

Fiscal Austerity and Reputation*

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Abstract

This paper investigates whether government reputation in financial markets explains the implementation of fiscal austerity during a recession, as opposed to a countercyclical response. In a model with endogenous default risk we show that, if 1) the value of the government's discount rate is private information, 2) a recession takes place, 3) the initial public debt is high enough, a benevolent government has an incentive to deviate from the optimal countercyclical policy followed under full information. In this case, the government implements fiscal austerity, reducing spending and increasing taxation. The rationale for austerity is different depending on the depth of the recession. In mild recessions, the government restrains its fiscal policy to send a credible signal to financial markets. It maintains its reputation and lowers its borrowing costs. In deep recessions, signalling through austerity becomes impossible. Although a separating equilibrium no longer exists, the government must nevertheless tighten fiscal policy substantially, lest financial markets mistake it as being less creditworthy than it is. Overall, conditional on the economy's being in recession, the government follows a procyclical fiscal policy. Conditional on the economy's being in expansion, the government follows a standard countercyclical behaviour. An empirical assessment of the fiscal behavior of newly elected governments, for which we argue reputation is more important, confirms the results.

Jel Classification: E62, F34, D82

Keywords: Austerity, Fiscal policy, Sovereign default, Private information.

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1 Introduction

Since 2010, many European governments have implemented stringent fiscal austerity plans in periods of deep recession. Greece, Ireland and Portugal dramatically reduced their budget deficits. Italy, Spain and the UK enforced drastic cuts in public spending and/or increased taxation. The rationale of these choices has been extensively discussed. A common view in the academic debate is that fiscal austerity has been a mistake. Krugman (2010) and De Long and Summers (2012), among others, argue that a fiscal policy tightening exacerbates the recession without producing any positive effect on public balances. They assume that interest rates are constrained by the zero lower bound and they remain constant after the fiscal adjustment. We argue, however, that this view is incomplete, as it does not consider the effect of fiscal policy on the sovereign risk premium.

This paper provides an explanation of the fiscal policy developments observed around Europe. We show that in a recession characterized by uncertainty about the creditworthiness of the government and by a high stock of public debt, a fiscal consolidation is the optimal response of a benevolent government that worries about a possible loss of reputation. A fiscal adjustment implemented in such conditions improves the government's reputation, defined as the belief that financial markets form about the creditworthiness of the government. The reputation achieved through fiscal adjustment reduces the government risk premium and thus the interest rate. Although the fiscal adjustment has a significant cost in terms of lower economic growth and lower public consumption, however, the welfare gains derived from the reputational channel are bigger than the costs, justifying the implementation of austerity during a recession.

We formalize this mechanism in an endogenous sovereign default model along the lines of Arellano (2008). We augment the model with distortionary fiscal policy, private information and political turnover. There are three agents in the economy: a government, a household and foreign financial markets. The household does not have access to borrowing and chooses labour and consumption. The government decides whether or not to default and borrows on behalf of the household. Moreover, it sets distortionary taxation and chooses public spending. Foreign financial markets lend to the government, taking into account its default probability. We introduce private information in this setting assuming that financial markets do not observe the discount factor of the government in power. In the paper we show how a lower government discount factor implies a higher propensity to default. Using this framework, we are able to explain why a government that in general follows

countercyclical policies, as in the case of European economies¹, might implement a procyclical fiscal policy exactly at the time of a recession. In particular, we find two distinct reasons to rationalize austerity: in a mild recession the government implements fiscal austerity for signalling considerations, while in a deep recession it does so for budgetary considerations. Our underlying assumption is that every country can be run by one of two types of government: either a high discount factor type (Good type, non present-biased), more willing to repay its debt, or a low discount factor type (Bad type, present-biased), less willing to do so. We show that in an environment with full information the Good type follows a countercyclical fiscal policy, while the Bad type follows a procyclical one. With private information the model produces different implications in terms of fiscal policy, as the two types of government and the lenders are engaged in a signalling game.

In this setting, we obtain the following results. First, in a mild recession a tighter fiscal policy aims at improving the government's reputation. Tighter fiscal policy acts as a credible signal for the Good government to convey information to the financial markets about its higher creditworthiness, on which depends the interest rate charged by foreign lenders. As a consequence, lenders charge the Good government a lower interest rate. A fiscal austerity implemented for this reason is what we name a *signalling austerity*. The government can choose between lower borrowing and lower interest rates (austerity) - and higher borrowing and high interest rates (no austerity). The government chooses the former policy following welfare considerations. The welfare benefit of the austerity policy is in terms of a reputational benefit, which guarantees lower interest rates and lower repayments in the future. The welfare cost is in terms of lower public spending and a significant reduction in economic activity, as the model entails a fiscal multiplier larger than one. Nonetheless, since the benefits are greater than the costs, austerity is the optimal response.

Second, in a deep recession there is a different rationale for austerity. We show how in a deep recession financial markets compel the Bad government to reduce its deficit up to the point where it receives the risk-free bond price and avoids defaulting in the next period. Given this responsible behaviour of the Bad government, it is more difficult for the Good government to signal its type. We show that in a deep recession the Good type does not succeed in signalling its type and loses its reputation. Nonetheless, the Good government curbs its budget and tightens its fiscal policy. If the Good government did not reduce its borrowing, lenders would be uncertain whether they were lending to the Good type, who is following its full information countercyclical policy, or to the Bad type who is trying to exploit the lack of information and expand its budget. Hence, lenders would charge the unknown type of government a far too high interest rate. Since in deep recessions the default

¹See, for instance Kaminsky, Reinhart and Vegh (2004).

probability (and therefore the interest rate) of the Bad type increases faster than the increase in the level of borrowing, the Good government would find itself beyond the peak of its debt Laffer curve and the government budget would be unbalanced. Anticipating this behaviour of financial markets, the Good government reduces its borrowing and prevents its primary balance to worsen. A fiscal austerity implemented for such reason is what we name a *budgetary austerity*. The Government chooses the same level of borrowing as the Bad type and implements the same fiscal policy, because at this low level of borrowing they both already receive the risk-free interest rate. An additional reduction in borrowing would imply a null reputational benefit but positive welfare costs, removing any incentive for the Good government to send a costly signal to financial markets.

The numerical simulations of the model show that, irrespective of the rationale behind the implementation of fiscal austerity, the presence of private information generates a regime change in the cyclicity of the Good government fiscal policy. Conditional on the economy being in a recession, the government implements a procyclical fiscal policy, in order to prevent to be mimicked by the Bad type and to avoid the resulting high interest rates. It increases taxation and decreases borrowing as the productivity shock becomes more negative. On the other hand, when the economy is in expansion, the government follows its first best countercyclical fiscal policy, as the incentives to mimic for the Bad government arise only for sufficiently negative productivity shocks.

The last section of the paper provides some empirical evidence to show that the intuitions of the model are consistent with the data. We identify a period of private information with the first year of the mandate of a newly elected government, if this government is in power for the first time. We document that the OECD countries for the period 1995-2009 followed a procyclical behaviour in the periods characterized by the joint presence of private information and recession. In all other cases, they followed the standard textbook countercyclical fiscal policy.

The paper is structured as follows. Section 1.1 presents a literature review, while section 1.2 offers some stylized facts about the magnitude of the austerity measures implemented in Europe. Section 2 presents a simple three period model, while section 3 illustrates the results. Section 4 provides the full model in infinite periods, generalizing the intuitions of the three period model. Section 5 offers some empirical evidence, documenting the consistency of the predictions of the model with the empirical findings. Section 6 concludes.

1.1 Literature Review

The paper is related to several strands of the literature. First, it relates to the literature analysing the effects of fiscal policy on economic activity. In particular, it relates to the body of work studying fiscal consolidations episodes. This literature, starting with Giavazzi and Pagano (1990) and Alesina and Perotti (1995), proposed the reputational channel as a mechanism able to explain why fiscal consolidations can foster economic growth, through a reduction in the sovereign risk-premium. Giavazzi and Pagano (1990) and Alesina and Perotti (1995) study empirically the effect of fiscal adjustments and inspect the relevance of the credibility channel. They document that this channel is most powerful when the economy is experiencing high debt levels. The same question has been further investigated by Alesina and Ardagna (1998, 2009), Ardagna (2004) and more recently by Favero, Giavazzi and Alesina (2012), in a series of empirical papers about expansionary fiscal consolidations. However, to the best of our knowledge, there is not a theoretical framework in the literature useful to think about the reputational perspective of fiscal policy. Our model is a first attempt. We use the model to study under which conditions the reputational channel is relevant and we evaluate the benefits and the costs of this mechanism. We find that this channel operates when the following conditions are met: 1) there is private information in financial markets about the creditworthiness of the government, 2) there is a strong enough recession, 3) the stock of public debt is high enough.

In the theoretical literature, few papers study the relationship between fiscal policy and government reputation. Corsetti, Kuester, Meier and Muller (2012) study the impact of a fiscal retrenchment in the presence of sovereign default risk. They show that if the risk-premium falls far enough, a fiscal consolidation may have positive effects on output. However, the default decision is not modelled explicitly. They assume an exogenous negative relationship between the amount of government borrowing and the government interest rate. In a related paper, Corsetti and Dedola analyse the determinants of the sovereign risk-premium and show how it depend both on the fiscal policy and on market confidence. In this paper we provide a model that endogenously links fiscal policy, the government interest rate and economic growth.

Second, the paper draws on the literature studying sovereign default. The question of government reputation is intimately related to the question of sovereign default. Indeed, it is the option of defaulting that makes government reputation relevant, which in turn affects the interest rate the government receives. The core of our model is a sovereign default model, along the lines of Arellano (2008) and Aguiar and Gopinath (2004). This model has been used to study the dynamics of sovereign default in emerging markets, abstracting from distortionary fiscal policy. Cuadra, Sanchez and Sapriza (2010) augmented the standard sovereign default model with distortionary fiscal policy. We build on

Cuadra, Sanchez and Sapriza (2010), using their modelling framework to introduce fiscal policy in a sovereign default model. We build on Hatchondo, Martinez and Sapriza (2009) to model political turnover in the full model of section 4. However, we expand these models introducing asymmetric information about the type of government in charge. Our contribution is to augment the sovereign default literature by a signalling game with fiscal policy.²

Third, our paper is related to the literature that studies the cyclicity of government fiscal policy. This literature finds that advanced countries implement a mild countercyclical or even acyclical fiscal policy, while emerging countries implement a very procyclical one, e.g. Gavin and Perotti (1997), Kaminsky Reinhart and Vegh (2004), Ilzetzki and Vegh (2008). Our study finds that the presence of private information generates a regime-change in the fiscal policy cyclicity of a country. In the presence of private information, a country optimally follows a procyclical fiscal policy in recession and a countercyclical one in expansion.

