq y_2$, if $y_2 \in B(b) \Rightarrow y_1 \in B(b)$*

4 Quantitative Analysis

4.1 Data

In this section we present business cycle data and define political events from the last 60 years in Argentina. Quarterly seasonally adjusted real data of output, consumption and trade balance are taken from the Ministry of Finance (MECON). The spread between Argentinian government bonds and international rates starting from third quarter 1983 is taken from Neumeyer and Perri (2005). In contrast with Arellano (2008), business cycle moments are estimated from a common dataset from the third quarter 1983 to the first quarter of 2002. Consumption and output series are taken in logs while trade balance is taken as percentage of total output. All variables are filtered with a linear trend. Our data transformation replicates the approach used in Arellano (2008), with the only difference that all business cycle moments are evaluated in a balanced dataset, while in Arellano (2008), GDP and consumption data start from the first quarter of 1980, spread from second quarter 1983 and trade balance to output ratio start from 1993. Debt to GDP data is taken from Reinhart and Rogoff (2010), and corresponds to an annual time series of total (domestic plus external) gross central government debt over GDP that averages to 50% in our sample. To evaluate the performance of the model we compare political turnover[4] in the data with the same output from the model. Our data includes government changes in Argentina which have occurred in the last decades as summarized in table 1. In the sample used for computing business cycle moments we observe 4 government changes from 1983 to 2002, that corresponds to a political turnover of 20% in the data.

4.2 Model Solution and Simulation

The model is solved by value function iteration by discretizing asset and output grid. Output shock is discretized into a 21-state Markov chain from an AR(1) process with the parameters reported in Arellano (2008)[5]. Without loss of generality, the average level of output has been set to 10.

[4]We define political turnover as the number of years when we observed a change in the ruling party or leader over the total number of years in the sample

[5]We did not re-estimate the AR(1) in our shorter sample in order to better compare results.

Table 1: Political Events in Argentina from 1955 to 2008

1955	Military Coup: Peron's Exile	GC
1958	Election of Frondizi	GC
1963	Election of Illia after Military Coup in 1962	GC
1966	Military Coup: Ongania	GC
1971	Lanusse	GC
1973	Election of Peron	GC
1975	Isabel Peron succeded Peron after his death	
1977	Military Coup: Dictatorship of Videla. National Reorganization Process.	GC
1981	Dictatorship of Viola	GC
1982	Dictatorship of Galtieri	GC
1983	Alfonsin Election	GC
1990	Menem Election	GC
2000	De La Rua Election	GC
2002	Duhalde substituted De La Rua	GC
2003	Mr. Kirchner Election	
2007	Ms. Kirchner Election	
2011	Ms. Kirchner Election	
2015	Macri Election	GC

GC: government change

According to Hatchondo et al. (2010), the number of states for output chosen in the standard Arellano setup is too small and generates spurious excess volatility of the spread. In order to limit computational time we have not increased the number of states, acknowledging that this choice is not problematic if we do not target the volatility of the spread in the structural estimation. We follow Hatchondo et al. (2010) in reducing the width of the asset grid and extending the grid to include lower values of debt to GDP in equilibrium[6]. The last point is relevant since the model generates larger levels of debt to GDP compared to standard default models. Finally, we have implemented one loop value function iteration following Hatchondo et al. (2010), which speeds up computational time. We assume that utility function is CRRA, while the value at the opposition state, $\tilde{W}$, is estimated. Business cycle moments are derived by simulating the economy for 100000 periods. Business cycle moments in tranqul periods are evaluated by considering periods in the simulated economy with more than 67 quarters without defaults. Standard deviation of output, consumption and spread are the only exception: they are calculated by taking the standard deviation of the simulated series in the full estimation sample.

[6] In our approach the asset grid is step wise uniform. We set 250 points in the interval $[-45, 0.05]$ of asset/output percentage, 50 points in the interval $[-60, 45)$ and 50 points in the interval $(0.05, 15]$.

4.3 Structural Estimation without Risk Aversion

We calibrate some benchmark parameters of the model as follows

- $\sigma = 2$
- $r^f = 0.017$
- $\hat{y} = 9.69$
- $\mu = 0.282$
- $\lambda = 0$

as in Arellano (2008). Some robustness checks are presented in this section, for $\hat{y}$, representing the output cost of default and μ, representing re-entry probability. Regarding risk aversion of international investors, we set $\lambda = 0$ for our benchmark results. A version of the model with risk aversion for international investors is presented in section 4.4.

The remaining parameters $\phi = [\beta, \tilde{W}, \psi, \gamma]$ are estimated by matching the following business cycle statistics:

1. correlation between trade balance to output ratio and output
2. relative standard deviation of consumption and output
3. autocorrelation of consumption
4. autocorrelation of trade balance to output ratio
5. default frequency (ratio of total number of years with default in the full history).

In particular, our estimation approach is designed to obtain the closest match between business cycle moments in the data and in the model. We emphasize that we do not target the level of debt to GDP or political turnover directly. In constrast with Arellano, we are not targeting a specific value of default frequency. In the Arellano calibration, parameters are set in order to match a default frequency of 3% that corresponds to the number of default events in Argentina in a century of data[7]. Our estimation approach instead requires that default frequency in the model should fall in a pre-specified interval. To calibrate this interval we used information of expected default frequency implicit in the spread between Argentinian and US Treasury bonds. In particular, according to our assumption on the stochastic discount factor of the international investor, the variability of the spread is mostly driven by the variability of expected default frequency[8]. This implies that using the empirical relationship 9

$$spr_t = \alpha + \beta \tilde{y}_t + \gamma \tilde{b}_t + \epsilon_t \tag{9}$$

where $\tilde{y}_t$ and $\tilde{b}_t$ are output gap and debt in the data, the component $\beta \tilde{y}_t + \gamma \tilde{b}_t$ represents a rough estimate of the expected default component of the spread[9]. From the time series[10] of this component, we compute 25th and 75th percentile, corresponding to 2%-6%, as an estimate of admissible values for the default frequency in the structural estimation that we implemented.

To estimate the parameters we solved and simulated the model for a grid of parameters value In particular, the boundaries of the grid are defined as follows: $\beta \in [0.91, 0.985]$, $\psi \in [0, 0.3]$,$\gamma \in [0.67, 1]$ and $\tilde{W} \in [-1.111, -9]$. We choose the parameters vector ϕ^j such that a loss function is minimized

$$L(\phi^j) = (m(\phi^j) - \bar{m})' G (m(\phi^j) - \bar{m})$$

under the constraint

$$0.02 < DF(\phi^j) < 0.06$$

where $m(\phi^j)$ are target moments associated to the parameters vector ϕ^j and $\bar{m}$ are the business

[7] Two default events in Argentina are reported in Beim and Calomiris (2001): one in 1956 when Argentina defaulted on its suppliers credit in the post-Peron budget crisis, and another in 1982 when it defaulted on its foreign bank loans in the midst of another budget crisis. Finally Arellano also considers the 2001 default event for calibrating default frequency.

[8] In our benchmark calibration with risk aversion, the variability of the expected default component of the spread is approximately 4 times the variability of the risk aversion component.

[9] The assumption of the linearity of the relationship between spread and the other explanatory variables is confirmed in the data: quadratic terms added in 9 are not significant and the analysis of variance between model 9 and the same model with quadratic terms does not accept the null hypothesis that the second model is the true one

[10] The time series covers the period 1983-2001, but we have excluded the years 1989-1990 from the computation of the interval. In this specific period the spread series reached 30% as a result of hyperinflation in Argentina

cycle moments from the data. As weighting matrix G we choose the variance covariance matrix, Σ of the business cycle moments $\bar{m}$ estimated in the data using GMM.

The solution of the minimization problem is below

$$\hat{\phi} = (\hat{\beta}, \hat{\bar{W}}, \hat{\psi}, \hat{\gamma}) = (0.984, -6.725, 0.143, 0.976) \tag{10}$$

compared to the Arellano calibration

$$\phi^{Are} = (0.953, \bar{W}, 0, 1) \quad \forall \bar{W} \in \Re \tag{11}$$

Excluding the political parameters, the main difference is in the estimate of the discount factor. In the Arellano calibration agents discount future consumption at a rate of 21.1%, much larger than standard values chosen to match business cycle moments in developed economies and far from usual calibrations of real business cycle models applied to the Argentinian economy[11]. In our calibration, agents discount future consumption at a rate of 6.7%, much closer to empirical studies and to standard calibrations of this parameter. Impatience in our model is also driven by political uncertainty that changes according to the default status of the economy.

In table 2 simulated business cycle moments from our benchmark calibration (1) are compared with business cycle moments estimated from the data and derived from the Arellano (2008) calibration (4) and other calibrations.

The model produces more realistic results regarding the level of debt to GDP, 34%, lower than the 48% of total public debt over GDP from Reinhart and Rogoff but in line with the 31% of long term external long term public debt over GDP. Furthermore the model reproduces more countercyclical trade balance to output ratio compared to the Arellano calibration, closer to the correlation observed in the data (-0.80). The model is also successful in matching co-movements between spread, output and consumption[12]. Furthermore, the model predicts larger deviations of

[11] Neumeyer and Perri (2005) calibrated the discount rate to 0.98 in case of Cobb Douglas utility function to match an average real interest rate in Argentina of 14.8% in their sample. Garcia-Cicco et al. (2010) calibrated the annual discount factor in their Real Business Cycle model of Argentina to 0.9224 corresponding to a real interest rate of about 8.5%

[12] Tomz and Wright (2007) argue that the correlation between output fluctuation and default event is actually negative but surprisingly weak.

Table 2: Business cycle statistics: simulated vs empirical moments

	data	**Benchmark No RA** (1)	$\hat{y} \to \infty$ (2)	$\mu = 1$ (3)	**Arellano** (4)
Default Frequency	0.03	0.02	0.02	0.01	0.05
Trade Balance volatility	2.72	2.90	2.96	1.80	1.39
$Std(C)/Std(Y)$	1.11	1.20	1.20	1.10	1.04
Spread	10.16	2.62	2.66	4.09	6.70
Debt/GDP	50.52	33.79	33.29	14.60	5.11
Std (Y)	7.51	7.08	7.07	6.75	7.18
Std (C)	8.30	8.49	8.51	7.45	7.49
Std(Spread)	5.70	8.97	9.30	14.44	8.17
$corr(Y, C)$	0.98	0.93	0.92	0.96	0.97
$corr(Spread, Y)$	-0.81	-0.54	-0.55	-0.53	-0.41
$corr(Spread, C)$	-0.85	-0.54	-0.53	-0.52	-0.46
$corr(TB/Y, Y)$	-0.80	-0.41	-0.39	-0.35	-0.26
Output Deviation default	-12.41	-14.99	-15.15	-17.02	-7.88
Cons. Deviation default	-14.82	-14.32	-14.48	-16.72	-7.76
autocorr(C)	0.90	0.73	0.72	0.77	0.77
autocorr(TB/Y)	0.86	0.37	0.36	0.27	0.22

output and consumption in default periods, which is much closer to the data. The reason is that the incumbent decides to default only when she faces very severe economic downturns compared to the Arellano model, because she wants to avoid political risk. The model matches almost exactly default frequency in the data. As a result of investors' risk neutrality, the spread is much lower compared to what we observe in the data. Trade balance volatility in our model is also much closer to the data, even if in Arellano (2008) the volatility reported is much lower (1.75) since trade balance in his paper is computed from 1993, while in our paper empirical moments in the data are calculated in a common dataset from 1983. Finally, relative standard deviation of consumption and output turns out to be larger in our model compared to the data.

The output of alternative calibrations are presented in column (2) and (3). The model in column (2) is calibrated as in the benchmark model, except that output cost is excluded, while in column (3) the only difference is that exclusion and default last for one period only. Eliminating the output cost of default has minimal effects on business cycle statistics deriving from the model, while the effect of reducing default duration is more relevant. Indeed, shorter exclusion periods are associated with shorter periods of political instability in the model. In this calibration, the debt to GDP ratio falls to 14.6% but it is still much larger than the Arellano benchmark case. These

Figure 3: Borrowing policy rule in Arellano calibration

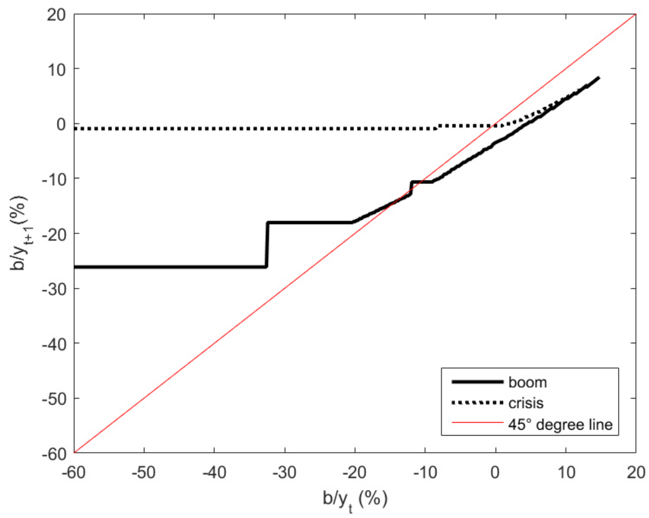
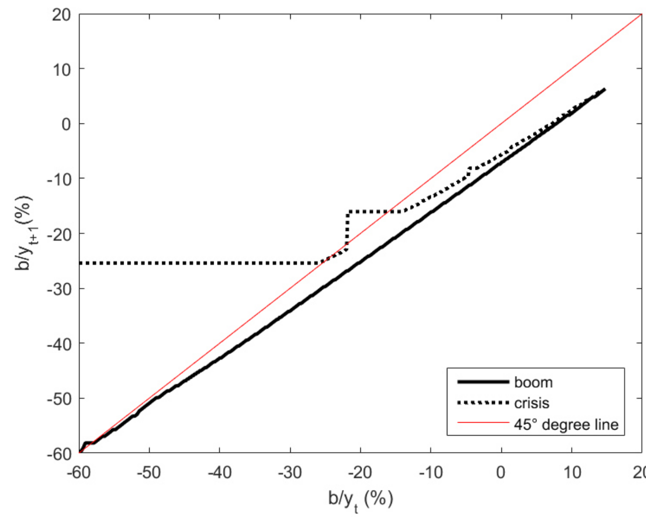


Figure 4: Borrowing policy rule in Benchmark calibration



Booms and recessions are defined as 7% deviation of output from trend.

calibrations show clearly that political uncertainty can be a much more relevant source of default cost compared to the external channel that is usually considered.

In the following, we present an analysis of the policy functions derived from the model. Figures 3 and 4 present the saving functions resulting from the Arellano calibration and from our benchmark calibration. In each plot we represent the level of assets over output in the next period as a function of the level of asset to output at the current period during a crisis or a boom. In the Arellano calibration, in the best scenario the incumbent is not able to borrow more than 20% of output, while in our benchmark calibration, the political cost of default is large enough to eliminate any incentive to default during booms. This feature generates the large levels of debt to GDP that we get from the simulation of the model. Furthermore the agent will always accumulate debt during expansions, implying that during booms trade balance is most likely negative. This is the reason why targeting the correlation between trade balance to output and output is relevant for capturing the large political cost in the structural estimation.