1.2 Stylized Facts

This section provides some stylized facts regarding the fiscal policy stance in Europe during the period 2008-2014, in order to quantify the magnitude of the austerity measures implemented.

To address this question correctly we would need an exogenous measure of fiscal policy, able to reflect the willingness of the government to implement a fiscal consolidation independent on the economic cycle. However, the fiscal policy outcomes that we observe, namely the government budget items, are the result of the two forces at work in the real world: the intention of the government and the effect of the economic cycle. Although no general agree to disentangle the two has been found, we propose three measures to quantify the fiscal policy stance. The first one refers to the change in the cyclically adjusted primary balance ($\Delta CAPB$). The second measure considers the change in discretionary government spending. The third is a narrative measure, as reported by OECD surveys and governmental provisional budget laws.

The change in the CAPB is one of the most common measures used in the literature to proxy the government fiscal position net of cyclical effects³. Figure 1 plots the change in the CAPB⁴, for Greece, Ireland, Italy, Portugal, Spain and the UK, from year 2008 to 2013. The figure makes clear how fiscal policy has changed during this period. In the first two years fiscal policy was expansionary

²Other works study private information in sovereign default models, e.g. Cole, Dow and English (1994), Alfaro and Kanczuk (2003), Sandleris (2006), D'Erasmus (2011). However, none of these model explicitly fiscal policy.

³See Alesina and Ardagna (1998) and Guajardo *et al* (2010) for a more detailed discussion

⁴As a percentage of GDP

Figure 1: Change in Cyclically Adjusted Primary Balance (CAPB)

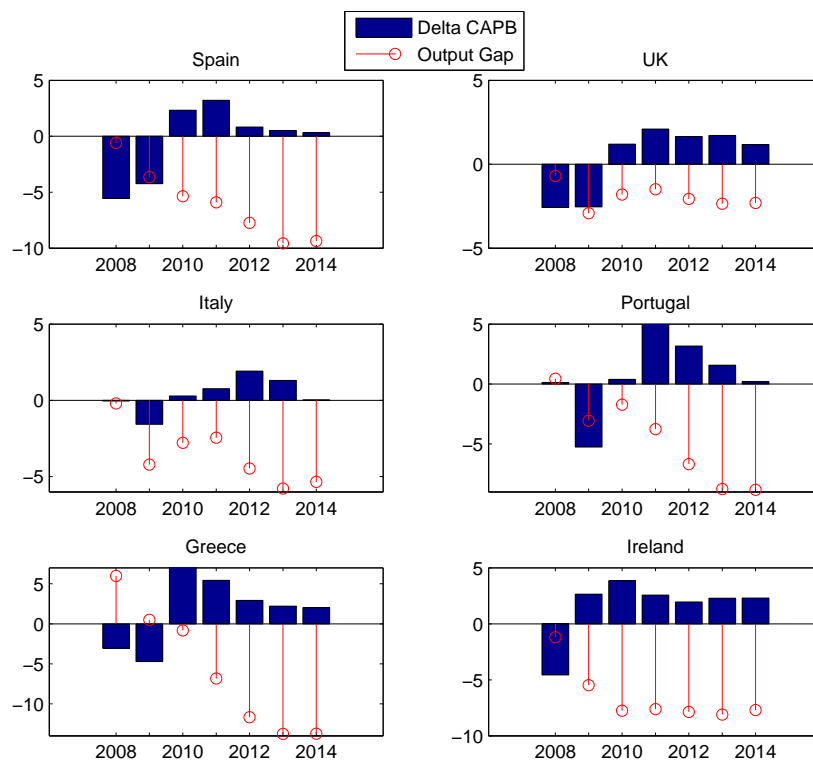


Figure 1 depicts the change in the Cyclically Adjusted Primary Balance ($\Delta CAPB$) as a percentage of GDP and the output gap, in percentage deviations from the trend. Data are from year 2008 to 2014. The countries considered are: Spain, the UK, Italy, Portugal, Greece and Ireland.

in all the countries considered, but since 2010 the fiscal stimulus has been reverted and fiscal austerity has taken its place. Moreover, this has happened in a period of continuing economic vulnerability, as represented by a constant negative output gap. The country that experienced the tightest fiscal policy was Greece, where the cumulative value of the austerity measures reached 17.8% of GDP. The UK, Spain and Italy experienced a cumulative fiscal austerity of, respectively, 6.6%, 6.9% and 4.3% of GDP.

The second measure relates to the change in government spending. The first column of Table 1 reports the change in total government expenditure as a percentage of GDP, between 2009 and 2013. All the peripheral European countries and the UK experienced a decrease in the ratio of total

Table 1: $\Delta\%$ *Government Spending*

	$\Delta G/Y$ (2013 vs 2009)	$\Delta Gd/Y$ (2012 vs 2009)
Greece	-4.2%	-35.7%
Ireland	-5.4%	-12.8%
Italy	-1.3%	-7.8%
Portugal	-2.3%	-22.2%
Spain	-4.0%	-18.3%
UK	-2.5%	-5.8%

Table 1 (left column) reports the change in total government spending as a percentage of GDP (left column) between 2009 and 2012. Table 1 (right column) reports the change in the discretionary government spending as a percentage of GDP (left column) between 2009 and 2012.

government expenditure over GDP. Total government expenditure considers all kinds of government spending, including the spending on automatic stabilizers, which automatically increases in a recession. The fact that nonetheless this form of spending declined is illustrative of the size of the fiscal austerity measures implemented. The second column of Table 1 reports the change in discretionary government spending⁵. This measure, netting out the main part of fiscal transfers, is less dependent on the economic cycle and should reflect more accurately the government fiscal policy stance. We report the rate of change of real discretionary government spending between 2009 and 2012⁶.

The third measure that we propose is a narrative one, extracted from the OECD Fiscal Consolidation survey (2012) and from provisional government budget laws. It summarizes the *ex-ante* fiscal program of the various governments. This does not take into account the actual multiplier effect on output and unemployment resulting from the withdrawal of demand from the economy. Hence the figures provided can turn out to be different from the data realized, for the effect of the economic cycle. The cumulative value of the fiscal austerity plans for the period 2010-2015, according to our narrative measure, ranges from 18.5% of GDP for Greece to 6.1% of GDP for Italy, as reported in Figure 2.

Overall, the three measures reported here suggest unambiguously that, starting from 2010, the countries analysed changed their response to the weak economic cycle. Before 2010 these countries responded in a countercyclical fashion, but from this date they implemented a very procyclical fiscal

⁵Discretionary spending is calculated by subtracting from total government expenditure, social benefits and transfers in kind, capital transfers and other transfers. This measure is then transformed in real terms using the GDP deflator.

⁶No data are yet available for the year 2013.

Figure 2: Narrative measure: Cumulative Fiscal Adjustment (2010-2015)

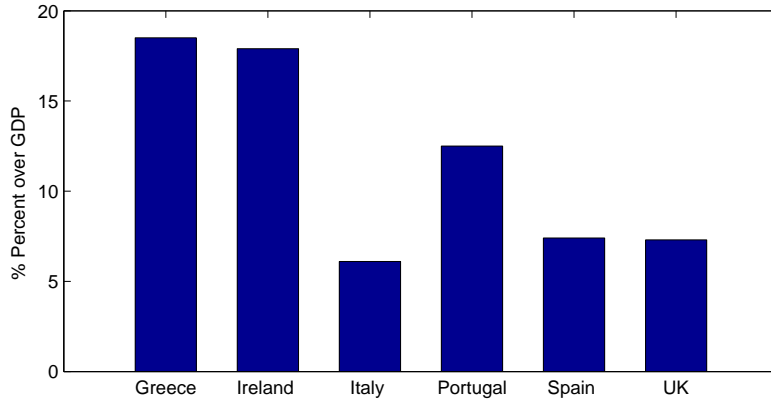


Figure 2 reports the cumulative fiscal adjustment (2010-2015), according to the narrative report in the OECD Fiscal Consolidation Survey (2012).

policy. In the next section we provide a modelling framework able to account for this behaviour, based on the joint presence of sovereign default risk and private information in financial markets.

2 A simple model

In this section we provide the model in three periods; the full model is illustrated in section 4. There is a small open economy with three agents: household, government and foreign lenders. The household only decides how much to work and how much to consume. It cannot transfer resources from one period to another. The government is benevolent and acts to maximize household’s utility. The government takes several decisions. First, it decides whether to default or not on its debt inherited from the previous period. Second, it borrows from abroad on behalf of the household. Third, it chooses the optimal level of government expenditure G and the optimal level of taxation T . Lenders are risk neutral and lend a non-state contingent bond to the government. The price that they charge accounts for the probability that the government in the following period will decide to default.

2.1 Household

In each period the representative household faces the same problem. It chooses how much to consume and how much to work, taking government actions as given. The household’s utility function depends on consumption C , leisure $1 - L$ and government consumption G . Assuming a production function

which depends on labour L and productivity Z , the household's problem is the following⁷:

$$\begin{aligned} \text{Max } E_t \sum_t \beta^t U(C_t, 1 - L_t, G_t^*) \\ \text{s.t. } (1 + T_t^*)C_t = Z_t F(l_t) \end{aligned} \quad (1.1)$$

Equation (1.1) is the consumer budget constraint, where T is a tax on consumption and $Z_t F(L_t)$ is total output Y_t . Productivity Z_t evolves over time according to a Markov process, with $H(Z_{t+1}|Z_t)$ representing the transition probability from Z_t to Z_{t+1} . β is the household's discount factor, with $\beta \in (0, 1)$.

The household problem is simple and does not involve any intertemporal decision. The household does not have access to financial markets and therefore cannot smooth consumption over time. The solution to the problem described by Equation (1) is given by the first order condition

$$(1 + T^*) \frac{U_l(C, 1 - L, G^*)}{U_c(C, 1 - L, G^*)} = Z F_l(L)$$

For any value of the tax T^* and government spending G^* , the household chooses consumption and leisure such that the marginal rate of substitution between consumption and leisure (adjusted by the tax) equals the marginal product of labour.