To further validate our calibration strategy, in figure 5 we present a comparative static exercise on the correlation of trade balance over output as a function of the parameters of our model. Figure 5 shows that large levels of ψ and β are associated with a more countercyclical trade balance, closer to the levels we observe in the data. Figure 6 is helpful for understanding why in calibration 10,

Figure 5: Correlation trade balance over output and output vs ψ and β

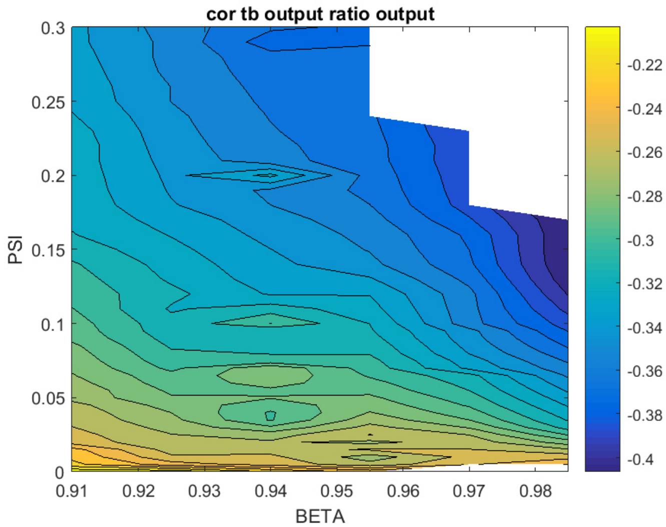
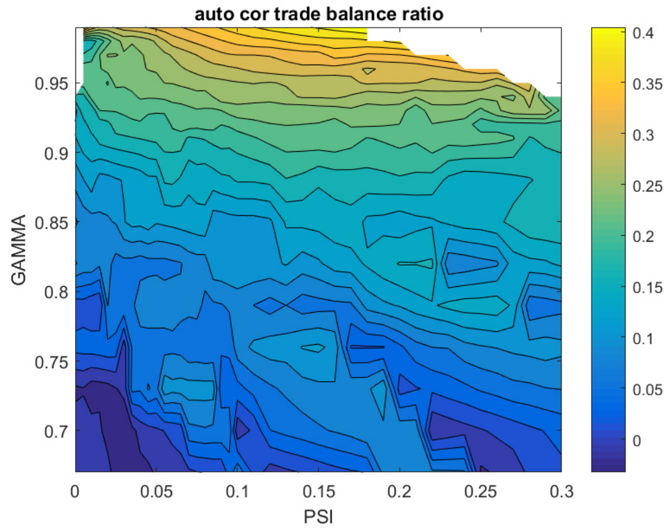


Figure 6: Autocorrelation of trade balance output ratio vs ψ and γ



The other parameters are set to be equal to the values of the benchmark calibration.

political uncertainty in normal times (γ) turns out to be small. With low levels of γ, trade balance to output ratio is much less autocorrelated compared to the data (0.86). As a result, structural estimation generates low political uncertainty in normal times.

4.4 Structural Estimation with Risk Aversion

As pointed out by Arellano (2008) and Arellano and Ramanarayanan (2012), risk aversion is a key ingredient to match the level of the spread. Without risk aversion, the model generates a spread that is tight to the probability of default, resulting in a counterfactually low spread compared to the data (10.75%). Furthermore, without risk aversion, the model predicts a null constant spread in periods where probability of default is zero. Borri and Verdelhan (2011) show that average sovereign bond excess returns compensate investors for taking on aggregate risk and that this new determinant of sovereign bond prices is relevant for pricing.

To estimate the model allowing for risk aversion ($\lambda > 0$), we set γ to 0.976 as in 10 and we estimate the parameter vector using the same approach described in 4.3 by targeting an additional moment: the average level of the spread in the data. We left γ unchanged to reduce the computational cost associated with estimating an additional parameter dimension in the grid. As a result of the estimation, the parameter vector is the following

$$[\hat{\phi}, \hat{\lambda}] = (\hat{\beta}, \hat{\tilde{W}}, \hat{\psi}, \hat{\gamma}, \hat{\lambda}) = (0.984, -6.562, 0.18, 0.976, 28) \tag{12}$$

Comparing calibrations 10 and 12, we find that allowing for risk aversion of international investors, the political cost of default is larger while utility at the opposition state is lower.

Table 3: Business cycle moments assuming Risk Aversion

	data	**Benchmark RA** (5)	**Arellano** (6)	**Arellano (RA)** (7)
Default Frequency	0.03	0.04	0.05	0.03
Trade Balance volatility	2.72	2.41	1.39	2.53
$Std(C)/Std(Y)$	1.11	1.16	1.09	1.16
Spread	10.16	10.96	6.70	9.38
Debt/gdp	50.52	15.15	5.11	5.53
Std (Y)	7.51	6.72	7.27	5.66
Std (C)	8.30	7.77	7.91	6.59
Std(Spread)	5.70	41.77	12.74	12.23
$corr(Y, C)$	0.98	0.94	0.97	0.91
$corr(Spread, Y)$	-0.81	-0.52	-0.41	-0.35
$corr(Spread, C)$	-0.85	-0.50	-0.46	-0.37
$corr(TB/Y, Y)$	-0.80	-0.37	-0.26	-0.15
Output Deviation default	-12.41	-14.92	-7.88	-9.15
Cons. Deviation default	-14.82	-14.58	-7.76	-8.95
autocorr(C)	0.90	0.74	0.77	0.65
autocorr(TB/Y)	0.86	0.39	0.22	0.08

Column (5) of table 3 summarizes the results of the calibration of the benchmark model with risk aversion. Also, in this case, the model is able to match spread, default frequency and to predict a large level of debt to GDP. The level of debt to GDP is lower compared to the calibration without risk aversion because the higher the price of risk generates a larger interest rate that reduces the incentive to accumulate debt. Spread volatility is large in our model, as in the Arellano model with risk aversion. This is explained by the ''stepwise" shape of the policy rule (see figure 4). This is not specific to our model but is a common drawback of this class of quantitative default models. Arellano and Ramanarayanan (2012) introduce recovery rates in a reduced form in order to match the quantitative behavior of the spread. Yue (2010) shows that, in a model in which the debt recovery rate is endogenously determined by a bargaining process between lenders and a defaulting borrower, the recovery rate is decreasing and convex. By introducing recovery rates, the transition from low to high default risk is slow and smooth, accounting for the much more stable behavior of sovereign spreads. Arellano and Ramanarayanan (2012) pointed out that the level of the spread is strongly influenced by the degree of risk aversion of the agent, but that the volatility of the spread is influenced by the time variation of default probability. This is also confirmed in our model. In our benchmark calibration, the risk neutral price has a standard deviation of 0.19; instead the standard deviation of the component of the price related to risk aversion is 0.04.

4.5 Testing the model

In this section we present statistical tests associated with the benchmark model without risk aversion (calibration 10). In table 4 we report standard errors associated with the parameters of the model. Standard errors are quite large, in particular the one associated to the political cost of default ψ and $\tilde{W}$.

Table 4: Parameters estimates and Standard Errors

	Par.	St. Err.
β	0.984	0.060
$\tilde{W}$	-6.725	2.945
ψ	0.143	0.369
γ	0.976	0.054

In table 5, we also compare standard errors of the moments in the data estimated with the GMM procedure with the standard error of the moments from the model. Moments in the data are estimated with larger uncertainty compared to the model. The model instead assigns larger uncertainty to the estimate of the autocorrelation of trade balance. In general confidence intervals from the data and from the model overlap, except for the relative standard deviation of consumption and output. This means that the moments estimated from the model are not statistically different from the moments in the data.

Our model is a generalized version of standard default model of Arellano (2008). This implies that we can recover the Arellano model by imposing a set of restrictions on the parameters vector.The calibration strategy in Arellano (2008) is different[13] but, interestingly, if we estimate the

[13]She targets the following moments in her paper: default probability, debt service to GDP ratio and the standard deviation of trade balance.

Table 5: Empirical Moments: Standard Errors in the data and in the model

	data	St. Err. Data	Model	St. Err. Model
autocorr(TB/Y)	0.856	0.208	0.365	0.869
$corr(TB/Y, Y)$	-0.796	0.285	-0.406	0.030
$Std(C)/Std(Y)$	1.106	0.043	1.200	0.003
autocorr(C)	0.905	0.351	0.727	0.001

Arellano model as described we obtain a discount rate of $\beta = 0.950$ close to the calibration of 0.953 in the original paper. This confirms that high impatience is an empirical regularity of this model where we do not allow for political uncertainty. We can derive the asymptotic distribution of the parameters of our GMM estimator:

$$\sqrt{(T)}\left(\hat{\phi} - \phi\right) \sim \mathcal{N}\left(0, \hat{V}\right)$$

$$\hat{V} = (M'GM)^{-1}M'G\Sigma GM(M'GM)^{-1}$$

where Σ is the variance covariance matrix of the errors of the model, G is the weighting matrix and M is the Jacobian of the moment conditions.

According to the Arellano model, $\beta = 0.95$, $\gamma = 1$, $\psi = 0$. We can test this hypothesis on the parameters by performing the Wald test:

$$T(R\phi - r)'\left(RVR'\right)^{-1}(R\phi - r) \sim \chi^2_3$$

where:

$$R = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad r' = [0.95, 0, 1]$$

Finally, the p-value associated to the Chi-square statistic for this test is 0.046. This implies that we reject the null hypothesis that restricting the parameters value as in the Arellano calibration delivers the same goodness of fit as our more general model.

5 Measuring political uncertainty

In the previous section we showed how political uncertainty is a relevant component in explaining debt and spread dynamics. However, we have not yet addressed whether the model delivers realistic predictions for the political turnover of Argentina around default events. In this section, we try to answer this question with the available data.

First, we want to assess whether the model is able to roughly match political turnover in Argentina. Using the events listed in table 1, we can measure political turnover as the number of years when a government change is observed as a ratio of total number of years in the sample. If we calculate political turnover during the years of the estimation sample of our analysis, we obtain 20% according to the events in the table. If we simulate the model in our benchmark calibration, we obtain 11% as an estimate of political turnover. The model seems to be more conservative in estimating the degree of political uncertainty, but the numbers are relatively close.

What is more interesting is to compare the estimate of political losses from the model with the evidence from other papers. For example Borensztein and Panizza (2009) measured political losses for the incumbent around the 2001 default event using electoral data[14] as 20.6%. Looking at electoral data can be problematic during the Argentinian default. Indeed the party of the leader De la Rua did not present in 2003 elections. Furthermore the country was ruled by Mr Duhalde starting from the resignation of De la Rua in 2001. General elections took place in 2003 and the new government implemented new reforms to deal with the difficult economic situation in Argentina. For these reasons, electoral data are not reliable to evaluate the political loss of the incumbent at the time of the default.

In this section, we present some results applied to polling data where confidence in the government is measured on a yearly basis and compare the numbers with the decline in re-election probability implicit in the model. Since our polls are measured more frequently compared to electoral data, the indeterminacy of the incumbent does not apply if we look at confidence levels in the years 2000 and 2001 since De la Rua was still in power in that period. The main disadvantage

[14]This roughly corresponds to the difference between the share of Mr. Duhalde's party in 1999 election, Partido Justicialista and the 2003 share of Alianza Movimiento Federal para Recrear el Crecimiento, the party that supported his action during his government in 2002.

of using confidence data is that having low confidence in the government does not necessarly imply low political support at the time of elections. As a result, the confidence rate, the percentage of population that has high confidence in the government, may be lower than realized voting share. Nevertheless we try to minimize this issue by looking at the difference between confidence rate from year 2000 to year 2001 as a proxy for unobserved variation in electoral support.

Polling data used in the following analysis are extracted from Latino Barometer Survey data. Latino Barometer surveys data for several Latin American countries from 1995. Around 1000 individuals for each country are surveyed on an annual basis. The database includes answers to specific questions regarding several topics such as the following:

- Sex, Age, Marital status, Education
- Media usage: internet, TV, newspaper, radio
- Political orientation, Religion
- Socioeconomic status, Economic conditions of the family in the present, past and future
- General economic conditions in the present, past and future
- Opinions on society, politics and economic policy
- Trust in institutions, in the president and in the government

Key characteristics of the population interviewed in year 2000 are summarized[15] in table 6. The variable *sex* is a dichotomous variable that takes value 1 when the sex is male. The variable *age* is the age of the individual. The education level of individual is measured by *edu*, the total number of years in education. The variable *cath* takes value 1 if the individual is Catholic, while *devout* ranges from 0 (not devout) to 3 (very devout). Political orientation is described by *right*, ranging from 0 (left) to 10 (right). The variable *natproud* has the same range and direction of *devout* and represents the pride of an individual in her nation. Finally, the variable *polnews* is a dummy variable that summarizes whether the individual pays attention to political news on television, newspaper or radio.

[15] We present a subset of characteristics that are used in the analysis

Table 6: Summary Characteristics of individuals in year 2000

Statistic	N	Mean	St. Dev.	Min	Max
sex	1,200	0.478	0.500	0	1
age	1,200	42.521	17.686	18	86
cath	1,200	0.807	0.395	0	1
devout	1,064	1.136	0.970	0	3
right	904	5.702	2.104	0	10
natproud	1,183	2.439	0.759	0	3
polnews	1,126	0.763	0.426	0	1

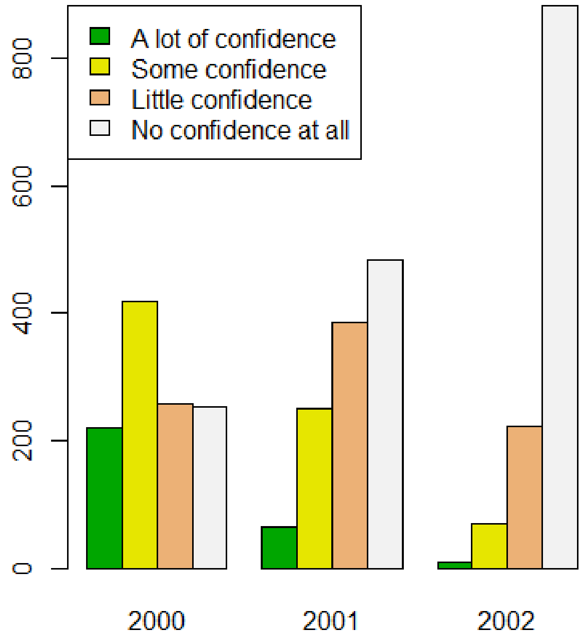
Latino Barometer data are repeated cross sections. In each year different individuals are interviewed. This implies that we can not observe the evolution of confidence for a specific individual, but instead of a class of individuals by aggregating responses from different years and groups. We measure the confidence of an individual using the answer to the following questions, depending on the year of the survey, due to a change in wording:

Year 2000-2001: *How much confidence do you have in each of the following groups, institutions or persons mentioned on the list: a lot, some, a little or no confidence? (President)*
Year 2002: *How much confidence do you have in each of the following groups, institutions or persons mentioned on the list: a lot, some, a little or no confidence? (Government)*

In all the years considered, polling data have been collected in the first half of the corresponding year. When individuals were surveyed in 2001, the Argentinian economy was already experiencing an economic downturn and large capital flows. President De la Rua left office in December of 2001 and his successor, president Saá declared default during his first presidential speech the same month. At the beginning of January 2002, the Parliament elected Duhalde as the new temporary President of Argentina. As a result at the time of the survey in 2002 President De la Rua had already been replaced.

Responses to the question above are summarized in figure 7. The figure shows the number of respondents with "a lot of confidence" or "some confidence" in the president or government declined from 2000 to 2002, while the number with "little confidence" or "no confidence at all"

Figure 7: Respondents to the question on confidence in the President/Government across Years



rose.

This provides initial evidence that political support for the President around the default event in 2001 declined. There are several reasons why we can not directly interpret this decline as originating from political cost of default. The first potential problem is that observed decline in confidence could be driven by common factors other than default decision during the period. Voters might have reduced their political support because of expected economic contraction instead of the default decision *per se*, a mechanism that is not present in our model but that has been already studied in the literature[16]. A potential solution to this problem is to measure confidence across groups with similar expectations about country's economic prospects. We use the answer to this question:

And in the next 12 months do you think that, in general, the economic situation of your country will improve, stay the same or get worse compared to the way it is now? 1. Better 2. The same 3. Worse

To conduct the analysis we construct an indicator of confidence in the government for individual

[16] See Rogoff (1990) and Pancrazi and Prosperi (2016)

i at time t, cr_{it}, in the following way:

$$cr_{i,t} = \begin{cases} cr_{i,t} = 1 & \text{if "A lot/some confidence"} \\ cr_{i,,t} = 0 & \text{if "Little confidence/No confidence at all"} \end{cases} \tag{13}$$

We group confidence in the government across individuals with same economic prospects, we measure a confidence rate for a specific group as the share of individuals with $cr_{i,t} = 1$ in the population of the group and we report the results in table 7. In table 8 we report the variation of the confidence rate for each group with associated confidence bands. As we observe, the decline in confidence in the government from 2000 to 2001 is large in the full sample, around 29%. The group of individuals that expected ''better or same" economic conditions declined from 2000 to 2002 in favor of individuals with negative expectations about the economy. The shift from "optimistic" to ''pessimistic" could potentially explain the decline in confidence at the aggregate level. However, according to table 8, the decline in confidence is also observed among individuals with better or "same" economic prospects. This suggests that the default decision per se had negative effects on confidence even after controlling for expectations on the evolution of the economy. Individuals with positive views about the future have greater confidence in the President, while the opposite holds for individuals with negative prospects. Nevertheless, in 2002, confidence rates fell below 5% even among individuals with positive economic views.

Since Latino Barometer is not a panel, grouping individuals at each point in time on the basis of economic expectations can give misleading results because of changes in the composition of the group. Furthermore, expectations for the economy are likely to be endogenous with respect to confidence in the government[17]. To deal with this problem we adopt the approach of Attanasio et al. (1998). We define groups in terms of their predicted probability of having different economic prospects and we average confidence across these predicted groups. Specifically, the approach works by predicting economic prospects in 2001 and 2002 using weakly exogenous covariates. Given $t = \{2000, 2001, 2002\}$, when $t = 2000$ we estimate 3 logit models, one for each possible class (better/same/worse prospects). In each logit regression 15, the dependent variable is a

[17]Individuals might have strong confidence in the government and for this reason they are optimistic about economic conditions

Table 7: Confidence rates across classes of individuals with similar economic prospects

	Confidence rate			Population size		
	2000	2001	2002	2000	2001	2002
All	0.55	0.27	0.03	1082	1115	1101
Better eco. cond.	0.74	0.38	0.04	464	366	254
Same eco. cond.	0.48	0.24	0.03	379	409	262
Worse eco. cond.	0.30	0.17	0.01	239	340	585

Table 8: Change in confidence rates across classes of individuals with similar economic prospects and confidence interval

	2000-01	2001-02
All	0.289	0.24
	0.251-0.327	0.213-0.268
Better eco. cond.	0.361	0.336
	0.296-0.425	0.279-0.394
Same eco. cond.	0.237	0.21
	0.17-0.303	0.162-0.258
Worse eco. cond.	0.135	0.154
	0.063-0.207	0.113-0.196

Confidence intervals are associated with a 5% confidence rate

dummy that takes value 1 if the individual is in class g,

$$cl^g_{i,t} = \begin{cases} 1 & \text{if i is in class g} \\ 0 & \text{otherwise} \end{cases} \tag{14}$$

$$cl^g_{i,t} = \Phi(Z^g_{i,t}) \quad Z^g_{i,t} = \beta X_{i,t} + \varepsilon_{i,t} \tag{15}$$

where $\Phi(Z)$ is the logit link and $X_{i,t}$ are the exogenous covariates used to predict class ownership. Explanatory variables used for this analysis are summarized in table 9. Most of the chosen covariates are exogenous since they do not vary over time or they vary in a predictable way such as sex or age. National pride, political orientation, religion and attention to political news are covariates that are associated to the education of individuals and are usually stable over time. We have included in the regression interaction terms between the variables that are significant in explaining economic expectations by individuals. Finally we report some goodness of fit statistics at the bottom of table 9.

Once the model is estimated, we classify in-sample individuals in $t+1$ using the model estimated

Table 9: Logit Regression results

	Dependent variable: eco. conditions		
	Better	Same	Worse
	(1)	(2)	(3)
age	0.039^{***}	-0.033^{**}	
	(0.013)	(0.013)	
devout	0.122	0.560	-0.209^{*}
	(0.295)	(0.413)	(0.110)
right	−0.089	−0.067	0.226^{**}
	(0.183)	(0.172)	(0.092)
natproud	−0.107	0.078	0.143
	(0.506)	(0.621)	(0.305)
sex	0.755	1.051^{**}	-1.255^{**}
	(0.518)	(0.504)	(0.628)
polnews	−1.354	0.412	1.436
	(1.001)	(1.025)	(1.130)
cath	−1.101	5.032^{***}	-2.017^{***}
	(0.994)	(1.817)	(0.681)
age:devout	-0.014^{***}	0.014^{***}	
	(0.005)	(0.005)	
natproud:polnews	0.699^{**}		-0.698^{**}
	(0.293)		(0.336)
right:polnews	0.207^{**}		-0.180^{*}
	(0.095)		(0.106)
sex:cath	-1.247^{**}		1.452^{**}
	(0.545)		(0.660)
devout:right	0.096^{**}	-0.116^{**}	
	(0.042)	(0.045)	
age:polnews	-0.026^{**}	0.022^{*}	
	(0.012)	(0.012)	
natproud:cath	0.613	−0.860	
	(0.376)	(0.534)	
polnews:cath		-1.676^{*}	1.073
		(0.900)	(0.700)
devout:cath		-0.520^{*}	
		(0.306)	
right:natproud	−0.086	0.093	
	(0.057)	(0.059)	
right:sex		−0.118	
		(0.081)	
Constant	−0.505	−3.157	−0.803
	(1.485)	(2.080)	(1.017)
Observations	696	696	696
Log Likelihood	−447.510	−428.338	−331.389
Akaike Inf. Crit.	927.020	888.676	684.779
ROC	0.664	0.635	0.656
Sensitivity (%)	81.270	74.274	56.429
Hosmer Lemeshow test (pvalue)	0.422	0.346	0.460

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 10: Confidence rates across classes of individuals with similar economic prospects using the approach of Attanasio et al. (1998)

	2000	2001	2002
All	0.56	0.29	0.07
Better eco. cond.	0.55	0.32	0.03
Same eco. cond.	0.57	0.29	0.02
Worse eco. cond.	0.54	0.26	0.1

Table 11: Change in confidence rates across classes of individuals with similar economic prospects and confidence intervals using the approach of Attanasio et al. (1998)

	2000-01	2001-02
Better eco. cond.	0.232	0.288
	0.181-0.284	0.248-0.328
Same eco. cond.	0.288	0.261
	0.232-0.344	0.217-0.306
Worse eco. cond.	0.282	0.159
	0.197-0.367	-0.074-0.391

Confidence intervals are associated to a 5% confidence rate

in $t = 2000$ according to their fitted probability: if $\Phi(\hat{Z}_{it}^{g})$ is large enough, we assign the individual to the specific class. As a threshold level for fitted probability, we follow Attanasio et al. (1998), choosing the ratio of individuals in class g at time $t+1$ over the total population at time $t+1$.

Using this approach, we can create groups of individuals according to their economic prospects in 2001 and 2002, calculate confidence rates in all these groups and compare the output with the confidence rate of the corresponding group in year 2000. The results are reported in table 10 and can be compared directly with table 7. Classifying individuals according to their predicted probability reduce the differences in confidence rates across groups: in 2000 the confidence rate was around 55% in all 3 groups and declined in the following years reaching 2-3% in 2002 for individuals with better and same economic prospects. Confidence rates for individuals with worse economic expectation are poorly estimated in 2002, since only one individual, predicted to belong to this group, was reported as "confident". Variation in confidence rates are reported in table 11. The analysis shows that the decline in confidence rate from this approach is quantitatively similar in the aggregate to the decline in confidence rate in table 8.

Finally, we compare the results of this analysis with the predictions of our model in terms of the political cost of default. In particular, we can compare estimated decline in confidence rate from Latino Barometer data with the estimated decline in re-election probability in the simulated economy. Looking at Latino Barometer data the decline from 2000 to 2002 is around 53% at the aggregate level (table 7). Taking parameters γ and ψ in the model, it is possible to calculate the increase in the expected probability of losing power after two years[18] from default as the difference between probability of losing power, $ele_{t+8} = 0$ conditional on default state: $Pr(ele_{t+8} = 0|def_{t+s} = 1 \,\forall\, s = 1, \ldots 8)$ and the probability of losing power conditional on repayment $Pr(ele_{t+8} = 0|def_{t+s} = 0 \,\forall\, s = 1, \ldots 8)$

$$\Pr(ele_{t+8} = 0|def_{t+s} = 1 \,\forall\, s = 1, \ldots, 8) - \Pr(ele_{t+8} = 0|def_{t+s} = 0 \,\forall\, s = 1, \ldots, 8) = (1 - (\gamma - \psi)^8) - (1 - \gamma^8) \quad (16)$$

According to the benchmark calibration of our model, the default state increases the probability of political turnover by 59% after two years. This estimate is larger than the decline in confidence rates observed in Latino barometer data, but reasonably close.

6 Conclusions

In this paper we presented a model of sovereign default where the government can face a political shock and be replaced by another agent in the economy. Political uncertainty is greater in times of default, for this reason the government is more reluctant to default compared to a setting where political frictions are not considered. Our model is a generalized version of the model in Arellano (2008) where a simplified political process is introduced. In order to test the output of the model, we set some parameters value as in Arellano (2008), while the discount rate and political parameters are estimated by matching business cycle moments for the Argentinian economy. We show that the model can match the level of debt to GDP when investors are risk neutral, in contrast with Arellano (2008). By introducing risk adverse investors, we are also able to jointly match the spreads and still predict fairly large levels of debt to GDP. We test the restrictions on the parameters of the model that would correspond to the model of Arellano (2008), rejecting the restrictions on

[18]Note that the survey data is collected on annual basis while the model is calibrated on quarterly data.

the political parameters corresponding to the absence of political uncertainty. Finally, we show that the political turnover implied by the model is lower than the political turnover observed in Argentina from 1983 to 2001, but due to the short sample available, given that Argentina turned to a democracy quite recently, political turnover in the data is roughly estimated. Moreover, we compare the decline in confidence rate around default event of 2001 using Latino Barometer survey data with a comparable number from our model. Political loss is larger in the model compared to the decline in confidence rates during Argentinian default, but the numbers are reasonably close.

A Appendix

A.1 Proof of proposition 2

Proof. If default is optimal for b_2 in some states y then $V^d(y) > V^{nd}(b_2, y)$, that implies

$$\gamma V^c(b_2, y) + (1-\gamma)\tilde{W} = \gamma \left(u(y - q(b', y)b' + b_2) + \beta E V^o(b', y')\right) + (1-\gamma)\tilde{W} < V^d(y)$$

Since $u(y - q(b', y)b' + b_1) < u(y - q(b', y)b' + b_2)$, we have that

$$\gamma \left(u(y - q(b', y)b' + b_1) + \beta E V^o(b', y')\right) + (1-\gamma)\tilde{W} < V^d(y)$$

■

A.2 Proof of proposition 3

Proof. By contradiction. Suppose there are contracts $\{q(b'), b'\}$ available to the economy such that $b - q(b')b' > 0$, but that the government chooses under the contract utility some $\hat{b}$ to maximize utility such that $b - q(\hat{b})\hat{b} < 0$, and then finds default to be the optimal option because

$$(\gamma - \psi)\left(u(y) + \beta E V^d(y')\right) + (1 - \gamma + \psi)\tilde{W} > \gamma \left(u(y - q(\hat{b}, y)\hat{b} + b) + \beta E V^o(\hat{b}, y')\right) + (1-\gamma)\tilde{W}$$

Note that under all contracts $\{q(b'), b'\}$ that deliver $b - q(b')b' > 0$, staying in the contract is always preferable to default. Indeed

$$\gamma \left(u(y - q(b', y)b' + b) + \beta E V^o(b', y')\right) + (1-\gamma)\tilde{W} > (\gamma - \psi)\left(u(y) + \beta E V^d(y')\right) + (1 - \gamma + \psi)\tilde{W}$$

$$\gamma \underbrace{\left(u(y - q(b', y)b' + b) - u(y)\right)}_{A_1} + \gamma\beta \underbrace{\left(E V^o(b', y') - E V^d(y')\right)}_{A_2} + \gamma \underbrace{\left(u(y) + \beta E V^d(y') - \tilde{W}\right)}_{A_3} > 0$$

To verify the last inequality,notice that

- $A_1 > 0$ since $b - q(b')b' > 0$
- $A_2 \geq 0$ since $EV^o(\hat{b}, y') \geq EV^d(y')$ by 6
- $A_3 > 0$ by assumption 1

This implies that $\hat{b}$ cannot be the maximizing level of assets and then default be optimal, because it is a contradiction. ■

A.3 Proof of proposition 4

Proof. If $y_2 \in D(B)$ then by definition

$$(\gamma - \psi)\left(u(y_2) + \beta EV^d(y')\right) + (1 - \gamma + \psi)\tilde{W} > \gamma\left(u(y_2 - q(b^2)b^2 + b) + \beta EV^o(b^2, y')\right) + (1 - \gamma)\tilde{W}$$

Define

$$A_1 = \left\{\gamma\left(u(y_2 - q(b^2)b^2 + b) + \beta EV^o(b^2, y')\right) + (1 - \gamma)\tilde{W}\right\} - \\ - \left\{\gamma\left(u(y_1 - q(b^1)b^1 + b) + \beta EV^o(b^1, y')\right) + (1 - \gamma)\tilde{W}\right\} \quad (17)$$

$$A_2 = \left\{(\gamma - \psi)\left(u(y_2) + \beta EV^d(y')\right) + (1 - \gamma + \psi)\tilde{W}\right\} - \left\{(\gamma - \psi)\left(u(y_1) + \beta EV^d(y')\right) + (1 - \gamma + \psi)\tilde{W}\right\}$$

If $A_1 > A_2$ is satisfied, then $y_1 \in B(b)$. We need to verify this condition.

Since output shocks are i.i.d, A_2 simplifies to $(\gamma - \psi)\left(u(y_2) - u(y_1)\right)$. Because of utility maximization

$$u(y_2 - q(b^2)b^2 + b) + \beta EV^o(b^2, y') \geq u(y_2 - q(b^1)b^1 + b) + \beta EV^o(b^1, y')$$

Define

$$\tilde{A}_1 = \left\{\gamma\left(u(y_2 - q(b^1)b^1 + b) + \beta EV^o(b^1, y')\right) + (1 - \gamma)\tilde{W}\right\} - \\ - \left\{\gamma\left(u(y_1 - q(b^1)b^1 + b) + \beta EV^o(b^1, y')\right) + (1 - \gamma)\tilde{W}\right\} \quad (18)$$

where $A_1 \geq \tilde{A}_1$. Thus if $\tilde{A}_1 \geq A_2$, we prove the claim. Simplifying further

$$\gamma \left(u(y_2 - q(b^1)b^1 + b) - u(y_1 - q(b^1)b^1 + b) \right) > (\gamma - \psi) \left(u(y_2) - u(y_1) \right) \tag{19}$$

Because of proposition 3, $y_2 \in B(b^1) \Rightarrow b - q(b^1)b^1 < 0$. Since $\gamma > \gamma - \psi$ and because utility is increasing and strictly concave, 19 holds, which implies $y_1 \in B(b)$ ■

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Risk Weighting, Private Lending and Macroeconomic Dynamics

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Abstract

According to current regulation, European banks can apply zero risk weights to sovereign exposures in their balance sheet independently from the rating assigned. We claim that zero risk weighting of sovereign bonds has implications by distorting banks' asset allocation decisions. Due to the lower regulatory cost of sovereign bonds, banks invest more in those bonds at the expense of lending to the real sector. To quantify the effect of the distortion induced by this regulation, we build a standard RBC model featuring financial intermediation and a government sector calibrated to the Euro Area economy. Financial regulation is introduced via a penalty function that punishes banks if they deviate from the target capital ratio. We study the zero risk weight policy during normal times when there is no sovereign default risk and find that a policy introducing positive risk weights on government bonds has both long-run effects and stabilization properties with respect to the business cycle. This policy makes the steady state lending spread on firm loans decline, stimulating investment and output. Also, it stabilizes the lending spread leading to a lower volatility of investment and output.