2.2 Government

The government solves a Ramsey problem, meaning that the government makes its decisions taking into account the reaction of the household. The government problem is different in each of the three periods of the economy, as we show below. The model is solved by backward induction. For this reason we show the third period first, followed by the second and finally the first.

Third period

We impose that in the third period the government cannot borrow from abroad, since this is the last period of the economy. Furthermore, we assume that the government cannot default on its debt at the beginning of the third period. The government simply chooses G and T in order to maximize the household's utility. The government raises tax revenues equal to $T_3 C_3^*$ and uses them to finance public spending G_3 and to repay the bond inherited from the previous period, B_2 . The government

⁷The variables with a star * are chosen by the government and they are considered by the consumer as given.

problem in the third period is given by:

$$\underset{G_3, T_3}{Max} U(C_3^*, 1 - L_3^*, G_3) \quad (2)$$

$$G_3 = T_3 C_3^* - B_2 \quad (3)$$

$$Z_3 F(L_3^*) = (1 + T_3) C_3^* \quad (4)$$

$$\frac{\partial Y_3}{\partial L_3^*} = (1 + T_3) \frac{U_l(C_3^*, 1 - L_3^*, G_3)}{U_c(C_3^*, 1 - L_3^*, G_3)} \quad (5)$$

where C^* and L^* represent the household's optimal choice of consumption and labour. Equation (3) is the government budget constraint. Equations (4) and (5) are respectively, the consumer budget constraint and the consumer first order condition. The solution to this problem is represented by the following Intra-Temporal condition

$$U_c \frac{ZF(l^*)}{(1+T)^2} = U_g \left[\frac{ZF(l^*)}{(1+T)^2} + \frac{ZTF_l(l^*)}{(1+T)} \frac{\partial l^*}{\partial T} \right] \quad (6)$$

Should labour not depend on the tax rate, condition (6) boils down to the standard condition $U_c = U_g$, which equalizes the marginal utility of private consumption to the marginal utility deriving from public consumption.

Second Period

At the beginning of the second period the government decides whether to default or not on the debt inherited from the first period. Given the productivity realization Z_2 and the amount of bond holding inherited B_1 , the government chooses the option which provides the higher utility. The benefit from defaulting derives from not having to repay the debt contracted in period 1. The cost of defaulting is, as standard in the literature of sovereign default models, an output cost. We assume a proportional output cost in the following way

$$Z_3^{def} = \alpha Z_3 \quad (7)$$

where α is a parameter smaller than 1. As in Hatchondo, Martinez and Saprizza (2008) we assume that the output cost is paid in the third period. We do not impose an additional cost in terms of exclusion from financial markets. The government chooses whether or not to honour its debt comparing the value function of defaulting (V^d) and the value function of not defaulting (V^{nd}). The

resulting default decision is described by the indicator function

$$d(B_1, Z_2) = \begin{cases} 1 & \text{if } V^{nd}(B_1, Z_2) < V^d(0, Z_2) \\ 0 & \text{if } V^{nd}(B_1, Z_2) \geq V^d(0, Z_2) \end{cases}$$

The function $d(B_1, Z_2)$ shows, for every possible combination of productivity Z_2 and bond B_1 ⁸, what the optimal decision is in terms of defaulting or not. This defines a default set $D(B_1)$, i.e. a set of values for the productivity shocks Z_2 such that it is optimal to default for any given bond holding B_1 .

$$D(B_1) = \{Z_2 \text{ s.t. } d(B_1, Z_2) = 1\} \quad (8)$$

Integrating the transition function H for all the values of Z belonging to the default set we can recover the implied default probability in period 1.

$$P(B_1, Z_1) = \int_D H(dZ'|Z) \quad (9)$$

The default probability is, for each Z_1 and each bond choice B_1 , the perceived probability in period one that the government will default at the beginning of period two. This probability is fundamental in determining the price of the bond in the first period, as we show later.

After the decision to default or not, the government chooses the level of public spending and taxation and how much bond B_2 to borrow at price $q^{risk-free}$.⁹ The government chooses G , T , and B solving the following problem:

$$\underset{G_2, T_2, B_2}{Max} E_2 \sum \beta^t U(C_2^*, 1 - L_2^*, G_2) \quad (10)$$

$$G_2 + B_1 = T_2 C_2^* + q^{risk-free} B_2 \quad (11)$$

$$Y_2 = (1 + T_2) C_2^* \quad (12)$$

$$\frac{\partial Y_2}{\partial L_2} = (1 + T_2) \frac{U_l(C_2^*, 1 - L_2^*, G_2)}{U_c(C_2^*, 1 - L_2^*, G_2)} \quad (13)$$

Solving the maximization in (10) we obtain an Intra-temporal condition, represented again by Equation

⁸ B_1 , the bond inherited from the previous period, is a state variable in period 2.

⁹The government borrows risk-free because we have assumed that in the last period it cannot default and thereby debt will be repaid with probability one. This is enough to guarantee that the second period interest rate is exactly the risk-free one, exogenous in the model.

(6), and the following Inter-temporal condition:

$$U_g = \beta(1 + r^{risk-free})E_Z \left(U_{g(+1)} \right) \quad (14)$$

Equation (14) is an Euler equation, which represents the trade-off between public spending today and public spending tomorrow. The optimal level of G is set equating the marginal utility of government spending today to the expected present value of the marginal utility tomorrow.

First period

We assume that in the first period there is no default option on the bond inherited from period 0 and thereby that the government always repays its debt. After the repayment, the government can borrow an amount B_1 from financial markets at price $q(B_1, Z_1)$. If the government decides to borrow it receives an amount equal to $q(B_1, Z_1)B_1$ and the following period it has to pay back the amount B_1 . Unlike the second period, where the price of the bond is constant and exogenous, the price of the bond in the first period depends on the amount borrowed B_1 and on the realized productivity shock Z_1 . The higher the level of borrowing, the lower the price. The higher the productivity shock, the higher the price. In the next subsection we show how the price of the bond is related to the amount of borrowing, to the productivity shock and to the the government default probability.

In the first period the government solves:

$$Max_{G_1, T_1, B_1} E_1 \sum \beta^t U(C_1^*, 1 - L_1^*, G_1) \quad (15)$$

$$G_1 = T_1 C_1^* + q(B_1, Z_1)B_1 - B_0 \quad (16)$$

$$Y_1 = (1 + T_1)C_1 \quad (17)$$

$$\frac{\partial Y_1}{\partial L_1} = (1 + T_1) \frac{U_l(C_1, 1 - L_1, G_1)}{U_c(C_1, 1 - L_1, G_1)} \quad (18)$$

The solution to this problem delivers the same Intra-temporal condition as in period 2 and 3. However, the Inter-temporal condition is now different:

$$U_g \left(q + b' \frac{dq}{db'} - \frac{TZ}{1+T} \frac{\partial l}{b'} \right) = \beta \int_{Z \notin D(B)} U_{g(+1)} H(dZ' | Z) \quad (19)$$

The government, borrowing an extra unit of bond, can increase public spending by $(q + b' \frac{dq}{db'} - \frac{TZ}{1+T} \frac{\partial l}{b'})$.

This generates a marginal utility equal to the left hand side of Equation (19). In the following period the government has to repay its debt. In order to do so it has to reduce government consumption, generating a discounted marginal utility equal to the right hand side of the equation. We integrate only for those shocks that do not belong to the default set, to take into account the fact that the government reduces public spending only in the case that it does not default.

2.3 Foreign Lenders

The market for lending to the small open economy is perfectly competitive. There is an infinite number of risk-neutral lenders who act in order to maximize their profits, taking prices as given. Lenders discounted profits Π are given by

$$\Pi = \frac{P(B_1, Z_1)}{1 + r^{risk-free}} 0 + \frac{1 - P(B_1, Z_1)}{1 + r^{risk-free}} B_1 - q(B_1, Z_1) B_1$$

where $P(B_1, Z_1)$ is the probability of default, given by Equation (9). The sum of the first two terms on the right hand side is the discounted value of the expected payoff from lending, while $q(B_1, Z_1) B_1$ is the cost. Using the zero profit condition we can recover the asset price condition:

$$q(B_1, Z_1) = \frac{1 - P(B_1, Z_1)}{1 + r^{risk-free}} \quad (20)$$

Equation (20) shows how the bond price depends one-to-one on the default probability. When the default probability is zero, the interest rate implied by the bond price is the risk-free one. This is what occurs in the second period of the economy, as the probability that the government will default in the third period is zero. Contrariwise, when the default probability is different from zero, the bond price changes with the level of borrowing and productivity. This is what happens in the first period, as in the following period the government can choose to default.

3 Results

The key parameter of the model is the government discount factor.¹⁰ The lack of knowledge, from the point of view of foreign lenders, about the value of this parameter determines the private information setting arising in the paper. We assume that the discount factor can take two different values, reflecting the two different types of government. A patient government (Good type), with a high discount factor, and an impatient government (Bad type), with a low discount factor. The government in charge can

¹⁰The consumer discount factor coincides with the government discount factor.

be one of these two types. We first solve the model for the case in which the value of the discount factor is known to foreign lenders (public information case) and then we compare the results with the case where lenders are unable to observe this value (private information case).

The model is solved analytically and the proofs of the propositions are reported in Appendix A. However, for ease of exposition, we supplement the propositions with the graphical results obtained in solving the model numerically. We assume the household utility function to be separable between government spending and consumption, and to be given by:

$$U(C, G, 1 - L) = \psi \log(G) + (1 - \psi) [\log(C) + \log(1 - L)]$$

where ψ represents the share of utility derived from government consumption. In the three period model we use this simple functional form, while we relax this assumption in the full model, where we use a standard GHH formulation. The production function is linear in labour:

$$ZF(L) = ZL$$

The parametrization used to solve the model is standard and it is reported in Table 7 of the Appendix B. Here we do not provide the full description, since in section 4, when we introduce the full model, we instead describe in detail the calibration used.

3.1 Results: Public information

According to the value of the discount factor, the model delivers different implications, in terms of default, spending, taxation and borrowing decisions. We focus on the results relating to the first period. Only in this period is the interest rate charged by foreign lenders non-constant. Therefore only the first period is interesting for our purpose of analyzing the relationship between credibility, fiscal policy and the interest rate. The following propositions and figures summarize the results, in terms of the default set and the choices of spending, taxation and borrowing for each of the two possible types of government.