JEL classification: E44, E32, G21, G32

Keywords: Sovereign Bonds, Risk Weighting, RBC, Lending

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1 Introduction

Since the Financial crisis, policy makers have started an intensive reform on banking regulation with the ultimate goal of strengthening the banking system and disincentivizing risk taking behavior. So far, this process has not involved a comprehensive reform on the regulatory treatment of sovereign exposures that has remained broadly unchanged from the Basel I framework (BCBS, 2017). According to existing rules, the regulatory treatment for sovereign exposures is more favorable than for any other asset. In particular, risk weights are assigned to different types of assets in order to adequately measure the risk embodied in banks' balance sheet and to evaluate their capital position. However, at national discretion, banks are allowed to assign zero risk weights to government debt denominated in domestic currency, no matter which is the default risk of a country. Even considering only those assets with investment grade rating, risk weights for other types of exposures (including loans) are usually positive. This implies that sovereign debt receives a more favorable regulatory treatment compared to private lending, even among the highest rated assets, which may encourage banks to accumulate public debt (Nouy, 2012).

In academic research the special regulatory treatment of sovereign debt that assigns zero risk weight (ZRW) on government bonds in capital adequacy rules has not received much attention yet. Most of the papers in this field focus on the effect of banking rules on excessive domestic bond holdings and the sovereign-bank nexus as a source of instability during a crisis. However, the impact of these rules in normal times is a much less studied issue. With this paper we aim to fill this gap and show the financial and macroeconomic effects of relaxing the zero risk weight rule on sovereigns in the extreme case of a risk-less scenario with no possibility of sovereign and firm default.[1] We argue that the ZRW rule favors capital allocation of banks towards government securities and "crowds out" the provision of credit to the private sector by distorting the marginal cost of holding these assets. We study the macroeconomic implications of varying the regulatory risk weights on government bonds within a standard DSGE framework in which banks are subject to regulatory capital requirements. As in most of RBC models with banking sectors, financial regulation is specified via a penalty function that punishes banks if they deviate from the target capital ratio. In our model regulation has no beneficial effects for the economy as it only absorbs aggregate resources. This framework is extended by a government sector that finances its expenditures by levying taxes on households and issuing bonds that are held by domestic banks.

[1] We acknowledge that this is a rather unrealistic assumption as firms may also default during normal times.

We claim that removing zero risk weights on sovereigns would increase the flexibility of banks, since they can accommodate a reduction of risk-weighted assets by changing the composition of the balance sheet. In particular, if after a shock the capital ratio falls below the regulatory threshold the bank can now sell bonds and loans (and not only loans) to reduce risk-weighted assets. As a result loans are less penalized by regulation compared to sovereign bonds and for this reason interest rates on loans carry a lower marginal cost from banking regulation. We embed this mechanism in our model and calibrate it to the Euro Area economy to quantify the effects of removing these zero risk weights.

We find that increasing the risk weights on sovereign bonds in the capital adequacy ratio of banks has important stabilization properties and stimulates investment in the long-run. Due to the relatively lower risk weight on firm loans, the lending spread in the steady state decreases, making it more profitable for firms to invest, which leads to a higher long-run output. When looking at the volatility of the business cycle, we find that this policy stabilizes the lending rate on loans, reducing the variability of investment and output. As investment is financed via loans provided by banks, this also implies a lower volatility of the bank's balance sheet.

These results may look surprising. Increasing sovereign risk weight tightens an unnecessary constraint (capital regulation) and absorbs aggregate resources. One might therefore expect negative effects on the economy from this policy scenario. However penalizing bond holdings reduces the distortion on loans induced by regulation, that would boost investment and final output, compensating the negative effects from tighter capital conditions.

Since regulation is introduced in a reduced form, our model does not consider some of the possible costs that may arise from this policy. For example, bonds have no real use in our economy even though in practice, banks use them for different purposes such as liquidity management[2], credit risk mitigation and profitable investments (BCBS, 2017). Moreover we abstract from any implications on sovereigns' default risk. Indeed, while removing zero risk weights might potentially lower lending rates, we show that it has the opposite effect on government bond rates. This might create concerns on fiscal sustainability, since public debt would be larger in the long-run to cover interest expenses. Moreover, increased sovereigns' default risk can potentially trigger defaults in the banking sector, a channel that is not explicitly modeled in our framework. Nevertheless, since this policy increases long-run output, the government can increase tax revenues and counteract the

[2]Since sovereign bonds are the most liquid assets, they are used as a collateral for interbank lending and to access monetary policy financing. Moreover, banking regulation imposes banks to old a buffer of liquid assets.

rise in sovereign debt induced by larger bond yields. To conclude, we do not provide a complete argument in favor of or against this policy. Importantly, due to the limitations of our analytical framework, results should be treated with caution as it is uncertain if they still hold in a model with sovereign and firm default risk.

Our results shed new light on the ongoing policy debate on banks' exposure to sovereigns. Not only, according to the literature, excessive bond holdings can be problematic during a crisis as it happened in 2012, but we found that it also has implications on marginal costs of investment for banks even in tranquil periods. In particular, whenever zero risk weighting is in place, banks invest relatively more in government bonds compared to loans to firms. Importantly, while reducing domestic sovereign exposure is clearly an important goal for financial stability, the distribution of debt across countries is not relevant in our setup. Regardless of the nature of the sovereign debt, bonds are simply considered as an alternative investment opportunity for banks. Therefore, even if caps on domestic exposures are imposed (De Groen, 2015; Véron, 2017), banks in the Euro Area will likely buy sovereign debt issued by other European countries, keeping thus aggregate sovereign exposure unchanged.

The remainder of the paper is structured as follows. In Section 2, we review the related literature. Section 3 recaps (briefly) the current banking regulation under Basel III and the policy discussion on Basel IV about sovereign exposures, and relates them to the results of our analysis. In Section 4, we present the general equilibrium model. Section 5 presents our benchmark calibration and discusses the main quantitative results. Robustness checks are provided in Section 6. Section 7 concludes.

2 Related Literature

In the aftermath of the global financial crisis, a large number of DSGE models featuring a banking sector have been developed in order to analyze the role of bank capital and leverage constraints in the propagation of shocks through the banking sector. In these models, bank capital is motivated either by mitigating moral hazard problems in financial contracts (see e.g. Meh and Moran, 2010; Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gertler et al., 2012) or by exogenous regulatory requirements (see e.g, Van den Heuvel, 2008; Gerali et al., 2010; de Walque et al., 2010; Darracq Pariès et al., 2011). The latter is justified by the concern that monetary policy may be insufficient in addressing financial imbalances such that other instruments such as regulatory tools might be necessary (see Blanchard et al., 2010). A large number of studies evaluate macroprudential policies such as the Basel (I-III) capital requirements, and compute optimal capital regulation.[3] While most of these papers focus on the effects of minimum capital requirements (such as the 8% rule) or risk-sensitive or countercyclical capital buffers, we are among the first to study the implications of zero sovereign risk weights under the current regulatory regime.

This paper introduces bank capital requirements in a DSGE framework as an exogenous penalty which reduces bank profits when the bank is not sufficiently capitalized. The main advantage of this approach is the the possibility to apply perturbation methods and solve large scale DSGE models. For this reason it has been largely adopted in the past (see e.g. Gerali et al., 2010; Kollmann et al., 2011; Kollmann, 2013; Lambertini and Uysal, 2014; Fève et al., 2019; Lozej et al., 2017). Alternatively, instead of using the penalty approach to prevent banks from falling below the target capital ratio, Abad (2018) assume that the banks' leverage constraint is always binding, since equity issuance is more costly than deposit financing. However, this modeling assumption is in contrast with the data, since banks usually operates above the minimum requirements. In our case we target average capital ratios among European banks.

Since the onset of the European debt crisis, research devoted much attention to the negative feedback loop between banks and sovereigns and its implications for macroeconomic activity.[4] Bocola (2016) shows that government default risk has adverse effects on the funding ability of banks and it raises the risks associated with lending to the private sector. Abad (2018) shows that the possibility of a sovereign default acts as an important source of systemic risk, by which an initial shock to a small fraction of banks translates into system-wide instability. Most of these papers claim that zero risk weights exacerbate the negative feedback loop between banks and sovereign in times of stress by incentivizing banks to hold an excessive amount of bonds. In his quantitative study, Abad (2018) provides a counterfactual exercise showing that introducing capital requirements for banks' sovereign exposures reduces banks' endogenous exposure to sovereign risk and makes bank effectively safer and, consequently, helps mitigating the feedback effects between banking and sovereign crises and its negative spillovers on economic activity. The empirical study by Acharya and Steffen (2015) finds that undercapitalized banks with high risk-weighted returns undertook long peripheral sovereign bond positions to earn higher and riskier returns on their

[3] See e.g., Gerali et al. (2010), Covas and Fujita (2010), Curdia and Woodford (2010), de Walque et al. (2010), Darracq Pariès et al. (2011), Gertler and Karadi (2011), Kollmann et al. (2011), Angeloni and Faia (2013), Agénor et al. (2013), Cecchetti and Kohler (2014), Christiano et al. (2014), Quint and Rabanal (2014), Angelini et al. (2015), Benes and Kumhof (2015), and Brzoza-Brzezina et al. (2015).

[4] See Abad (2018) for a detailed review of the literature.

diminished capital while still meeting regulatory capital requirements. Also in our study, zero risk weighting induce excessive bond holdings but, since default risk is not explicitly modeled, it has no effect on the solvency of banks and governments and on macroeconomic stability. However, even in absence of default risk, we claim that zero risk weights have detrimental effects on private lending and macroeconomic activity in normal times.

Finally, our paper relates to the capital taxation literature. The distortion from differential risk weighting in our framework with costly regulation acts as if there was a higher tax on firm loans than on government bonds. This translates into a higher tax on physical capital as firm loans are used for capital formation. When removing this distortion, we find that the level of output and the capital stock increases in the steady state. Hence, our results are in line with the findings of Judd (1985) and Chamley (1986) who find that in models of exogenous economic growth, where capital and output in units of effective labor stay constant in the steady state and savings only finance the formation of fixed capital, taxes on capital and capital income have detrimental effects on capital stock and output levels. However they find that economic growth is unaffected by these taxes. In a recent study, Bösenberg et al. (2018) study the effects of broad capital taxation on the capital stock, output, and welfare within a dynamic model of a small open economy estimated on 79 countries over the period 1996-2011. The authors find that capital tax reductions induce economically significant positive effects on output and the capital stock (per unit of effective labor). Effects on welfare instead may be positive or negative for a country as a reduction in tax revenues reduces consumption in the short-run and raise it in the long-run so that welfare outcomes depend on the net effect of this tax policy. That transition phases may often overturn positive long-run welfare gains is often found in the literature. Russo (2002) finds negative welfare effects along the transition to the new steady state in an exogenous growth model.

3 Banking regulation

Before presenting our model framework, we briefly recap the current regulation scheme in the banking sector in order to provide a better understanding on both the current debate on the regulatory treatment of government bonds and the insights of our model. Introduced from 2013 the Basel III accord is supposed to maintain banks' solvency by strengthening the regulation, supervision, and risk management. More precisely, these frameworks impose capital adequacy requirements which limit the amount of assets (including loans) that a bank may hold relative to its own capital, with the goal of ensuring that losses may be absorbed without prejudicing the rights of creditors and depositors. From the capital side, the banks should hold a certain amount of quality and type of assets sufficient to absorb losses. On the assets side the bank must calculate the value of all assets in the balance sheet by weighting each asset according to its riskiness. In particular, banks are required to satisfy

$$\frac{Capital}{RWA} > 8 + CAPB + CCYCB\%$$

where RWA are risk weighted assets, $CAPB$ is the capital conservation buffer and $CCYCB$ is the countercyclical buffer[5]. The rule requires that banks should have total regulatory capital not lower than a given threshold (from 8% to 13% according to the buffers) of RWA. Risk weighted assets are simply a weighted sum of assets where weights are assigned according to different asset categories and riskiness. Focusing on sovereign exposures, under the standardized approach of Basel III risk weights should be applied to these assets according to external ratings. These weights are summarized in Table 1. If we compare these weights with the ones associated to other counterparties we find that government bonds usually receive a favorable treatment. For instance, AAA sovereign exposures attract a zero per cent risk weight while AAA corporate exposures attract a twenty per cent risk weight (see Table 2).

Table 1: Risk weights for sovereigns (Standardized Approach)

Cred. rating	AAA	A	BBB+	BB+	below B-	unrat.
RW	0	0.2	0.5	1	1.5	1

Table 2: Risk weights for private loans and assets (Standardized Approach)

categories	banks	firms	equity	retail	resid. mortgages
RW	0.2-1.5	0.2-1.5	1-2.5	0.75	0.35

Moreover, following current regulation sovereign debt denominated in domestic currency are treated using national discretion.[6] In Europe, the Capital Requirement Directives (CRD) transpose Basel

[5]The capital conservation buffer is intended to be large enough to enable banks to maintain capital levels above the minimum requirement throughout a significant sector-wide downturn. The countercyclical buffer is an additional requirement which will be implemented by national supervisors when there is excess credit growth in their economy, with the intention of dampening such credit growth.

[6]See Basel II (comprehensive version published in June 2006): "At national discretion, a lower risk weight may be applied to banks' exposures to their sovereign (or central bank) of incorporation denominated in domestic currency and funded in that currency. Where this discretion is exercised, other national supervisory authorities may also permit their banks to apply the same risk weight to domestic currency exposures to this sovereign (or central bank) funded in that currency."

regulation into the European legislation and assigns zero risk weight to all sovereign exposure no matter which is their rating.

Banking regulation is evolving and different rules on risk weights on private assets have been established and will likely enter in the finalized version of Basel IV accord. However no agreement has been reached on a possible change in sovereign risk weighting. Sovereign exposure of the banking sector is still very large in the Euro Area and most importantly exposures are strongly concentrated domestically. According to policy makers and academics the bank-government vicious circle is at the core of the European Debt crisis. The home-bias phenomenon is one of the main obstacles in reaching the completion of the banking union and an agreement on the European Deposit Insurance scheme (Véron, 2017).

However the policy change is contrasted for different reasons. Firstly, increasing risk weights would be very costly for the banking sector in countries with lower credit ratings. Second, limiting banks' holdings of sovereign bonds would constraint their ability to stabilize the sovereign debt market. Since 2012, in case of distress a sovereign has the opportunity to apply to an ESM program and activate ECB Outright Monetary Purchases. However, this option is politically costly and governments are usually reluctant in doing so. Third, governments are aware that such a change would very likely increase interest rates of sovereign bonds in the long-run.

For these reasons alternative policies have been proposed to limit banks' exposure to sovereign bonds. An option is to set a common cap on holdings in relation to each sovereign issuer (De Groen, 2015). A second recent proposal is to apply concentration charges on domestic sovereign holdings above a certain threshold, 33% of TIER1 capital (Véron, 2017). A common argument of these alternative proposals is that excessive domestic bond holdings is a potential source of distress during a crisis. These alternative proposals go in the direction of redistributing holdings across different banking sectors, while the overall exposure to sovereigns in the Euro Area might remain unchanged, as well as risk weights. As a result, if these policies are implemented, the banking sector would still be highly exposed to European sovereign debt that benefits from a favorable treatment in terms of risk weights.