Proposition 1 The default set increases as β decreases: $D^{\beta^1}(B_1) \subset D^{\beta^2}(B_1)$, with $\beta^1 > \beta^2$. It follows that: $D^{Good}(B_1) \subset D^{Bad}(B_1)$

Proof: See Appendix A

In the cost-benefit analysis that determines the default decision, the only difference between governments with different discount factors resides in how these governments value the cost of default.

Because the output cost is paid in the third period, the lower the discount factor, the more the government discounts the output loss related to the default choice and the lower is the cost of defaulting. This means that a government with a low discount factor features more productivity states such that it defaults, as opposed to a government with a high discount factor. In other words, the default set of the Good type is smaller and included in the default set of the Bad type.

We assume that the discount factor of the Good government is high enough to keep its default set and borrowing needs small and it always borrows in a region of the (B_1, Z_1) space which entails a zero probability of default. Therefore it always receives the risk-free interest rate. Conversely, we assume that the Bad government, given its lower discount rate, has a larger default set and engages in risky borrowing. This implies that in general the Bad government will not obtain the risk-free interest rate, as Proposition 5 clarifies.

Proposition 2: The Good type's tax policy is acyclical ($\frac{\partial T_1^*}{\partial Z_1} = 0$). The Bad type's tax policy is countercyclical (i.e. $\frac{\partial T_1^*}{\partial Z_1} < 0$)

Proof: See Appendix A.

Figure 3 (left panel) reports the choice of the tax rate for the two types of government, against the productivity shock.¹¹ When the state of productivity is low, the Bad government cannot borrow much, as financial markets take into account its high propensity to default and reduce the level of lending. This makes the Bad government unable to raise enough funds to finance the desired higher level of public spending. In order to raise revenues it is forced to raise the level of taxation. For low productivity shocks, it sets the tax rate above the rate chosen by the Good government. As productivity increases and it can borrow more, the Bad government reduces the tax rate. The Good government, instead, is not constrained by the default probability and keeps the tax rate constant.¹²

Proposition 3: The Good type's spending policy is acyclical (i.e. $\frac{\partial(\frac{G}{Y})^*}{\partial Z} = 0$). The Bad type's spending policy is procyclical (i.e. $\frac{\partial(\frac{G}{Y})^*}{\partial Z} > 0$)

Proof: See Appendix A

Figure 3 (right panel) reports the choice of spending over GDP for the two types of government, against the productivity shock. When the productivity shock is low, the Bad government (red line) chooses a level of spending lower than the Good government (blue line). When the shock is high, the

¹¹The model is solved for a constant initial level of debt B_0 , set equal to the average value of debt, across all the possible values used in the grid

¹²If both governments could borrow risk-free, the difference in the discount factor of the two governments would simply translate to a downward shift of the tax policy of the Bad government with respect to the Good government.

opposite occurs. The reason is the same as the one highlighted for the tax policy. Indeed, the level of spending and the tax rate are related one to one with each other through the Intra-temporal FOC (6).

Figure 3: Left panel: Taxation. Right panel: Public Spending

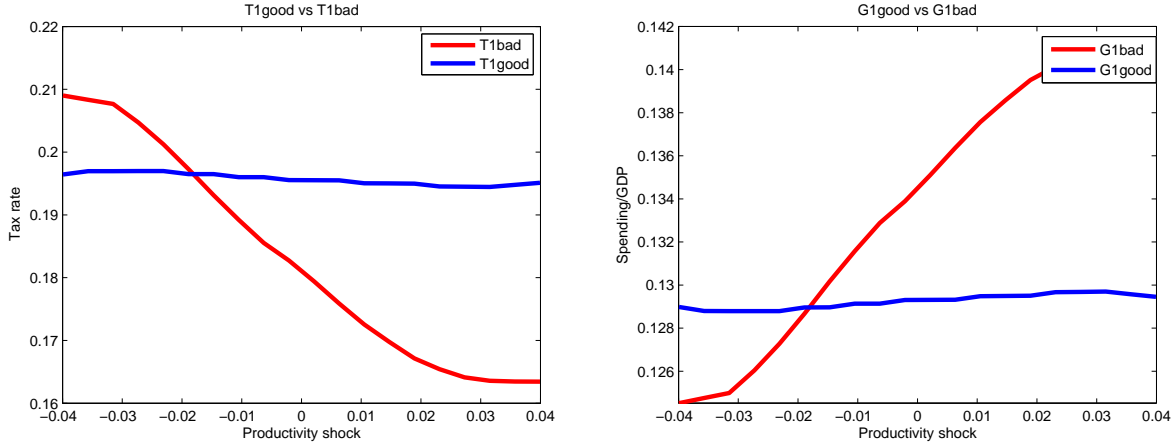


Figure 3 (left panel) reports the tax rate of the Good type (blue line), and of the Bad type (red line), across productivity states. Figure 3 (right panel) reports the spending policy (spending/GDP) of the Good type (blue line), and of the Bad type (red line), across productivity states.

Proposition 4: The Good type’s borrowing policy is countercyclical (i.e. $\frac{\partial q^{free} B_1^*}{\partial Z_1} < 0$). The Bad type’s borrowing policy is procyclical (i.e. $\frac{\partial q^*(B_1, Z_1) B_1^*}{\partial Z_1} > 0$)

Proof: See Appendix A

Figure 4 (left panel) reports the borrowing policy for the two types, against the productivity shock. The Good type’s borrowing policy is mildly countercyclical. It borrows slightly more in recession and slightly less in expansion. In contrast, the Bad type borrowing policy is procyclical. It borrows less in recession, because it is constrained by the interest rate schedule, whereas it demands to borrow more in expansion. We can think of the borrowing policy as a good proxy for the overall fiscal policy stance. Thereby we can highlight the stark difference between the two types in terms of fiscal policy. The Good type follows a countercyclical fiscal policy, while the Bad type follows a procyclical one.

Proposition 5: The Good type equilibrium bond price is constant. For every Z , $q^{*Good} = q^{risk-free}$. For the Bad government, for $Z < \bar{Z}$, $q^{*Bad} = q^{risk-free}$. For $Z > \bar{Z}$, $q^{*Bad} < q^{risk-free}$.

The value \bar{Z} is the productivity shock identified by Lemma A (below)

Proof: See Appendix A

Lemma A: \bar{Z} is the highest productivity shock that satisfies the following condition:

$$\lim_{B \rightarrow \bar{B}^+} \frac{\partial [q^{Bad}(B, Z) * B]}{\partial B} \leq 0 \quad (21)$$

where $\bar{B} = \sup \{B \text{ s.t. } D^{Bad}(B) = \emptyset\}$. The condition imposes that, taking the limit of the above expression calculated when B tends to \bar{B} (from the right), the amount of resources raised from financial markets does not increase with the increase of borrowing B . This implies that the price function $q^{Bad}(B, Z)$, following an increase in B , decreases faster than the rate at which B increases. When this condition is satisfied, for each $Z \leq \bar{Z}$, \bar{B} is the maximum amount of borrowing that is sensible to borrow. A higher borrowing than \bar{B} would imply simply less in resources $q \cdot B$ today and higher repayments tomorrow. Therefore, for $Z \leq \bar{Z}$, the Bad government always borrows an amount $B \leq \bar{B}$. For each $B \leq \bar{B}$, the corresponding interest rate $q(B, Z) = q^{risk-free}$, because $D^{Bad}(B, Z) = \emptyset$ by definition. For $Z > \bar{Z}$ the opposite condition holds, (i.e. $\lim_{B \rightarrow \bar{B}(+)} \frac{\partial [q(B, Z) * B]}{\partial B} > 0$) and the government can engage in risky borrowing, obtaining $B > \bar{B}$ and $q(B, Z) < q^{risk-free}$, because for $B > \bar{B}$ we have $D(B, Z) \neq \emptyset$.

Proof: See Appendix A

Figure 4 (right panel) shows the bond price obtained in equilibrium by the two types, for each state of productivity. The interest rate is simply the inverse of the bond price. The Good type always borrows risk-free, since it never defaults. However, the Bad type borrows risk free only for very low productivity levels. For such levels it has no choice other than to reduce its borrowing, choosing a level that guarantees to lenders that it will not have incentives to default the following period. For just slightly higher levels of borrowing the default probability increases so fast that it would not be convenient to borrow, as Lemma A shows. For values $Z > \bar{Z}$, the interest rate schedule becomes less steep and the Bad type can borrow more. For those states, it receives an interest rate higher than the risk-free one.

Figure 4: Left panel: Level of borrowing. Right panel: Bond price

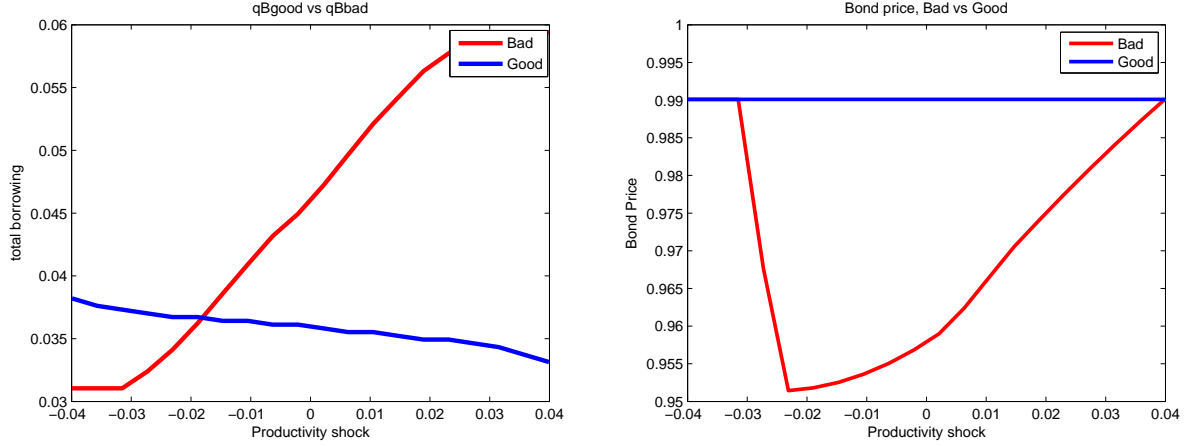


Figure 4 (left panel) reports the primary balance of the Good type (blue line), and of the Bad type (red line), across productivity states. Figure 4 (right panel) reports the equilibrium bond price of the Good type (blue line), and of the Bad type (red line), across productivity states.

Role of Reputation

In the public information setting there is no role for reputation. The government cannot alter the perceived creditworthiness it has towards lenders. Lenders are able to identify the type of government in charge with probability one and thus they apply the corresponding interest rate schedule. In this context, there is no link between the stance of fiscal policy and government credibility. For every level of productivity, the Bad and the Good government make different choices in terms of G , T and B . Given a productivity shock, we can think at these choices as a separating equilibrium between the Bad and Good type. Overall, the solution of the model delivers a set of separating equilibria. The two types make different decisions and lenders are able to identify them. In the next section we show the consequences of introducing private information in this framework.

3.2 Results: Private information

Private information in our context means that foreign financial markers do not know the value of the government discount rate. We define reputation as the financial markets' belief that the government is of the Good type,

$$R^i(G_1, T_1, B_1) = \text{Prob}(\text{Good}|G_1, T_1, B_1)$$

In the case of public information $R^{\text{Good}}(G, T, B) = 1$ while $R^{\text{Bad}}(G, T, B) = 0$, by definition. In the case of private information this no longer has to hold. The Bad and the Good government might both have incentives to behave differently with respect to the public information case, in order to deceive the lenders. These incentives will have an impact on the reputation value $R^i(G, T, B)$ and will affect the lenders' lending policy. It is mainly the Bad government that has incentives to change its choices. The Bad government pays a higher interest rate and would like to be perceived as a Good government in order to be charged less. The Bad government, if it changes its behaviour, can try to look like a Good type. In order to do so, it has to make exactly the same choices as the Good government would make. Therefore, the sensible option for the Bad government is either to stick to its public information plan, which results from the solution of a maximization problem, or to mimic the Good type's plan, in the cases where this alternative guarantees a higher utility. The Good type does not have a direct incentive to follow the Bad's type behaviour, since it does not receive any benefit.

The incentives for the Bad government to behave differently with respect to the public information case are present only when the productivity shock is low enough. More precisely, only for those productivity states Z lower than Z^* , i.e. the productivity state corresponding to the point in Figure 3 where the public spending of the Bad and the Good type cross each other. We call Z^* the productivity threshold. Let $V^{\text{Bad}}(B_0, Z; \text{mimic})$ represent the Bad type value function when it mimics the Good type (i.e. chooses the same level of G_1 , T_1 and B_1 as the Good type). Let $V^{\text{Bad}}(B_0, Z)$ represent the Bad type value function when it follows its own public information plan.

Proposition 6: . For $Z < Z^*$ the Bad government has incentives to mimic the Good government, as $V^{\text{Bad}}(B_0, Z; \text{mimic}) > V^{\text{Bad}}(B_0, Z)$. For $Z \geq Z^*$ the opposite holds, with $V^{\text{Bad}}(B_0, Z; \text{mimic}) \leq V^{\text{Bad}}(B_0, Z)$.

Proof: See Appendix A.

For $Z < Z^*$ the Bad government has incentives to change its behaviour and to copy the Good government's choices. In section 3.1 we showed how, given low productivity states, the Bad type is forced to choose low levels of G and B , and high levels of T . However, if the Bad type mimics the Good type, it can unambiguously increase its own utility, in that it increases spending and borrowing, and reduces taxation. However, for $Z \geq Z^*$ the Bad government does not have incentives to change its behaviour.

Figure 5 summarizes the findings of Proposition 5. The figure represents the value function of the

Figure 5: Incentive to mimic

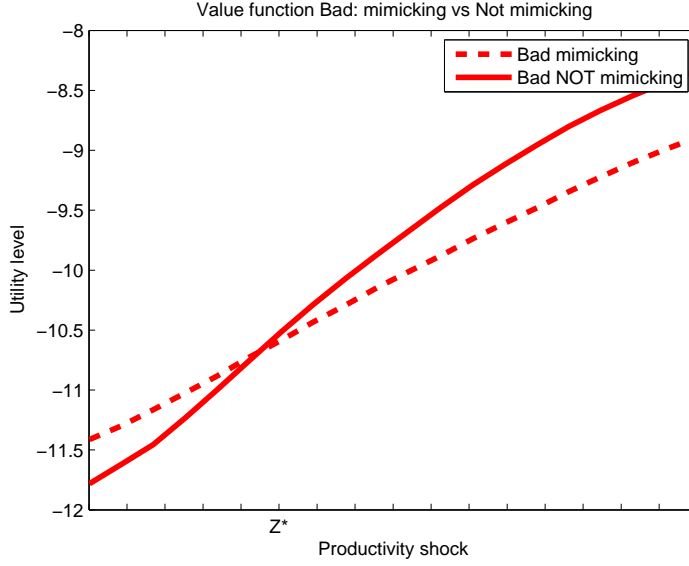


Figure 5 reports the value function of the Bad type when it mimics the Good type (dashed line) and the value function of the Bad type when it follows its own public information plan (solid line), across productivity states.

Bad type in the case where it mimics the Good type, $V^{Bad}(B_0, Z; mimic)$ (dashed line), and in the case where it does not, $V^{Bad}(B_0, Z)$ (solid line).

Overall, in the private information setting, for productivity levels lower than Z^* , one of the agents has an incentive to deviate from its public information strategy. Thereby the public information separating equilibria are not sustainable when private information issues are present. With private information the model presents a different solution. According to the level of the productivity shock, the model delivers two different equilibria: a pooling equilibrium and a separating equilibrium.

Equilibrium concept

Before showing the solution of the model, we define the equilibrium concept. The equilibrium concept adopted is the one of Perfect Bayesian Equilibrium (PBE), as standard in incomplete information games. In our context, a PBE is characterized by:

1. A set of value functions $V^i(B_0, Z_1)$, for $i = Bad, Good$
2. A set of consumption rules $C^i(B_0, Z_1)$, borrowing rules $B_1^i(B_0, Z_1)$, spending rules $G^i(B_0, Z_1)$,

tax rules $T^i(B_0, Z_1)$, and default rule $d^i(B_0, Z)$, for $i = Bad, Good$

3. A price bond function $q^i(B_1, Z_1)$ for $i = Bad, Good$

4. A set of in-the-equilibrium beliefs R^i and a set of out-of-equilibrium beliefs γ^i for $i = Bad, Good$

such that:

- Taking the government policies as given, the resource constraint is satisfied
- Taking the beliefs and bond price as given, the value functions, the government decision rules and the default set are consistent with the government's optimization problem.
- The equilibrium price $q^i(B_1, Z_1)$ is such that foreign creditors earn zero profits in expected value.

In other words, a PBE requires that, for each possible state (including those occurring off-the-equilibrium path), agents' beliefs over the types and strategies of the other agents must be specified. Given these beliefs, each agent must choose actions that are the best responses to the strategies of the other agents.

3.2.1 Pooling equilibria

For each $Z < \bar{Z}$, the model delivers a pooling equilibrium in which both types pool on the same level of spending (G^P), taxation (T^P) and borrowing (B^P). It is important to note that the optimal choices of B , G and T are inherently related to one another. In particular, if the two types of government choose the same level of borrowing, this implies they also choose the same level of spending and taxation, since the Intra-temporal condition and the budget constraint are the same for both types, irrespective of the discount rate. For this reason and for ease of notation we may think of the pooling equilibrium simply in terms of an equal choice of borrowing, and implicitly refer to an equal choice of spending and taxation.

Proposition 7: For each $Z \leq \bar{Z}$ the model generates a pooling equilibrium, where both types of government pool on the Bad type public information plan.

Proof: See Appendix A

When productivity is minimal ($Z < \bar{Z}$), the Good type reduces its borrowing and asks for exactly the same level of borrowing as the Bad type demands in public information. In other words, the Good type mimics the Bad type. Lenders charge the now unknown type of government an interest rate q^M ,

a weighted average of the two different interest rates that they would have charged the types in the case of public information:

$$q^M(B, Z) = q^{Good}(B, Z) \times R(G, T, B) + q^{Bad}(B, Z) \times (1 - R(G, T, B)) \quad (22)$$

Reputation $R(G, T, B)$ is now what the prior lenders have about the government's being a Good type. However, in the pooling equilibrium, independently of the value of the prior:

$$q^M(B^P, Z) = q^{risk-free}$$

given both $q^{Bad}(B^P, Z)$ and $q^{Good}(B^P, Z)$ are equal to $q^{risk-free}$, as shown in section 3.1.¹³

Our pooling equilibrium is supported by out-of-equilibrium beliefs γ as the following:

14

$$\gamma(Good) = \begin{cases} 1 & \text{if } B < B^P \\ 0 & \text{otherwise} \end{cases} \quad (23)$$

These beliefs implies that if the government chooses a level of B lower than the equilibrium one, then it is perceived as Good with probability one. The beliefs also imply that if a type chooses to borrow more than the equilibrium quantity B^P , lenders attach a zero probability to its being the Good type.

Given the out-of-equilibrium beliefs, we can show that neither the Bad nor the Good type has incentives to deviate from the pooling equilibrium. No type has an incentive to choose a lower B , despite the gain in reputation. In fact, reducing the level of borrowing would only diminish utility without any benefit. Lower B implies lower G and higher T but the same interest rate, since they already borrow risk-free. At the same time, no one has an incentive to increase B . In this case, the deviating government would be rewarded with the Bad type interest rate schedule. In the previous section we showed how in this case, even the Bad government, lowers its borrowing and settles on the lower level $B^{Bad} = B^P$.

The pooling equilibrium implies that the fiscal policies of the Good and Bad type are exactly the same. Lenders are not able to identify the type in charge and $R^{Good}(G, T, B) = Prior$, $R^{Bad}(G, T, B) = Prior$. However, reputation does not matter. The level of borrowing on which both types pool implies

¹³ B^P is exactly the same level of borrowing as the Bad type chooses in public information, B^{Bad} . We showed that for this level of borrowing and for the productivity shocks we are considering, $Z < \bar{Z}$, the Bad type is charged the risk-free interest rate, because its default probability is equal to zero.