While domestic exposure is certainly an issue, we claim that ignoring this special regulatory treatment for the whole asset class has negative macroeconomic implications. Firstly, risk weighting has implications on the marginal cost of investments by the banking sector. When risk weights on sovereigns is greater than zero, the bank can disinvest on both loans and bonds for deleveraging, while this is not the case in the current regulatory environment. This has two potential effects.

When risk weights on sovereigns are zero, lending rates are larger and sovereign bond rates are lower compared to a case without this special treatment on bonds. This has negative effects on output and investments in the long-run for the economy. Secondly, when a shock hits the economy usually banks' profitability and asset quality is also hit severely, inducing the bank to deleverage to prevent the capital ratio from falling below the 8% threshold. With zero risk weighting, deleveraging is realized only through loans with investments declining more intensively resulting in a long lasting recession in the economy. We argue that removing this special treatment for sovereign bonds would improve the resilience of output and investments to a capital quality shock.

Removing zero risk weights has potential positive effects for private lending while it has negative effects for government financing. Indeed, the policy change would likely increase interest rates on government bonds in the long-run since the marginal cost coming from regulation would increase. This might create concerns on fiscal sustainability, with public debt that increases to cover interest expenses. However, if this policy has positive effects on output, fiscal policy can be more restrictive and counteract the increase in sovereign debt.

Our model accounts for regulation by applying a penalty function approach.[7] With our choice of the penalty function we explicitly take into account the potential benefit that arises when the bank has several assets in his portfolio and can change the asset composition for deleveraging. In particular according to our penalty function loans and sovereign bonds are substitutes as far as there is no special treatment on RWA for public debt. This implies that when banks increase holdings of one asset, it reduces the marginal cost on the other. Our novel economy featuring non-zero risk weight on sovereigns is detailed described in the next section and it macro-implications are discussed in Section 5.

4 Model Description

Our model builds on the work of Gertler and Kiyotaki (2010) and Lambertini and Uysal (2014), and features households, firms, government and banks. Households supply labor and demand consumption goods and deposits. Perfectly competitive firms produce the final good using labor and capital. The latter is produced by capital producers subject to investment adjustment costs. To purchase capital, firms need to take loans from financial intermediaries. In the financial sector, banks use deposits and own net worth to provide loans to firms and buy government debt. In

[7] This approach has been widely employed by the recent literature (see, among others, Gerali et al., 2010; Lambertini and Uysal, 2014; Fève et al., 2019).

addition to domestic banks that make optimal portfolio decisions, we introduce an exogenous external sector that also provides funds to firms in order to match the balance sheet structure of European banks. Finally the government issues debt and imposes taxes on households to finance government spending. The model is calibrated to match macroeconomic and financial data for the Euro area.[8]. Let us stress that our main goal here is to maximize the intuition and insights into the relationship between different risk weights to sovereigns, lending activity, and the macroeconomy, and avoid tangential complications. We therefore strive to keep the model as simple as possible while still matching key RBC features. For this reason, we follow Gertler and Kiyotaki (2010) and Lambertini and Uysal (2014) and deliberately exclude a role for a monetary authority and potential interaction with macroprudential policies. Given that in our framework banks accumulate net worth due to regulatory requirements that are implemented by means of a penalty function as in Lambertini and Uysal (2014), regulation turns out to be only costly. We therefore abstract from welfare considerations.

4.1 Households

Households' utility is characterized by CRRA preferences and habit formation of the form

$$U_t = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left[\frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \nu \frac{L_t^{1+\varphi}}{1+\varphi} \right], \tag{1}$$

where C_t is consumption, L_t is labor, β is the discount factor, σ is the coefficient of relative risk aversion, φ is the inverse Frisch elasticity of labor supply, ν is the weight of labor in the utility function and h is the parameter capturing habit persistence. Infinitely lived households maximize utility subject to the following budget constraint:

$$C_t + D_t = L_t W_t + R_{D,t-1} D_{t-1} + \Pi_t - T_t, \tag{2}$$

where D_t are deposits, $R_{D,t-1}$ is the predetermined return on deposits, W_t is the wage received, and T_t are taxes levied by the government to finance government expenditure. Π_t are distributed profits from banks and capital producing firms and transfers from old bankers to new bankers.

[8]Different from us, Lambertini and Uysal (2014) calibrate the model on the US economy and model the Basel II and III regimes. They also do not assume that the government can issue debt to finance government expenditures. Therefore, concerns about the regulatory treatment of government bonds by bank capital regulation are absent. Finally, we introduce an external sector that provides funds to firms.

The optimal choice of consumption leads to the stochastic discount factor (SDF):

$$M_{t,t+1} = \beta \left[\frac{(C_{t+1} - hC_t)^{-\sigma} - \beta h \mathbb{E}_{t+1}[(C_{t+2} - hC_{t+1})^{-\sigma}]}{(C_t - hC_{t-1})^{-\sigma} - \beta h \mathbb{E}_t[(C_{t+1} - hC_t)^{-\sigma}]} \right]. \tag{3}$$

The household chooses deposits, D_t, optimally such that

$$\frac{1}{R_{D,t}} = \mathbb{E}_t[M_{t,t+1}]. \tag{4}$$

4.2 Capital Producers

Capital producing firms produce new capital using the final output subject to adjustment costs. The net profit is given by

$$NP_{CP,t} = Q_t I_t - \left[1 + f\left(\frac{I_t}{I_{t-1}} \right) \right] I_t, \tag{5}$$

where Q_t is the relative price of capital and adjustment costs are defined as

$$f\left(\frac{I_t}{I_{t-1}} \right) := 0.5\chi \left(\frac{I_t}{I_{t-1}} - 1 \right)^2, \tag{6}$$

with $f^{'} > 0$, $f^{''} > 0$. Hence, capital producers produce new capital at unitary cost $1 + f$, which is then sold to output-producing firms at the price Q_t. Maximizing present and future expected profits, the firm's optimally choose investment I_t such that

$$Q_t = 1 + f\left(\frac{I_t}{I_{t-1}} \right) + f'\left(\frac{I_t}{I_{t-1}} \right) \frac{I_t}{I_{t-1}} - \mathbb{E}_t \left[M_{t,t+1} f'\left(\frac{I_{t+1}}{I_t} \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \right], \tag{7}$$

which is the standard equation that defines Tobin's Q.

4.3 Firms

The final good is produced by perfectly competitive firms according to the following production function:

$$F_t = C_t + G_t + \left[1 + f\left(\frac{I_t}{I_{t-1}} \right) \right] I_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \tag{8}$$

where A_t is the level of total factor productivity (TFP), K_t is the capital stock, and L_t denotes labor supply. At the end of period t, the representative firm purchases capital K_{t+1} from capital producers for production purpose in the following period. To finance the acquisition of capital the firm receives loans $Q_t S_t$ from the banking sector at the lending rate $R_{K,t+1}$. More specifically, the firm issues S_t claims that are equal to the number of units of capital acquired K_{t+1} and prices each claim at the price of a unit of capital Q_t. Before production, the firm also pays the wage rate W_t on labor supplied by workers. After the final good is produced, the firm sells the depreciated capital to capital producing firms at price Q_t. Consequently, the firm's net profit is given by

$$NP_{F,t} = F_t - W_t L_t - R_{K,t} Q_{t-1} S_{t-1} + Q_t S_t - Q_t I_t. \tag{9}$$

The capital stock evolves according to:

$$S_t = (1-\delta) K_t + I_t, \tag{10}$$

$$K_{t+1} = \Psi_{t+1} S_t, \tag{11}$$

$$S_t = S_t^b + S_t^x, \tag{12}$$

where the amount of claims S_t issued are bought by domestic banks (S_t^b) and the external sector (S_t^x). The depreciation rate of capital is defined by δ, and Ψ can be interpreted as a capital quality shock. According to the zero-profit condition, the return on capital is given by:

$$R_{K,t+1} = \Psi_{t+1} \frac{d_{K,t+1} + Q_{t+1}}{Q_t}, \tag{13}$$

where dividends, $d_{K,t}$, are defined as

$$d_{K,t+1} = \alpha \frac{F_{t+1}}{K_{t+1}} - \delta Q_{t+1}. \tag{14}$$

and excess return for capital is given by

$$ExR_{K,t} = R_{K,t} - R_{D,t-1}. \tag{15}$$

TFP evolves according to the exogenous AR(1) process

$$\log A_t = \rho_a \log A_{t-1} + \epsilon_{a,t}, \tag{16}$$

where $0 \leqslant \rho_a < 1$ and $\epsilon_{a,t} \sim N(0, \sigma_a^2)$. The capital quality shock evolves according to the AR(1) process

$$\log \Psi_t = \rho_\Psi \log \Psi_{t-1} + \epsilon_{\Psi,t}, \tag{17}$$

where $0 \leqslant \rho_\Psi < 1$ and $\epsilon_{\Psi,t} \sim N(0, \sigma_\Psi^2)$.

4.4 Government

Government expenditures, G_t, evolve according to the exogenous AR(1) process

$$\log G_t = \rho_G \log G_{t-1} + (1 - \rho_G)\bar{G} + \epsilon_{G,t}, \tag{18}$$

where $\bar{G}$ are government expenditures in the steady state, $0 \leqslant \rho_G < 1$, and $\epsilon_{G,t} \sim N(0, \sigma_G^2)$. The government's budget constraint reads

$$G_t + R_{G,t-1}B_{t-1} = B_t + T_t, \tag{19}$$

where B_t are government bonds and $R_{G,t-1}$ is the return on government bonds. Following Leeper et al. (2010), we express the tax rate on output τ_t as

$$\tau_t Y_t = \kappa_b B_{t-1} + \kappa_y Y_{t-1}. \tag{20}$$

Total government revenues are given by $T_t = \tau_t Y_t$ (see Section 4.8 for our formal definition of GDP, Y_t). Importantly, in our model taxation adjusts in response to a deterioration in the business cycle and for stabilization purposes. This is a relevant ingredient in the model, since the policy change we are analyzing has a positive long-run effect on output that will make fiscal policy more restrictive.

4.5 Banks

Banks provide loans to firms using both external and internal funds. The former are deposits purchased by households while the latter is the banks' net worth. According to the banks' balance sheet constraint, the value of loans, $Q_t S_t^b$, provided to firms each period is equal to the sum of deposits D_t and bank net worth, N_t. Formally,

$$\underbrace{Q_t S_t^b + B_t}_{Assets_t} = N_t + D_t. \tag{21}$$

The bank's net worth at time t is defined as retained earnings which are given by interest received on assets (loans and government bonds) less the interest that has to be paid on liabilities (deposits) and other costs:

$$N_t = R_{K,t}Q_{t-1}S^b_{t-1} + R_{G,t-1}B_{t-1} - R_{D,t-1}D_{t-1} + \mathcal{P}_{t-1}. \tag{22}$$

$\mathcal{P}_{t-1}$ is a penalty that is associated with financial regulation in the form of minimum capital requirements. Suppose $\bar{\mathcal{P}} = 0$, if its regulatory capital ratio falls below a specified threshold, the bank will pay a certain penalty imposed by the regulatory authority ($\mathcal{P}_t < 0$). However, if the bank has more capital than required, it will be rewarded ($\mathcal{P}_t > 0$).[9] However, to avoid a counterintuitive creation of aggregate resources when $RAT > \gamma$, we calibrate $\bar{\mathcal{P}}$ to ensure that the penalty is always negative in our simulation. While this calibration helps interpreting regulation in our model as only costly, it has very limited quantitative effects. The penalty function representing capital requirements reads as follows:

$$\mathcal{P}_t = \bar{\mathcal{P}} + \phi \log\left(\frac{RAT_t}{\gamma}\right), \tag{23}$$

where RAT_t is the risk weighted capital ratio, γ is the target capital ratio, and $\bar{\mathcal{P}}$ is a scaling parameter. The sensitivity of the penalty to deviations from the regulatory target is measured by ϕ. Formally, the risk weighted capital ratio is defined as

$$RAT_t = \frac{N_t}{\underbrace{Q_t S^b_t + \theta B_t}_{RWA_t}}, \tag{24}$$

where θ can be interpreted as the relative risk weight of government bonds with respect to private loans. The penalty function that we propose satisfies some relevant properties that have been previously stated in Kollmann (2013). Defining excess capital as $X_t = N_t - \gamma RWA_t$, we can show that

- $\mathcal{P}(\cdot) < 0 \Leftrightarrow X_t < 0$,
- $\mathcal{P}''(\cdot) < 0$,
- $\mathcal{P}(0) = 0$.

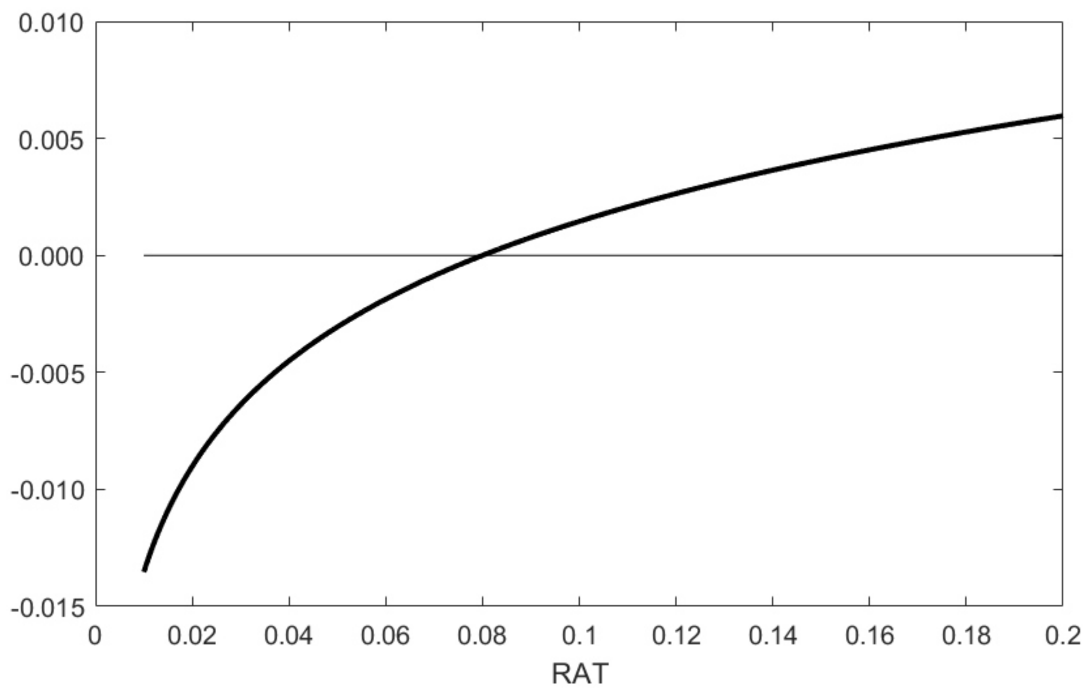
[9] Another example of this penalty approach using a different functional form is provided by Kollmann (2013), Gerali et al. (2010), Fève et al. (2019), and Lozej et al. (2017).