¹⁴ $\gamma(Good)$ represents the out-of-equilibrium probability that the agent making the deviation will be perceived as the Good type

a zero probability of default for both. The Good type, mimicking the Bad type, implements austerity with respect to its choices in the case of public information. Facing an unavoidable loss in reputation, austerity is the optimal response to prevent an unsustainable interest rate. The pooling equilibrium arises from the fact that the Bad government wants to exploit the private information situation, in order to improve its reputation and to borrow more. The Good government does not manage to guarantee its own reputation but responds by taking actions that make reputation non-important, i.e. reducing borrowing and spending, and increasing taxation, in order to be less dependent on the financial markets.

The following propositions analyse the properties of the pooling equilibria above.

Proposition 7.1: The pooling equilibria are resistant to the Intuitive Criterion, as developed by Cho and Kreps (1987).

Proof: See Appendix A

Proposition 7.2: Given the productivity shock, each pooling equilibrium is unique.

Digression: See Appendix A

3.2.2 Separating equilibria

For each $\bar{Z} < Z < Z^*$, the model delivers a separating equilibrium, different from the public information ones. The Good type reduces borrowing and spending and increases taxation¹⁵ as much as needed in order to send a credible signal to the markets about its discount rate. In this way lenders can identify the Good type and charge it with the interest rate schedule that reflects its true default probability. The Good type manages to maintain its reputation through its fiscal policy. The Good type restrains the minimum that is sufficient to discourage the Bad type from copying its decisions. Because it would be too costly, the Bad type does not have incentives to mimic the Good type and does not change its fiscal policy with respect to the public information case.

Proposition 8: For each $\bar{Z} < Z < Z^*$ the model generates a separating equilibrium. The Good type reduces spending and borrowing and increases taxation more than the Bad type does, in order to obtain the risk-free interest rate. The Bad type maintains its public information plan.

Proof: See Appendix A

In contrast to the pooling equilibrium, in the separating equilibrium the Good type does not settle for the Bad type's public information plan: it restricts more. The reason is the following. If the Good government chose the Bad type's public information plan, lenders would not be sure about

¹⁵With respect to the public information case.

the type they were facing and they would charge both types with the interest rate $q_1^M(B^{Bad}, Z)$, an average between the Good type's interest rate (the risk free) and the Bad type's interest rate (no longer risk-free for such productivity levels, as Proposition 5 shows). This interest rate is thus high for the Good government and low for the Bad one. The Good government, given its high discount rate, finds it profitable to reduce spending and increase taxation up to the point where the Bad government is about indifferent whether to mimic or not. At this point, the separating equilibrium, the Good government receives again the risk-free interest rate. The out-of-equilibrium beliefs that support the equilibrium are:

$$\gamma(Good) = \begin{cases} 1 & \text{if } B < B^{Good} \\ 0 & \text{if } B > B^{Good} \end{cases} \quad (24)$$

The out-of-equilibrium beliefs are similar to those in the pooling case. If lenders observe a level of borrowing lower than that of the Good type (B^{Good}), they assume the deviating agent is a Good type. If lenders observe a borrowing level higher than that of the Good type, they attach a zero probability that the agent making the deviation is the Good type.

As the equilibrium is a separating one, lenders can identify the agents and $R^{Good}(G, T, B) = 1$, $R^{Bad}(G, T, B) = 0$. The Good government maintains its reputation with respect to the public information case, but it has to pay a cost in terms of a more restrictive fiscal policy. The Bad government does not change its fiscal policy and sticks to its public information plan.

The following propositions summarize the properties of the separating equilibria. For a more detailed discussion, see Appendix A.

Proposition 8.1: The separating equilibria are resistant to the Intuitive Criterion, as developed by Cho and Kreps (1987).

Proposition 8.2: Given the productivity shock, the separating equilibria are not unique. However our separating equilibria are the unique equilibria resistant to the Intuitive Criterion.

Proof and Digression: See Appendix A

3.3 Discussion of the results

Figure 6 represents the two sets of equilibria that the model delivers in the case of private information. Very low productivity shocks ($Z < \bar{Z}$) generate the pooling equilibria. Higher productivity shocks ($\bar{Z} < Z < Z^*$) generate the separating equilibria. In the three panels of Figure 6, the red lines represent the Bad government's fiscal policy, which is the same in both the public and in the private information frameworks. The blue dotted lines represent the choices of the Good government in public information,

while the blue solid lines represent the choices of the Good government in private information. We use the difference between the fiscal policy of the Good government in the two information settings to define the magnitude of the austerity implemented¹⁶. This difference arises only for low enough productivity shocks, i.e. for $Z < Z^*$. For these shocks, the government reduces spending and increases taxation, thus implementing austerity in a recession. The private information framework generates a change in the cyclical policy of fiscal policy. With public information, the Good government consistently holds a countercyclical fiscal policy, as summarized by the borrowing policy (Figure 6, third panel). However, in the case of private information and recession, the same Good government consolidates its budget instead of expanding it, failing to provide the countercyclical response that it would otherwise have implemented. The lower the shock, the less the Good government borrows from financial markets, exactly the opposite policy to the one that the government adopts in the absence of private information issues.

It is important to highlight the intuition behind these results. Here we illustrate why fiscal austerity in recession is the optimal response of a benevolent government. Given a private information constraint, we show that fiscal austerity is the option that guarantees the lower loss for the household welfare. First, we focus on the welfare costs of fiscal austerity, in terms of lower government spending and lower private consumption. Second, we concentrate on the benefits, in terms of improved reputation and government budget.

When the Good government raises taxation and reduces spending, it reduces consumer welfare. The increase in taxation depresses consumption. Although with logarithmic utility function the optimal level of labour is constant and fiscal policy has zero impact on output, the tax hike lowers consumption through the budget constraint, as $C = \frac{Y}{(1+T)}$.¹⁷ As the household utility function is increasing in C and G , the tighter fiscal policy generates a welfare cost equal to $(\Delta W^C + \Delta W^G)$. The restrictive fiscal policy, together with this cost, generates a welfare gain, ΔW^R , related to the government reputation in financial markets. We can decompose the welfare gain into two sub-components. The first component, ΔW^S , quantifies the benefit of borrowing at a lower rate and having fewer repayments in the next period, and refers to the benefit of austerity in terms of signalling. The second component, ΔW^{GB} , quantifies the benefit of having a balanced budget. Overall, $\Delta W^R = \Delta W^{GB} + \Delta W^S$. First, we show that for all the productivity shocks $Z \leq \bar{Z}$, $\Delta W^S = 0$ and $\Delta W^R = \Delta W^{GB}$. Second, we show that for all the productivity shocks $\bar{Z} < Z < Z^*$, $\Delta W^{GB} = 0$ and $\Delta W^R = \Delta W^S$.

About the first case, we explained in the previous section that for $Z \leq \bar{Z}$, the Good government

¹⁶We look at the Good government because the Bad government implements a procyclical fiscal policy and thereby always implements austerity in a recession. Instead, we want to focus on a government that in general conducts a countercyclical policy and changes its behaviour only in certain cases.

¹⁷The optimal level of labour the household supplies is $L^* = \frac{1}{2}$

Figure 6: Equilibria in Private Information

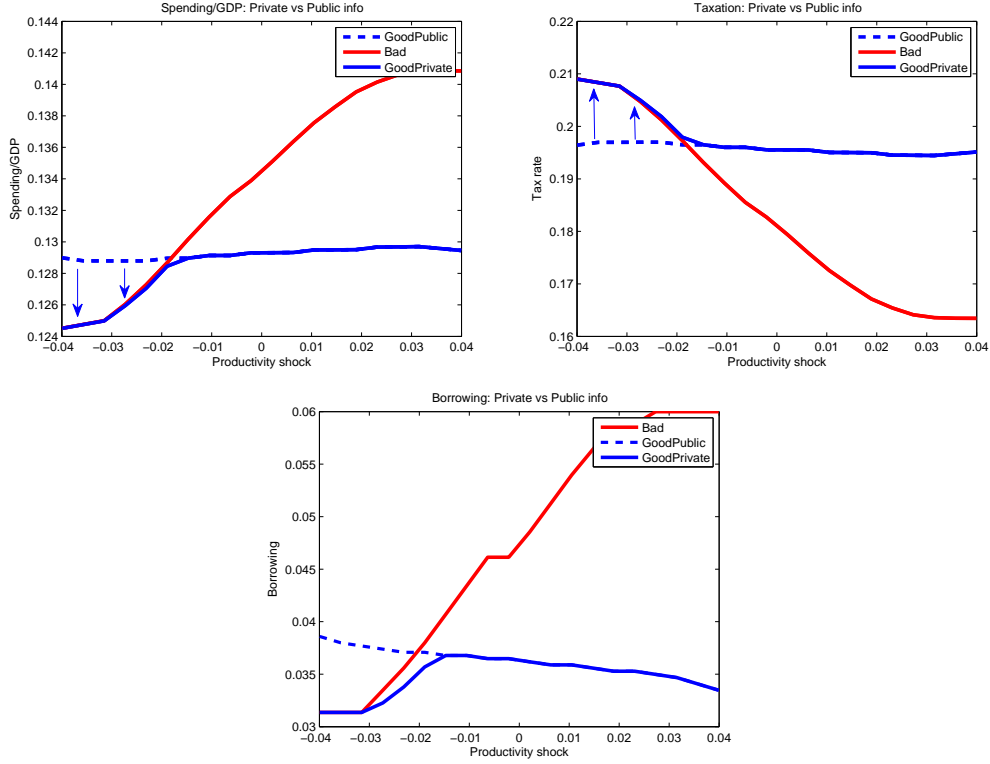


Figure 6 reports the tax, spending and borrowing policy of the Good type in public information (blue dashed line), the Good type in private information (blue solid line) and the Bad type in both information settings (red line).

reduces its borrowing and settles on a level B^P . Following Equation (23), if the government does not reduce its borrowing and asks for a borrowing $B' > B^P$, it would be charged a price $q^{Bad}(B', Z)$. Lemma A shows that, for $Z \leq \bar{Z}$ and $q = q^{Bad}$, the amount of resources raised from financial markets asking a level of borrowing $B' > B^P$ (i.e. no austerity) is lower than the amount of resources obtained asking a level of borrowing $B = B^P = B^{Bad}$ (i.e. austerity). This means that $q(B^P, Z) * B^P > q(B', Z) * B'$, despite $B^P < B'$. In other words, a level of borrowing $B' > B^P$ produces an unbalanced budget. The government does not manage to raise enough resources from financial markets, is forced to increase taxation and lower government spending, and faces high repayments in the following period. This would consequently produce a welfare cost $(\Delta W^C + \Delta W^G)$ higher than the one produced in the case of fiscal consolidation, with $B = B^P$. In this case the choice of the government to implement the austerity plan or not is very simple. The government does not even trade-off a tighter fiscal policy with lower interest rates. It simply observes its budget and realizes

that the budget and the fiscal policy are in better shape if it voluntarily asks for a lower level of borrowing. In this sense $\Delta W^S = 0$ and $\Delta W^R = \Delta W^{GB}$. For this reason we name this type of fiscal austerity a *budgetary austerity*.

However, for $\bar{Z} < Z < Z^*$, the state of the recession is not too deep and the government default probabilities are not too high. For these levels of productivity, if the government does not consolidate, the total amount of resources raised from financial markets is higher than the one obtained in the separating equilibria, $q(B^S, Z) * B^S < q(B, Z) * B$, for every $B > B^S$. This implies that $\Delta W^{GB} = 0$. However, the government implements austerity. Comparing the benefits of austerity ΔW^R with its costs ($\Delta W^C + \Delta W^G$), it prefers to reduce its borrowing today, obtaining a higher bond price $q(B^S, Z)$ through signalling and having less to repay tomorrow. In this case, $\Delta W^{GB} = 0$ and $\Delta W^R = \Delta W^S$. For this reason we name this type of fiscal austerity a *signalling austerity*.

Role of initial debt B_0

In this section we study the implications for fiscal policy of solving the model with different initial levels of debt B_0 . In the results we showed we assumed the government started with an average level of debt B_0 . Here we show the implications of starting the economy with a lower or higher level of debt. A higher initial level of debt widens the range of productivity shocks for which the two governments are engaged in the signalling game wider. The higher initial debt increases the borrowing needs of the two governments. However, the Bad government cannot appeal to financial markets to borrow, given that it is already constrained by the default probability even with a lower initial level of debt. In order to repay the inherited bond B_0 , the Bad government has to increase taxation and reduce spending even more. The Good government is instead less constrained and can resort more easily to financial markets. This fact amplifies the difference between the fiscal policy outcomes of the two types of government and generates stronger incentives for the Bad government to mimic the Good government, increasing the range of shocks that produce the signalling game. At the opposite extreme, when the initial level of debt is very low and the Bad type is less constrained, the Bad type might be allowed to borrow more than the Good type, eliminating any need for the Bad government to copy the Good government. In this case, even in the presence of private information, each of the two governments sticks to its own public information fiscal plan.

Figure 7 summarizes the effect of initial debt on the range of productivity shocks that generate the signalling game. For low levels of B_0 the two governments are not engaged in the signalling game: the presence of private information does affect fiscal policy and there is no austerity. As debt increases, the range of productivity shocks generating the signalling game increases, as represented by the black area in Figure 7. Therefore, we conclude that the initial level of debt is a very important parameter,

on which depend both the choice of implementing fiscal austerity and the magnitude of the fiscal consolidation to adopt.

Figure 7: Initial Debt B_0

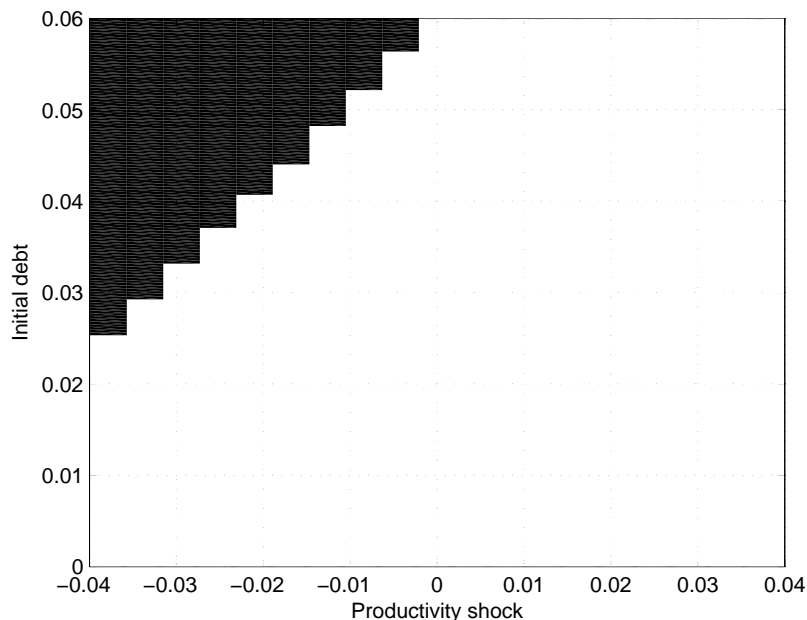


Figure 7 reports the range of productivity shocks that generate the signalling game (black area), for each possible initial level of debt B_0 .

4 Full model

Public Information

In this section we provide the full model, where the government maximizes utility over an infinite horizon. We assume, as before, that there are two types of governments (Good and Bad type), and these governments alternate in power. At the end of each period, the government in charge is replaced with probability π . The household problem is the same as the one outlined in section 2.1. The government problem, instead, is slightly different from the three period model one, as we have now to consider the effect of political turnover and to allow the government to default in every period.

The government in power takes the following decisions. At the beginning of each period, it decides whether to default or not. Subsequently, it decides the level of borrowing, taxation and public spending.

In case the government defaults, the government is subject to an output cost and to an exclusion cost. The exclusion cost makes it impossible for the government to borrow in the period of default. However, it regains access to financial markets in the following period with probability λ . The output cost follows the formulation of Arellano (2008):

$$Z^{default} = \begin{cases} \widehat{Z} & \text{if } Z \geq \widehat{Z} \\ Z & \text{if } Z < \widehat{Z} \end{cases}.$$

Let $V_i(B, Z)$ be the value function of government i , when i is in power. Let $W_i(B, Z)$ be the value function of government i , when $\neg i$ is in power. In a similar way, let $V_i^{Def}(B, Z)$ and $V_i^{\neg Def}(B, Z)$ be the value functions of defaulting and non-defaulting for government i , when i is in power. Let $W_i^{Def}(B, Z)$ and $W_i^{\neg Def}(B, Z)$ the value function of defaulting and non-defaulting for government i , when $\neg i$ is in power. The optimal borrowing, tax and spending decisions of a government that has defaulted at the beginning of the period solve the following problem:

$$\begin{aligned} V_i^{Def}(Z) = & \max_{B_i^*, G_i, T_i} U(C_i^*, 1 - L_i^*, G_i) + \\ & + \beta^i \left[\pi \left(\lambda E_t W_i(0, Z') + (1 - \lambda) E_t W_i^{Def}(Z') \right) + (1 - \pi) \left(\lambda E_t V_i(0, Z') + (1 - \lambda) E_t V_i^{Def}(Z') \right) \right] \end{aligned} \quad (25)$$

s.t.

$$\begin{aligned} G_i &= T_i C_i^* \\ Z^{default} L_i^* &= (1 + T_i) C_i^* \\ Z^{default} &= (1 + T_i) \frac{U_l^i(C_i^*, 1 - L_i^*, G_i)}{U_c^i(C_i^*, 1 - L_i^*, G_i)} \end{aligned}$$

With political turnover, the government in power takes into account that in the next period it will be replaced with probability π . In this case its utility is represented by the value function W , which does not need to coincide with the value function V , since the choices of the government $\neg i$, if in power tomorrow, might differ from the optimal choices that government i would implement, if it remained in power in the following period.

The optimal borrowing, tax and spending decision of a government that has not defaulted at the beginning of the period solves instead:

$$V_i^{\neg Def}(B, Z) = \max_{B', G, T} \left\{ U_i(C^*, 1 - L^*, G) + \beta^i [\pi E_t W(B', Z') + (1 - \pi) E_t V_i(B', Z')] \right\} \quad (26)$$

s.t.

$$G_i = T_i C_i^* + q_i(B, Z) B'_i - B$$

$$Z L_i = (1 + T_i) C_i^*$$

$$Z = (1 + T_i) \frac{U_l^i(C_i^*, 1 - L_i^*, G_i)}{U_c^i(C_i^*, 1 - L_i^*, G_i)}$$

The value function $V_i(B, Z)$ is computed as follows

$$V_i(B, Z) = \max \left\{ V_i^{Def}(B, Z), V_i^{\neg Def}(B, Z) \right\} \quad (27)$$

The optimal default decision of government i , denoted by $d_i(B, Z)$, is made comparing the value function of defaulting with the value function of not defaulting.

$$d_i(B, Z) = \begin{cases} 1 & \text{if } V_i^{Def}(B, Z) > V_i^{\neg Def}(B, Z) \\ 0 & \text{if } V_i^{Def}(B, Z) \leq V_i^{\neg Def}(B, Z) \end{cases} \quad (28)$$

The value function of government i when $\neg i$ is not in power and $\neg i$ does not default, $W_i^{\neg Def}(B, Z)$, is given by:

$$W_i^{\neg Def}(B, Z) = U_i(C_{\neg i}^*, 1 - L_{\neg i}^*, G_{\neg i}^*) + \beta^i [\pi V_i(B'_{\neg i}, Z') + (1 - \pi) W_i(B'_{\neg i}, Z')] \quad (29)$$

The value function of government i when $\neg i$ is not in power and $\neg i$ defaults, $W_i^{Def}(B, Z)$, is given by:

$$\begin{aligned}
W_i^{Def}(B, Z) = & U_i(C_{-i}^*, 1 - L_{-i}^*, G_{-i}^*) + \\
& + \beta^i \left[(1 - \pi) \left(\lambda E_t W_i(0, Z') + (1 - \lambda) E_t W_i^{Def}(Z') \right) + \pi \left(\lambda E_t V_i(0, Z') + (1 - \lambda) E_t V^{Def}(Z') \right) \right]
\end{aligned} \tag{30}$$

Finally, the value function $W_i(B, Z)$ is given by:

$$W_i(B, Z) = \begin{cases} W_i^{Def}(B, Z) & \text{if } d'_{-i} = 1 \\ W_i^{\neg Def}(B, Z) & \text{if } d'_{-i} = 0 \end{cases} \tag{31}$$

The market for lending is competitive and as in the three period model, the bond price satisfies the lenders' zero profit condition. However, lenders now consider that tomorrow the government might change with respect to the government in power today. They take this into account with the following bond price schedule:

$$q_i(B', Z) = \frac{1}{(1 + r^{risk-free})} [1 - \pi P_{-i}(B'_i, Z) - (1 - \pi) P_i(B'_i, Z)] \tag{32}$$

where $P_{-i}(B'_i, Z)$ and $P_i(B'_i, Z)$ are, respectively, the probability of default of government $-i$ and of government i , when the productivity shock is Z and government i chooses to borrow B'_i .