Moreover, an important property of the penalty function that has been adopted is the following

$$\frac{\partial \mathcal{P}_t}{\partial RWA_t} = \frac{\partial \mathcal{P}_t}{\partial Q_t S_b^t} = -\phi RWA_t^{-1}, \qquad \frac{\partial \mathcal{P}_t}{\partial N_t} = \phi N_t^{-1}, \qquad \frac{\partial \mathcal{P}_t}{\partial B_t} = -\phi\theta RWA_t^{-1}, \tag{25}$$

that implies that the marginal cost of increasing risk-weighted asset is decreasing in risk weighted asset and the marginal benefit of increasing capital is decreasing in capital. Finally the derivatives of the penalty function in Equation (25) do not depend on the regulatory capital ratio γ. The black line in Figure 1 represents this penalty function. Importantly, the first derivative with respect to private loans is decreasing in RWA, and it is also decreasing in sovereign bonds holdings and viceversa (as far as $\theta > 0$). This implies that government bonds and loans are substitutes; when the banks increase holdings of one asset it reduces the marginal cost on the other, and the degree of substitution increases with θ.[10]

Figure 1: Capital Requirements Penalty Function



Note: The penalty function is calibrated using the following set of parameters: $\phi = 0.0065$, $\bar{\mathcal{P}} = 0$, $\gamma = 0$.

Combining the bank's net worth and it's balance sheet constraint yields the following law of

[10] Besides ensuring substitutability between loans and bonds, the penalty function allows us to calibrate in the steady state both a positive lending spread on loans and the banks' average regulatory capital ratio from the data which is above the minimum threshold. This is not possible using the adjustment cost approach in Gerali et al. (2010).

motion for net worth

$$N_{t+1} = [R_{K,t+1} - R_{D,t}]Q_t S_t^b + [R_{G,t} - R_{D,t}]B_t + R_{D,t}N_t + P_t. \tag{26}$$

To ensure that banks rely on external financing to provide loans and buy government debt, it is assumed that banks exit with constant probability $1-\epsilon$ in every period. Therefore, the value of a bank satisfies the Bellman equation

$$V_t(Q_t S_t^b, B_t, N_t) = \max_{Q_t S_t^b, B_t} \Big\{(1-\epsilon)N_t + \epsilon \mathbb{E}_t[M_{t,t+1}V_{t+1}(Q_{t+1}S_{t+1}^b, B_{t+1}, N_{t+1})]\Big\}. \tag{27}$$

The optimal choices of $Q_t S_t^b$ and B_t imply, respectively,

$$\mu_{s,t}(Q_t S_t^b + \theta B_t) = \phi \mathbb{E}_t[M_{t+1}\Omega_{t+1}], \tag{28}$$

$$\mu_{b,t}(Q_t S_t^b + \theta B_t) = \phi\theta, \tag{29}$$

and the envelope condition with respect to N_t reads:

$$\Omega_t = 1 - \epsilon + \epsilon\mu_{n,t}, \tag{30}$$

where

$$\Omega_t := V_{N_{t+1}}, \tag{31}$$

$$\mu_{s,t} := \mathbb{E}_t\Big[M_{t,t+1}\Omega_{t+1}(R_{K,t+1} - R_{D,t})\Big], \tag{32}$$

$$\mu_{b,t} := (R_{G,t} - R_{D,t}), \tag{33}$$

$$\mu_{n,t} := \mathbb{E}_t\Big\{M_{t,t+1}\Omega_{t+1}\Big[R_{D,t} + \frac{\phi}{N_t}\Big]\Big\}. \tag{34}$$

Rearranging optimality conditions yields

$$\mathbb{E}_t\Big[M_{t,t+1}\Omega_{t+1}(R_{K,t+1} - R_{D,t})\Big] = -\frac{\partial \mathcal{P}_t}{\partial Q_t S_t^b}\mathbb{E}_t[M_{t+1}\Omega_{t+1}], \tag{35}$$

$$R_{G,t} - R_{D,t} = -\frac{\partial \mathcal{P}_t}{\partial B_t}. \tag{36}$$

Equations (35) and (35) determine the spread between interest rates on loans and government bonds versus the deposit rate. In absence of regulation, the interest rate on sovereign debt should be equal to the deposit rate (i.e., the inverse of the discount factor), while the expected discounted spread on loans should be equal to 0.

The transfers that new banks receive by households are equal to a fraction ω of the returns to loans of existing bankers

$$\omega R_{K,t} Q_{t-1} S^b_{t-1}. \tag{37}$$

Hence, the evolution of aggregate net worth can be written as

$$\begin{aligned} N_t = \epsilon \Big\{ [R_{K,t} - R_{D,t-1}] Q_{t-1} S^b_{t-1} + [R_{G,t-1} - R_{D,t-1}] B_{t-1} + R_{D,t-1} N_{t-1} + P_{t-1} \Big\} + \\ (1-\epsilon)\omega R_{K,t} Q_{t-1} S^b_{t-1}. \end{aligned} \tag{38}$$

For calibration purpose, we define return on assets, ROA_t, as the ratio of net interest income to total assets:

$$ROA_t = \frac{R_{K,t} Q_{t-1} S^b_{t-1} + R_{G,t-1} B_{t-1} + D_t - Q_t S^b_t - B_t - R_{D,t-1} D_{t-1}}{Q_t S^b_t + B_t}. \tag{39}$$

4.6 External Sector

In addition to domestic banks, we assume the existence of an external sector that exogenously provides funds to good-producing firms. The amount of claims, S^x_t, bought by the external sector at price Q_t is constant over time. Since we introduce this sector as external to the model, we do not specify a budget constraint.

4.7 Labor Market

The firm's optimal labor allocation leads to

$$W_t = (1-\alpha) \frac{F_t}{L_t}, \tag{40}$$

and the worker's optimal labor allocation leads

$$W_t = \frac{\nu L^\varphi_t}{(C_t - hC_{t-1})^{-\sigma} - \beta h \mathbb{E}_t[(C_{t+1} - hC_t)^{-\sigma}]}. \tag{41}$$

We assume that there are no frictions on the labor market.

4.8 Market Clearing Conditions:

Goods market clearing implies that

$$F_t = C_t + G_t + \left[1 + f\left(\frac{I_t}{I_{t-1}}\right)\right] I_t - \mathcal{P}_{t-1}. \tag{42}$$

As far as $\mathcal{P}_t < 0$ regulation has detrimental effects on aggregate output. We define GDP, Y_t, as

$$Y_t = C_t + G_t + I_t. \tag{43}$$

5 Quantitative Analysis

In this section, we present our benchmark calibration and the model results. First we discuss the dynamics of our model by showing impulse responses of key variables to a capital quality shock. Then, we discuss the macroeconomic implications of removing the zero risk weight on sovereigns in banks' regulatory capital ratio by comparing steady states and second moments, respectively, for the different regimes. We also employ a variance decomposition and impulse response analysis in order to show whether the new policy increases the resilience of the economy to specific structural shocks compared to the benchmark.

5.1 *Calibration*

Our benchmark model requires the specification of 23 parameters. For the sake of clarity, the parameter set is divided into three different categories. Table 3 summarizes our parameter choices. The first category includes nine parameters that cannot be easily identified and for this reason are calibrated in line with existing studies (Panel A). In the second category (Panel B), parameters are calibrated to match the steady state values and second moments of a restricted set of variables.[11] The remaining two parameters are set in accordance to the current banking regulation (Panel C).

As pointed out above, the first set of parameters in Panel A is standard in the literature. Importantly and consistently with our main analysis, parameter values employed in these studies are estimated for the Euro Area. An exception is Lambertini and Uysal (2014) who rely on US data.

The discount factor of households, β, is set to match an annual real interest rate on deposits

[11] Details on data are provided in Appendix A.

Table 3: Benchmark calibration

Parameter	Value	Description	Note
Panel A		*calibration from literature*	
σ	2.000	relative risk aversion	
ν	4.000	disutility from work	
h	0.700	habit parameter	CMS, FMS
φ	2.000	inv. Elasticity labour supply	CMS, FMS, FP
χ	0.800	firm adj. Cost	
α	0.300	share capital in production	
δ	0.025	capital depreciation	CMS, FMS
ρ_A	0.857	ρ productivity shock	LU
ρ_Ψ	0.880	ρ capital quality shock	LU
Panel B		*calibration from data*	
β	0.995	discount factor of households	Target S.S.[a] $RD = 2\%$
ϕ	0.007	penalty parameters	Target S.S. $R_K - R_D = 0.65\%$
$\bar{S}_x$	18.874	size of external financial sec	Target S.S. $B/(B + S_b) = 35\%$
$\bar{G}$	0.482	gov. expenditure steady state	Target $G/Y = 20\%$
κ_y	0.050	tax response to output	Estimated policy rule
κ_b	0.039	tax response to debt	Target $B/Y = 90\%$
ϵ	0.500	survival rate transfers	Target S.S. $std(ROA) = 0.26\%$
ω	0.114	transfers new bankers	Target $RAT = 11.7\%$
ρ_G	0.844	ρ government spending	AR(1) estimation
σ_G	0.003	σ government spending shock	Target S.S. $std(G) = 0.005$
σ_A	0.005	σ productivity shock	Target S.S. $std(Y) = 0.012$
σ_Ψ	0.002	σ capital quality shock	Target S.S. $std(I) = 0.038$
$\bar{\mathcal{P}}$	-0.004	scaling parameter penalty function	Negative penalty in simulation
Panel C		*calibration from regulation*	
γ	0.080	capital ratio constraint	Basel 3 regulation
θ	0.000	relative risk weight sovereign	Basel 3 regulation

Note: LU: Lambertini and Uysal (2014), FMS: Forni et al. (2009), CMS: Cahn et al. (2017), FP: Fève et al. (2019)

[a]Steady State

of 2%. In the literature alternative choices of β have been proposed, where the real interest rate ranges from 0.5% to 3%. Our calibration is inside this range but larger than the average real deposit rate in the Euro Area (1%) . The shape of the penalty function and the effect of regulation on the economy strongly depends on parameter ϕ. According to Equation (35), the larger the parameter ϕ, the larger is the compensation required by the banking sector for lending to the real economy. As a result, the parameter is calibrated to match the spread between the lending rate and the government bond rate, proxied by AAA Corporate-government bond rate.[12] The effect of sovereign risk weight on lending strongly depends on the size of government debt in the balance

[12]The spread is defined as the difference between the AAA corporate bond rate and the German government bond rate with same maturity. Since German bonds also have an AAA rating, the difference between these two rates does not reflect differences in maturity or credit worthiness and is likely to be affected by regulation. While the same spread in the US is above 100 bps in the full sample, for the Euro Area it is around 60 bps, also due to unconventional monetary policy measures of the ECB in the short sample considered.

sheet of the bank. To measure the share of sovereign bonds in the balance sheet of the banks $\overline{B/Assets}$ we proceeded as follows

$$\overline{\left(\frac{B}{Assets}\right)} = \frac{1}{T}\sum_{t=1}^{T}\frac{\sum_{j\in\mathcal{I}} SOV_{j,t}}{\sum_{j\in\mathcal{I}} SOV_{j,t} + Loans_{j,t}} \quad \mathcal{I} = \{DEU, FRA, ESP, ITA, GRE\}$$

where $SOV_{j,t}$ are domestic sovereign bonds held by the banking sector in country j at time t (source Breughel)[13], and $Loans_{j,t}$ are loans to the private non-financial sector provided by the banking sector in country j at time t (source BIS). Since in our model the stock of capital is lent from the financial sector and rolled over every period, the total amounts of loans is much larger than sovereign debt in the model. To target the share of sovereign bond holdings over assets in the data (i.e., 35%), we introduce an exogenous financial sector whose size S_x is calibrated to match this ratio. Note that what is key in this paper are aggregate sovereign holdings held by the banking sector, no matter if it is domestic or foreign debt. However Breughel data offers disclosure of the distribution of holdings only across residents. As a result we do not know, for example, the size of holdings by German banks of Italian public debt. This implies that 35% sovereign bond share in banking sector total assets is a conservative estimate.

Government expenditures are calibrated to obtain a share of 20% of output in steady state. To calibrate the tax response to output gap we estimate the policy rule in Equation (20).[14] The point estimate of the fiscal multiplier is 0.14, but the parameter is roughly estimated with a standard error of 0.09. Moreover the model is not stationary if we calibrate κ_y as in our point estimate, we set it to 0.05. Instead, κ_b has been set to match 90% debt to GDP in the Euro Area. As in Fève et al. (2019), we calibrate ω to target the average Common Equity TIER1 ratio across European banks ($RAT = 11.7\%$).[15] When the survival rate, ϵ, is zero, bankers will become consumers at the end of the period and they will maximize retained earnings. When ϵ increases, banks care more about the future value of being bankers and less about retained earnings, which become more volatile. As a result to calibrate this parameter we roughly match the standard deviation of Return of Assets for the Euro Area banking sector. Equation (18) is then estimated to calibrate the persistence and the standard deviation of government expenditure shocks in the model. Finally, the standard deviation of capital quality and technology shock is calibrated to (roughly) match the standard deviation of

[13] We decided to calculate the statistic on a restricted group of countries for which sovereign holding data is available.

[14] We detrended each series using "one-sided" HP filter as in Stock and Watson (1999)

[15] We calculate the average CET1 ratio in 2008 for the banking system of France, Germany, Italy and Spain using data from the IMF.

investment and output. To ensure that capital regulation is only costly in our model, we calibrate $\bar{\mathcal{P}}$ such that the penalty is always negative in the simulation exercise.

According to Basel 2, common equity tier 1 ratio (CET1) should lie above 8%. Therefore, we set $\gamma = 0.08$. In Europe CRD assigns zero risk weight to sovereign exposures, that implies $\theta = 0$.

The model is solved numerically by a second-order approximation using perturbation methods as provided by the `dynare` package.[16]

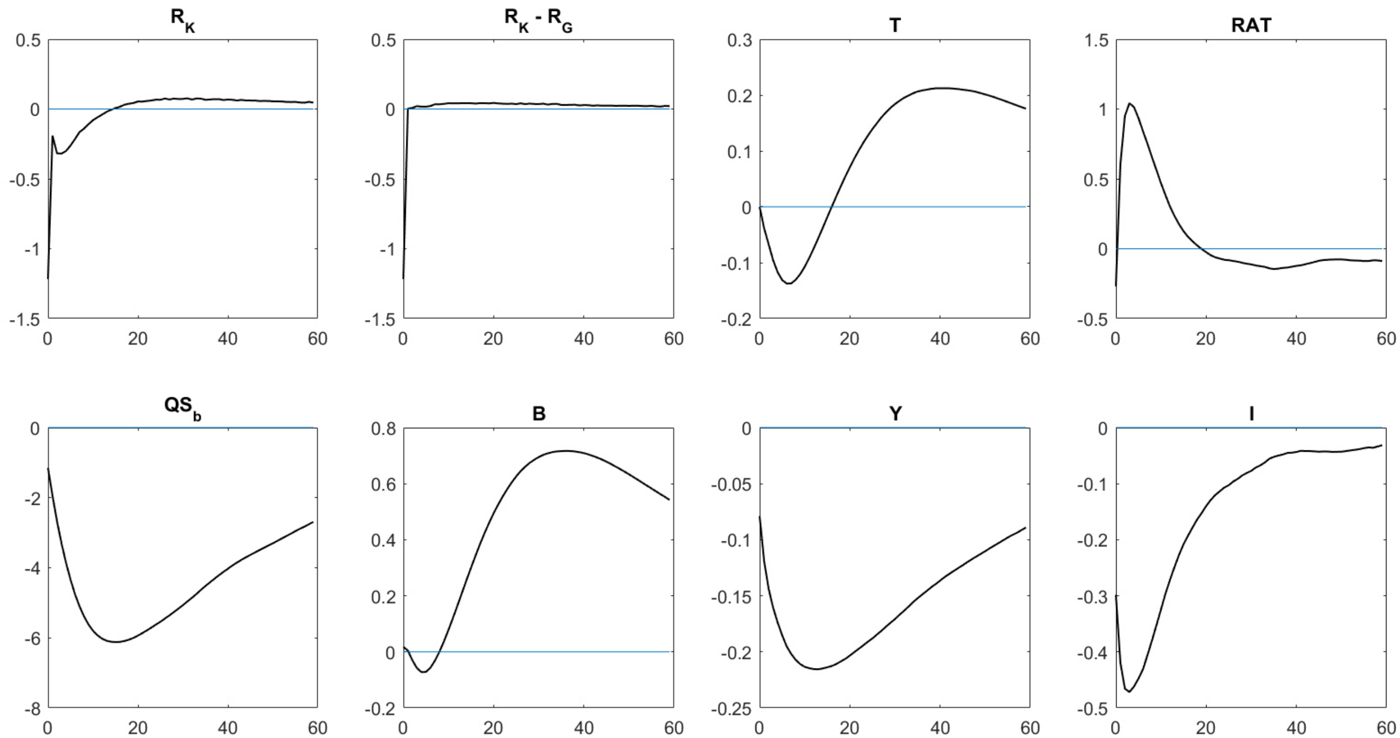
5.2 *The response to a capital quality shock*

To understand the mechanism of our model, we discuss the responses of endogenous variables to a capital quality shock. Specifically, in Figure 2 we plot impulse responses of various model variables to a negative capital quality shock. When the shock hits the economy the rate of return on loans is reduced on impact because of the decline in capital productivity. Since the interest rate on deposits falls by a smaller amount, banks' profitability deteriorates. A decline in profitability corresponds to a decline in the capital ratios. Since the return of capital, R_K, is low and because banks are undercapitalized, the banking sector de-risks by reducing loans to firms. As a result, after the immediate sharp deterioration the capital ratio rebounds quickly. Due to the process of deleveraging and de-risking the bank substitutes capital absorbing assets (loans) with bonds. Because of an increase in the demand by banks and a decline in interest rates on sovereigns, the government issues more debt to finance government expenditures. Since fiscal policy is aimed at stabilizing public debt, taxes increase.

After 5 years from the shock, debt to GDP has increased by 0.6% while loans intermediated by banks have declined by 5%. Due to lower productivity of capital and lower supply of loans, investments are negatively affected declining by -0.4% at the through. Households are negatively affected by the decline in the return of deposits and lower labor income. As a combination of a decline in investment and consumption, final output hits a low at almost -0.2% .

[16]Second order approximation allows to better capture the nonlinear effects from varying risk weights given the shape of the penalty function. To highlight the importance of nonlinearities, we present in Section 6 the results from a model solved using first-order approximation around the steady state.

Figure 2: Impulse Responses to a Capital quality shock



Note: Lending rate and spread are annualized. All responses are deviations from the steady state in percentage points.

5.3 Steady state effects of increasing risk weights on sovereigns

In what follows we examine the long-run effects of removing favorable risk weighting for sovereigns. In particular we consider two alternative calibrations of the model $\theta \in \{0.4, 1\}$, with the remaining parameters left unchanged to the benchmark calibration. The case with $\theta = 1$ corresponds to the situation in which sovereigns are treated as loans by regulators. In reality differences in risk weights should also reflects differences in credit worthiness, but in our model there is full commitment to repay the debt even if credit quality depends on the realization of a structural shock.

Increasing risk weights on sovereigns has an important effect on the shape of the penalty function and consequently on interest rates at the steady state. This effect is represented in Figure 3. On the left hand side the derivative of the penalty function with respect to loans, $-P_L = -\frac{\partial \mathcal{P}}{\partial Q_t S_t^b}$, is presented for different values of θ, while on the right hand side we have the corresponding picture for the derivative with respect to sovereign bonds $-P_B = -\frac{\partial \mathcal{P}}{\partial B_t}$.[17] When $\theta = 0$, $-P_L$ is positive and decreasing in loans while $-P_B$ is always zero. When θ increases, $-P_L$ declines and $-P_B$ increases. As stated in Section 4.5, this happens essentially because loans and debt are substitutes from a regulatory point of view. When government bonds holdings are included in RWA, loans attract lower regulatory cost. Since larger (lower) regulation cost commands larger (lower) interest rates, an increase in θ reduces the interest rate on loans and increases the interest rate on government bonds. As a result, removing zero risk weight stimulates investment and increase output in the steady state due to lower interest rates on lending.

Table 4: Steady states for selected variables of the model for different values of θ

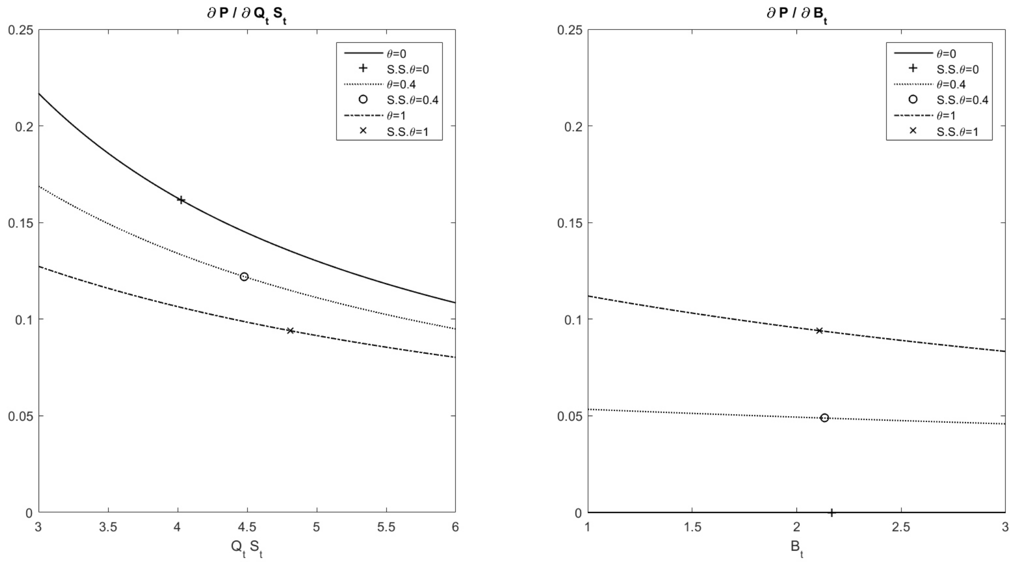
	$\theta = 0$	$\theta = 0.4$	$\theta = 1$	Delta (%) $\theta = 0.4 - 0$	Delta (%) $\theta = 1 - 0$
Y	2.41	2.42	2.43	0.55	0.96
C	1.35	1.36	1.36	0.20	0.33
K	22.90	23.33	23.64	1.85	3.24
I	0.57	0.58	0.59	1.85	3.24
Assets	6.19	6.57	6.88	6.14	11.00
R_D	1.98	1.98	1.98	0.00	0.00
R_G	1.98	2.06	2.36	0.08	0.38
$R_K - R_D$	0.64	0.49	0.37	-0.15	-0.27
B/A	35.00	32.31	30.63	-2.69	-4.37
S/A	65.00	67.69	69.37	2.69	4.37
RAT	11.70	9.78	8.06	-1.92	-3.64
B	2.17	2.12	2.11	-2.03	-2.85

Note: Interest rates are annualized

In Table 4, we present steady state values for different variables of the model for different θ. The first three columns present the steady states for $\theta \in \{0, 0.4, 1\}$, while the last two columns present

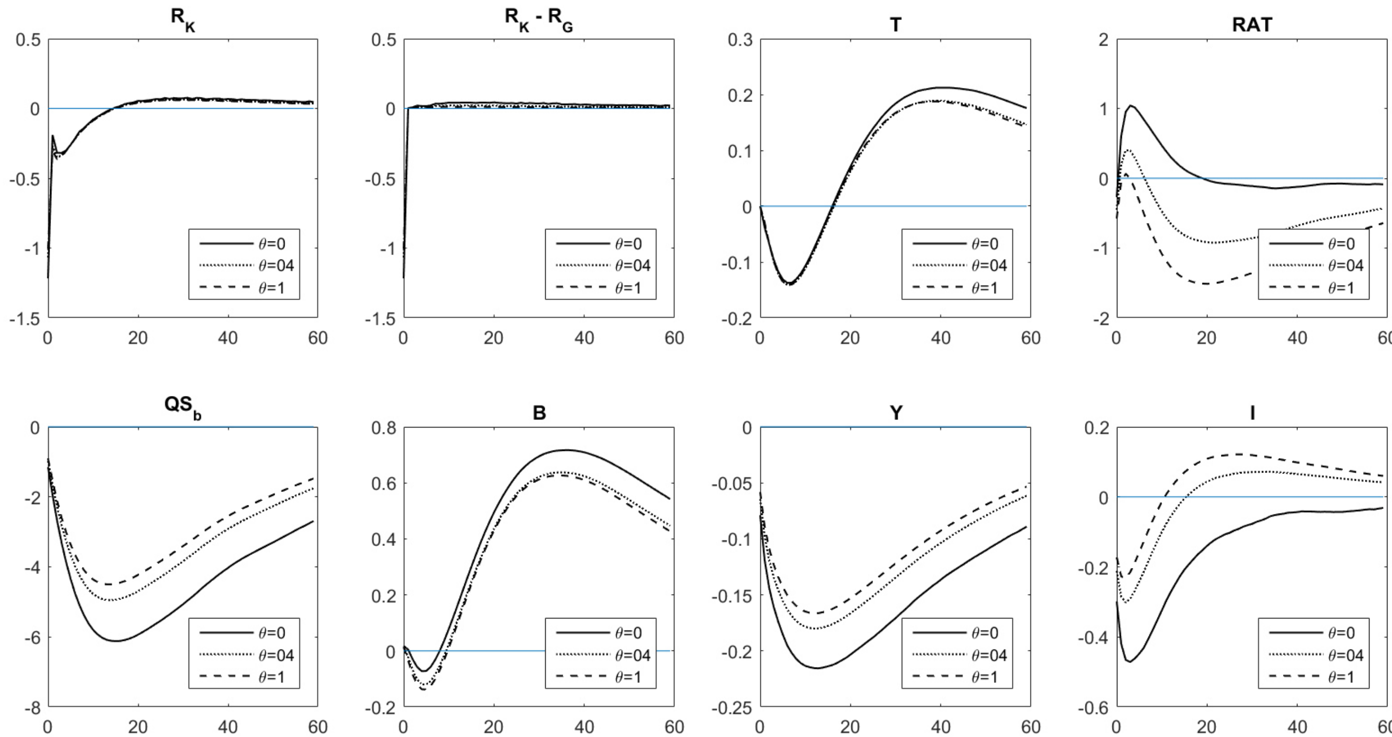
[17] We multiply the derivatives by minus one to interpret them as marginal costs.

Figure 3: First derivatives of the penalty function



the difference in steady state between $\theta \in \{0.4, 1\}$ and $\theta = 0$. When θ increases from 0 to 1, the interest rate on loans declines by 26 basis points while interest rates on government bonds increase by 38 basis points. As a result, increasing θ to unity stimulates investments in the steady state by 3% and output by almost 1%. The effect on the public debt to GDP ratio depends on the responses of interest rates and output. On the one hand, larger government bond yields imply a larger level of debt. On the other hand, since output is larger in the steady state, the government relies more intensively on taxation due to the cyclical fiscal policy rule, specified in Equation (20). The latter effect dominates, lowering sovereign debt by almost 3% if $\theta = 1$. This is an important result: a potential risk to removing zero risk weight on sovereigns might be that public debt increases with larger interest rates, creating concerns on fiscal sustainability. According to our calibration and penalty function specification that implies substitutability across assets, the potential negative effects on debt are more than mitigated if the government commits to the fiscal policy rule that is calibrated in the model. As a result of the change in risk weights, banks recompose their balance sheet by favoring loans to firms (from 65% to almost 70%). Since sovereign bonds are now included in RWA, the regulatory capital ratio RAT mechanically declines by 3.6%.

Figure 4: Impulse Responses to a Capital quality shock for $\theta \in \{0, 0.4, 1\}$ (% deviation)



5.4 Second order effects of increasing risk weights on sovereigns

In this section we examine the effects of increasing risk weights on macroeconomic dynamics. We therefore compare impulse responses to a capital quality shock for different values of θ. The idea hereis that zero risk weights on sovereigns not only affect the steady state of the model, but also increases the persistence of a negative shock to the economy. Impulse responses for different values of θ are depicted in Figure 4.[18] Upon the realization of a negative capital quality shock banks de-risk to prevent the capital ratio from falling below the threshold. When sovereign bonds are included in risk weighted assets the bank can de-risk by reducing the demand from bonds. As a result credit supply declines by a lower amount compared to the case with $\theta = 0$, providing benefits for investment and output.

Table 5: Second moments of selected variables from the model for different values of θ

Variable	**Data**	**Benchmark** [1]	$\theta = 0.4$ [2]	$\theta = 1$ [3]
Y	1.18	1.21	1.13	1.10
C	0.78	1.01	1.07	1.10
K		3.39	3.19	3.11
I	3.82	3.81	3.51	3.42
Assets	15.52	12.09	10.63	9.99
R_D	0.78	1.19	1.17	1.17
R_G	1.33	1.19	1.17	1.17
$R_K - R_D$	0.41	1.73	1.67	1.64
Return on Assets (ROA)	0.26	0.26	0.27	0.19

Table 6: Correlations between output and selected variables from the model for different values of θ

Variable	**Data**	**Benchmark** [1]	$\theta = 0.4$ [2]	$\theta = 1$ [3]
Y	1.00	1.00	1.00	1.00
C	0.67	0.67	0.64	0.63
K		0.57	0.53	0.50
I	0.89	0.88	0.84	0.81
Assets	-0.11	0.56	0.52	0.49
R_D	-0.47	-0.30	-0.33	-0.34
R_G	0.07	-0.30	-0.33	-0.35
$R_K - R_D$	-0.08	0.20	0.23	0.25
Return on Assets (ROA)	0.26	0.18	0.13	0.13

Increasing risk weights on sovereigns might also affect the volatility of the variables of the model.

[18] All the other parameter are calibrated to the values reported in Table 3.

Table 7: Autocorrelations for selected variables from the model for different values of θ

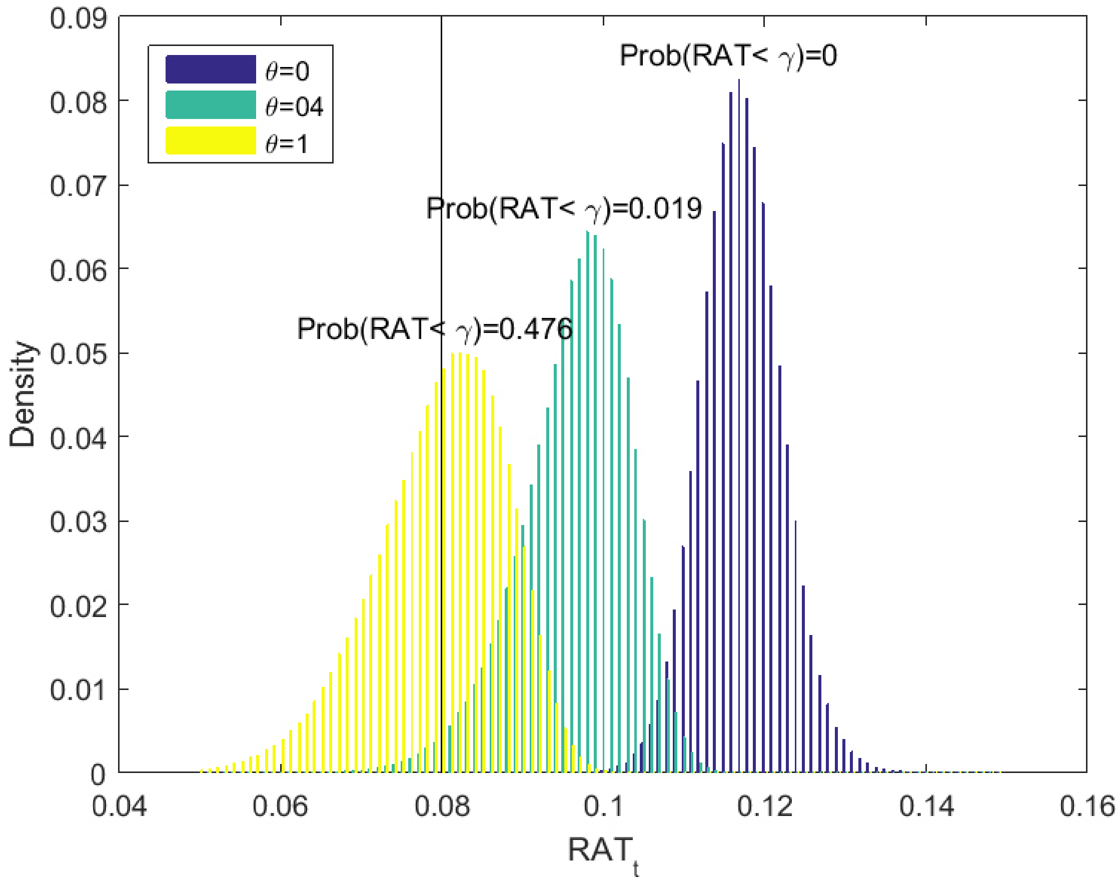
Variable	**Data**	**Benchmark** [1]	$\theta = 0.4$ [2]	$\theta = 1$ [3]
Y	0.85	0.92	1.00	1.00
C	0.81	0.96	0.96	0.97
K		0.97	0.97	0.97
I	0.84	0.90	0.89	0.89
Assets	0.97	0.96	0.96	0.96
R_D	0.81	0.40	0.40	0.40
R_G	0.89	0.40	0.40	0.40
$R_K - R_D$	0.84	-0.01	-0.01	-0.01
Return on Assets (ROA)	0.67	0.84	0.79	0.75

To investigate this we compute 5000 short sample simulations of 20 years of data and we compute the implied empirical moments. In Table 5 we report for selected variables, the empirical standard deviation in the data and the simulated moments from the model with different calibrations of θ. The first important result is that increasing θ would result in a mitigation of business cycle. The standard deviation of output would decline by 9% from the standard deviation simulated for the model with $\theta = 0$. This is mostly explained by a reduction of the variability of investments that declines by almost 10%, while standard deviation of consumption increases. Interestingly introducing risk weights for government bonds would not result in larger volatility of sovereign bond yields while it would stabilize the lending spread. Banks' assets, defined as $Assets_t = Q_t S_{b,t} + B_t$, would also be less volatile, essentially because of lower variability in loans. Because lending rates are more stable, bank's profitability proxied by Return on Assets (ROA) would also be more stable.

In Table 6 we report the effects from varying sovereign risk weights on the correlation of selected variables with GDP. The policy reduces somewhat the procyclicality of macroeconomic quantities like consumpion and investments and certain financial variables such as banks' assets and profitability. In contrast, interest rates and spreads would be slightly more correlated (in absolute terms) with output. In Table 7 we present the effects on first-order autocorrelations for the same variables. Except for Return on Assets, increasing θ has negligible effects on autocorrelations.

When sovereign risk weight increases, the capital ratio mechanically declines, increasing the probability for banks to miss capital requirements. To better assess the likelihood of this event, we report in Figure 5 the histogram of simulated capital ratios for our benchmark model compared with the simulations from the models with positive values of θ. According to our calibrated benchmark model, banks have zero probability of missing capital requirements. However, as θ increases to 0.4,

Figure 5: Histogram of Simulated Capital Ratios for different levels of θ



Note: Histogramms are generated from simulated capital ratios from the model calibrated with different values of sovereign risk weight. We also report the empirical probability that the capital ratio falls below γ

the probability increases to almost 2%, while for $\theta = 1$ it reaches 48%. As reported in Table 8, despite the capital ratio being above 8% in most of the cases, the penalty is almost always negative. This is due to our calibration of $\bar{\mathcal{P}}$, guaranteeing that capital regulation does not generate additional resources. When the capital constraint is more binding, the penalty deteriorates banks' retained earnings. In Table 8, we show that banks' penalty as a share of banks' wealth rises from 0.32% to 0.71% as θ increases.

Given the previous results, we found evidence that removing zero risk weighting on sovereigns would likely reduce the volatility of the business cycle and of other financial variables. However, it would be interesting to understand if the policy change has significant effects on the resilience of these variables to specific structural shocks that have been introduced. For this purpose we perform a variance decomposition for a selection of variables when $\theta = 0$ and $\theta = 1$. In figure 6 we

Table 8: SELECTED STATISTICS FOR DIFFERENT LEVELS OF θ (%)

Variable	**Benchmark**	$\theta = 0.4$	$\theta = 1$
	[1]	**[2]**	**[3]**
$Prob(RAT_t > \gamma)$	0.00	1.85	47.65
$Prob(\mathcal{P}_t < 0)$	99.54	100.00	100.00
$\mathcal{P}_t/N_t$	-0.32	-0.52	-0.71

present for each variable a barplot that shows the relative contribution of each structural shock to the variable's overall volatility. A first striking result is that total factor productivity and capital quality shock are the only shocks that are quantitatively relevant. In Table 5 we have shown that the volatility of output and investment decline when we increase θ. According to the variance decomposition this happens because the two variables are more resilient to capital quality shocks. More generally, the relative contribution of capital quality shocks to the system declines when we increase sovereign risk weights, with the only exception of the capital ratio. It's because, when a capital quality shock hits the economy, banks are required to reduce loans by a lower amount when $\theta = 1$, which has positive effects on investment and overall economic activity.

6 Robustness

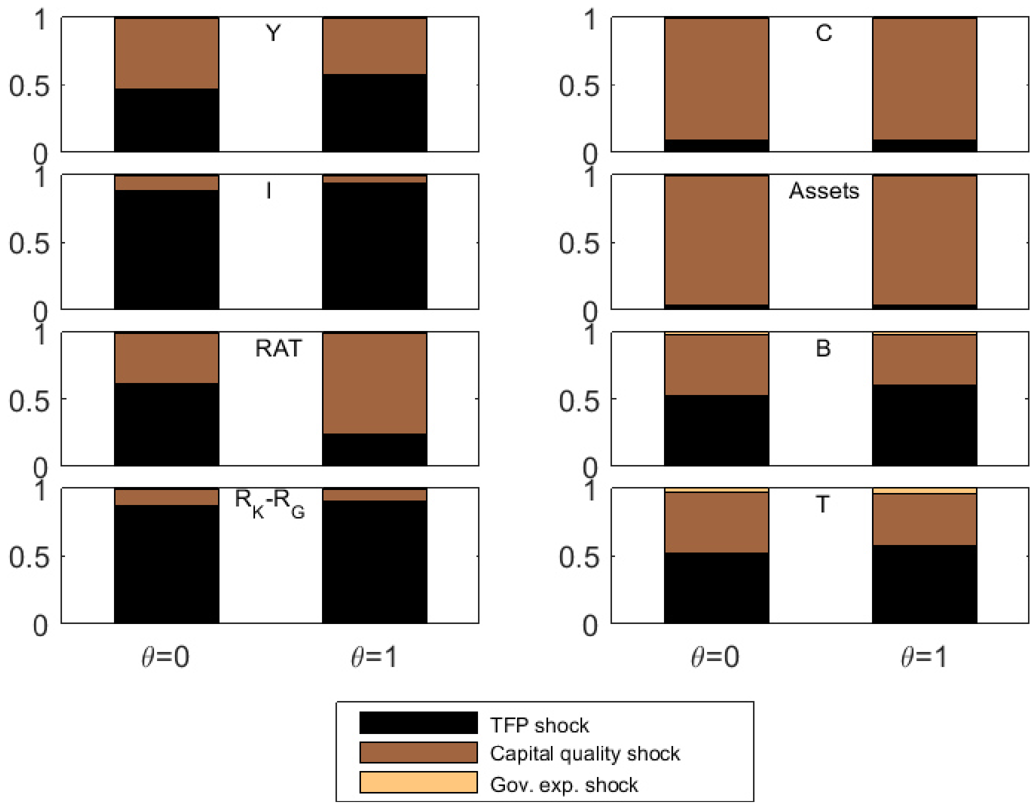
In this section we perform a battery of robustness checks with respect to the choice of several key parameter values, especially the ones in the penalty function. This is important since most of the parameters of the model are calibrated on a small sample (i.e., starting in 2000), consisting of macroeconomic and financial variables. In line with our previous analysis (see Table 5), we concentrate on the effect of different parameter choices on the second moments of main macro aggregates.

Table 9: RATIO BETWEEN THE STANDARD DEVIATIONS OF A TARGET VARIABLE IN THE ECONOMY WITH $\theta = 1$ AND THE ECONOMY WITH $\theta = 0$

	Benchmark	$\varphi = 1.5$	$\varphi = 2.5$	$R_D = 3\%$	$R_D = 1.5\%$	$\phi = 0.08$	First order approx.	Modified Penalty
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Y	0.911	0.903	0.919	0.935	0.894	0.887	0.924	0.865
C	1.089	1.076	1.100	1.062	1.112	1.114	1.081	1.123
K	0.918	0.914	0.921	0.934	0.906	0.896	0.929	0.876
I	0.896	0.900	0.895	0.935	0.865	0.859	0.918	0.841
Assets	0.826	0.825	0.829	0.865	0.799	0.788	0.867	0.750
R_D	0.983	0.984	0.983	0.988	0.980	0.979	0.989	0.967
R_G	0.982	0.983	0.982	0.987	0.979	0.978	0.988	0.963
$R_K - R_G$	0.946	0.944	0.952	0.961	0.939	0.935	0.959	0.919
Return on Assets (ROA)	0.737	0.701	0.719	0.546	1.056	0.845	1.697	0.904

In Table 9, we report the ratio of the standard deviation of a selected variable for the case with

Figure 6: Variance decomposition for $\theta \in \{0, 1\}$



$\theta = 1$ to the one with $\theta = 0$. The benchmark calibration is denoted by specification [1]. For the other specifications we report this ratio for alternative calibrations in which we change only one parameter compared to the benchmark, i.e., the respective parameters shown in the table. For specification [2] and [3], we change the inverse elasticity of labor supply. This parameter affects the intertemporal choice of labor supply and more generally the consumption and savings decisions. The results turn out to be robust to alternative calibrations of this parameter, as the ratios of standard deviations do not change significantly compared to the benchmark (specification [1]). The choice of the discount factor, β, which is chosen to match a real deposit rate, R_D, of 2% in the benchmark case affects our results to a larger extent. When the discount factor increases such that the real deposit rate equals 1.5%, the variability of output and investments would be reduced by 10% and 13%, respectively, under equally risk-weighted sovereign bonds. Therefore, as the average real deposit rate in the Euro Area fell below 1% after 2003, the potentially positive effects of a change in those risk weights are likely to be underestimated in our benchmark economy that targets a real deposit rate of 2%. Finally we consider changes in parameter ϕ that strongly affects the shape of the penalty function. We set the alternative value for ϕ such that the lending spread in the steady state equals 0.75% which is larger than the 0.65% in the benchmark economy.[19] Similar to increases in the discount factor, a higher sensitivity of the penalty to changes in the bank capital ratio leads to larger stabilization effects by removing the zero risk weight on government bonds. In column [7] we investigate differences in model results when using first instead of second order approximation around the steady state for solving the model. In this case increasing risk weights on sovereigns is slightly less effective as in the benchmark case. This suggests that nonlinearities in the model play a role but are not essential in shaping our results.

Finally, we report the ratio of standard deviations in a model with a different functional form of the penalty function compared to the benchmark, denoted by specification [8]. More specifically, we adopt a slightly modified penalty function which reads

$$\mathcal{P}_t = \bar{\mathcal{P}} + \phi \left(1 + \frac{N_t - \gamma RWA_t}{RWA_t} \right).$$

Similar to Fève et al. (2019), the penalty is defined in terms of excess capital with respect to capital

[19] In the same sample the average lending spread calculated as the difference between interest rate on loans to non-financial corporations and the deposit rate from ECB data is 1.32%. However these two rates might have different durations and credit ratings.

requirements, but as a fraction of risk weighted assets. The penalty can rewritten as

$$\mathcal{P}_t = \bar{\mathcal{P}} + \phi \left(1 + RAT_t - \gamma\right).$$

As in our benchmark case, the shape of the penalty function strongly depends on the parameter ϕ. Moreover, the derivatives of this penalty function are given by

$$\frac{\partial \mathcal{P}_t}{\partial Q_t S_t^b} = -\phi \frac{RAT_t}{(1 + RAT_t - \gamma) RWA_t}, \qquad \frac{\partial \mathcal{P}_t}{\partial B_t} = -\phi\theta \frac{RAT_t}{(1 + RAT_t - \gamma) RWA_t}. \tag{44}$$

As in the benchmark specification of the penalty function, the first derivatives with respect to loans and sovereign bonds are decreasing in the risk-weighted assets. This implies that there is still substitutability between government bonds and loans. Moreover, the capital ratio constraint γ negatively affects the derivative of the penalty function and, consequently, positively the spread. The parameter ϕ is calibrated to match the observed lending spread, while the remaining parameters have been left at the values from the benchmark calibration. Using this alternative penalty function, the effects from introducing positive sovereign risk weights on second moments is larger than for our benchmark calibration. In particular output and investment volatility declines by 13% and 16% respectively, while among financial variables, the volatility of assets and ROA would be lowered by 25% and 10%.

These exercises show that the estimated effects of removing differences in risk weights across assets are robust with respect to the choice of several key parameters and alternative penalty function specifications.

7 Concluding Remarks

This paper represents a first attempt to analyze the macroeconomic effects of increasing risk weights on government bonds in the regulatory capital ratio of banks. For this purpose, we make use of a standard RBC model incorporating a banking sector, where bank capital regulation is specified as a penalty (reward) for negative (positive) deviations from the target capital ratio. This framework is extended by a government sector issuing bonds that are held by domestic banks. Increasing the risk weight on government bonds in the capital adequacy ratio is found to have positive long-run (steady state) effects. The relatively lower weight on loans, used by firms for capital acquisition, leads to a decline in the lending spread, therefore stimulating investment and output. Moreover, the volatility of the business cycle decreases through lower investment volatility, as lending rates are stabilized. Our results are robust with respect to different calibrations of the parameters in the penalty function of banks. Of course, our analysis does not capture all possible benefits and costs of increasing risk weights on government bonds, making it difficult to judge at this stage whether this policy should finally be implemented or not. For instance, we do not account for transitional costs of switching between the regulatory regimes and we ignore the possibility of government default, which may be important in the case where increasing risk weights on government bonds drive up the interest rate on these assets. Given the connection of our results to the capital taxation literature, as differential risk weighting has detrimental effects on private lending and hence on the capital stock and output, it would be also straightforward to perform our analysis within a richer fiscal set-up. In general our results should be treated with caution as we consider a risk-less economy. It will be crucial to perform this analysis within a setup containing both firm and sovereign default risk. Those aspects are left for future research.

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A Data source

Table A.1: Data Description

Variable	Series	Source	Starting Year
R_D	Deposit rate to Households in the Euro Area (quarterly averages)	ECB	2003
$R_K - R_D$	AAA rated Corporate Bond - German government bond spread	Thomson Reuters	2000
$Loans$	Private lending from banks to non financial sector for Germany,France, Spain, Italy, Greece	BIS	1995
SOV	Domestic Sovereign bond holdings of banks for Germany,France, Spain, Italy, Greece	Breughel	1999
Y	GDP Euro Area	Eurostat	1995
I/Y	Investments over GDP Euro Area	Eurostat	1995
G/Y	Government expenditures over GDP Euro Area	Eurostat	1995
T/Y	Taxes over GDP	Eurostat	2002
B/Y	Public debt over GDP Euro Area	Eurostat	2000
ROA	Return on Assets Banks Euro Area (annual averages)	Fed, World Bank	1996