Finally, productivity Z evolves according to the following process:

$$\log(Z_t) = (1 - \rho)Z + \rho Z_{t-1} + \epsilon$$

with $\rho < 1$ and $\epsilon \sim N(0, \sigma_\epsilon^2)$.

Equilibrium Concept

We focus on Markov-perfect equilibria. Krussel and Smith (2003) show that typically there is a problem of indeterminacy of Markov-perfect equilibria in an infinite economy. To avoid this problem, we restrict our attention to the equilibrium arising as the limit of a finite horizon economy.

Definition In public information, a Markov-Perfect Equilibrium is characterized by:

1. A set of value functions $V_i(B, Z)$, $V_i^{Def}(Z)$, $V_i^{-Def}(B, Z)$, $W_i(B, Z)$, $W_i^{Def}(Z)$, $W_i^{-Def}(B, Z)$, for $i = Good, Bad$.
2. A set of borrowing policies $B'_i(B, Z)$, spending policies $G_i(B, Z)$, tax policies $T_i(B, Z)$, default policies $d_i(B, Z)$ for $i = Good, Bad$.
3. A bond price function $q_i(B'_i, Z)$ for $i = Good, Bad$.

such that

- $V_i(B, Z)$, $V_i^{Def}(Z)$, $V_i^{-Def}(B, Z)$, $W_i(B, Z)$, $W_i^{Def}(Z)$, $W_i^{-Def}(B, Z)$ satisfy Equations (1)-(7);
- $B'_i(B, Z)$, $G_i(B, Z)$, $T_i(B, Z)$ and $d_i(B, Z)$ solve the maximization problem specified by Equations (1)-(7);
- $q_i(B'_i, Z)$ satisfies the zero profit condition.

Private information

We introduce private information similarly to the simple three period model. We assume that financial markets do not observe the discount factor of the government in charge and therefore do not know its actual default probability. Furthermore, we assume that in each period financial markets forget about the type of government in charge in the previous period. With this assumption, the problem created by the presence of private information is static. A model of dynamic reputation in an infinite horizon framework would generate an issue of equilibria indeterminacy and goes beyond the scope of this paper.

The main difference between the public information and the private information frameworks relies on the bond price function. In the case of private information, the bond price is a function that depends on the incentives to mimic of the Bad government. The bond price is given by:

$$q^M(B', Z) = q_{Good}(B', Z) \times R(G, T, B') + q_{Bad}(B', Z) \times (1 - R(G, T, B')) \quad (33)$$

where $R(G, T, B')$ is the government reputation, which is equal to 1 if the types separate, or equal to a prior, if the types pool.

The Bad government has incentives to mimic the Good government in all the cases where:

$$V_{Bad}^{mimic}(B, Z) > V_{Bad}(B, Z)$$

with $V_{Bad}^{mimic}(B, Z)$ is defined as

$$V_{Bad}^{mimic}(B, Z) = U_{Bad}(C_{Good}^*, 1 - L_{Good}^*, G_{Good}^*) + \beta^{Bad} [\pi E_t W(B'_{Good}, Z') + (1 - \pi) E_t V_i(B'_{Good}, Z')]$$

In all the cases in which the Bad government does not have incentives to copy the Good government, $R^{Good} = 1$ and $R^{Bad} = 0$ and the two types are separated. In all the other cases, the two types are engaged in a signalling game. The equilibrium concept with private information is similar to the one described for the public information case. However, in the case of private information, beyond conditions (1) - (3), we need to define a system of out-of-equilibrium beliefs. Similarly to section 3.2 we specify the out-of-equilibrium beliefs by:

$$\gamma(B, Z) = \begin{cases} 1 & \text{if } B \leq B_{Good} \\ 0 & \text{if } B > B_{Good} \end{cases}$$

Finally, the bond price has to satisfy the zero profit condition, which is now given by equation (32) and (33).

Calibration

We assume the Good government has a discount factor $\beta^{Good} = 0.96$ whereas for the Bad government $\beta^{Bad} = 0.6$, in line with Hatchondo et al (2009). Table 2 summarizes the calibration of the parameters of the model. The risk-free interest rate is set equal to 1%. The productivity process is a discretized autoregressive process, with autoregressive parameter equal to 0.9. The relative risk aversion takes the standard value of 2. The elasticity of the labour supply, given by the parameter $\frac{1}{\Psi}$, is 2.22. We set the output cost $\hat{Z} = 0.969$, following Arellano (2008). The re-entry probability λ is set equal to

0.1. Finally, the probability of changing the government at the end of each period is set initially at 0% and to 5% later.

The production function is linear in labour, as in the three period model. The household utility function takes the following GHH form:

$$U(C, G, 1 - L) = \psi \frac{G^{1-\sigma}}{1-\sigma} + (1 - \psi) \left[\frac{\left(C - \frac{L^{1+\psi}}{1+\psi}\right)^{1-\sigma}}{1-\sigma} \right]$$

where ψ represents the share of utility derived from government consumption and σ represents the risk aversion parameter. We use a GHH formulation because it entails a very positive fiscal multiplier, as we explain below. In other words, we choose a functional form that does not favour a tightening of fiscal policy.

Table 2: Parametrization

Parameter	Symbol	Value
Discount rate Good	β^{good}	0.95
Discount rate Bad	β^{bad}	0.60
Weight in Utility	ψ	0.30
Risk-free interest rate	$r^{risk-free}$	0.01
Output Cost	\hat{Z}	0.969
Re-entry probability	λ	0.10
Risk aversion	σ	2
Elasticity of labor supply	$\frac{1}{\Psi}$	2.22
Autoregressive parameter	ρ	0.90
St. deviation shock	σ_ϵ^2	0.024
Political turnover	π	0.0, 0.05

Table 2 contains value used for the calibration of the model.

Results

The model is solved both in the case of public information and in the case of private information. The results in terms of the default set and the policy functions are reported in Appendix B (Figure 10 and 11), since they basically mirror those of the three period economy, previously presented. In this section we report the results obtained from simulating the model, both in the case of public information and in the case of private information.

We run 100 simulations of the model, each of length 1000 periods. First, we simulate the economy

assuming each government is never replaced (i.e. $\pi = 0$), in order to highlight clearly the different behaviour of the two types of government. In the robustness analysis section, we show how political turnover affects the results. Table 3 (first panel) reports, for the case of public information, the average correlation between de-trended output Y and primary balance $PB = q * B' - B$, and the correlation between de-trended output and the tax rate T , for the two types of governments.¹⁸ With public information, the Good government follows a countercyclical policy: it borrows less in expansion and more in recession, increasing taxation as the economy improves. At the opposite extreme, the Bad government behaves in a very procyclical way.

Table 3 (second panel) reports the same correlation coefficients, calculated with the assumption of private information throughout the model. The Bad government does not change its policy and the correlations are the same as in the case of public information. But, the Good government implements a very different fiscal and borrowing policy: it increases taxation and reduces borrowing in all the states in which the Bad government has incentives to mimic. This produces a change in the average cyclicity of the Good government's fiscal policy. Overall, the Good government moves from a countercyclical fiscal policy to a slightly procyclical policy. However, as Table 3 (third panel) shows, there is a stark difference in the correlations once they are calculated conditional on the economy being in an expansion (i.e. when de-trended output is positive, $Y > 0$) and when calculated conditional on the economy being in a recession ($Y < 0$). The reason for this difference relies on the incentives of the Bad government to mimic. As in the three period model, the Bad government has incentives to mimic the Good government only when the productivity shock is negative enough, since in these cases the Bad government is more constrained in borrowing than the Good government is. Given this behaviour, the Good government increases taxation and reduces borrowing, in order to avoid the rise in the interest rate that would appear if the Bad government copied its choices. This mechanism generates a procyclical behaviour in the Good government's fiscal policy in a recession. However, in an expansion, because there are no incentives to mimic from the Bad type, the Good government can follow its first best countercyclical policy.

¹⁸The variables Y , PB , T are de-trended using the Hodrick-Prescott filter, with a bandwidth equal to 1600.

Table 3: Correlation coefficients: Public and Private Information

Public Information			Private Information		
	$\rho(T, Y)$	$\rho(PB, Y)$		$\rho(T, Y)$	$\rho(PB, Y)$
Good	0.23	-0.22	Good	-0.39	0.40
Bad	-0.38	0.41	Bad	-0.38	0.41

Private Information, Good		
	$\rho(T, Y)$	$\rho(PB, Y)$
Good, when $Y > 0$	0.13	-0.14
Good, when $Y < 0$	-0.58	0.60

Table 3 reports the correlation coefficients between the tax rate and output and the correlation coefficients between the primary balance and output obtained by simulating the model. The first panel reports the results for the case of public information; the second panel, for the case of private information. The third panel reports the results for the case of private information, for the Good government alone, distinguishing when $Y > 0$ and when $Y < 0$.

We use the model simulations to highlight the aforementioned difference in the fiscal policy of the Good government, in the case of a negative shock and in the case of a positive shock. We study the behaviour of the tax rate and primary balance of the Good government around a negative shock such that the Bad government, if in power, would not default. Figure 8 reports the policy function of the Good government in the two private information settings, during 5 periods of the simulation characterized by negative productivity shocks. In public information, the Good government reacts to the negative shock by decreasing taxation and increasing borrowing. The same Good government, in the case of private information, cannot provide the first best countercyclical response. In order to avoid high interest rates, it increases taxation and decreases spending, generating a very procyclical policy.

At the opposite extreme, when the economy is hit by a series of positive productivity shocks, the difference between the response of the Good government in the two information settings disappears, as Figure 9 shows. In this case, even if financial markets cannot directly observe the discount factor of the government, markets are able to charge the appropriate interest rate schedule to each government, because the Bad type does not have incentives to copy the Good type and the two types separate.

Figure 8: Tax rate and Primary Balance around a default

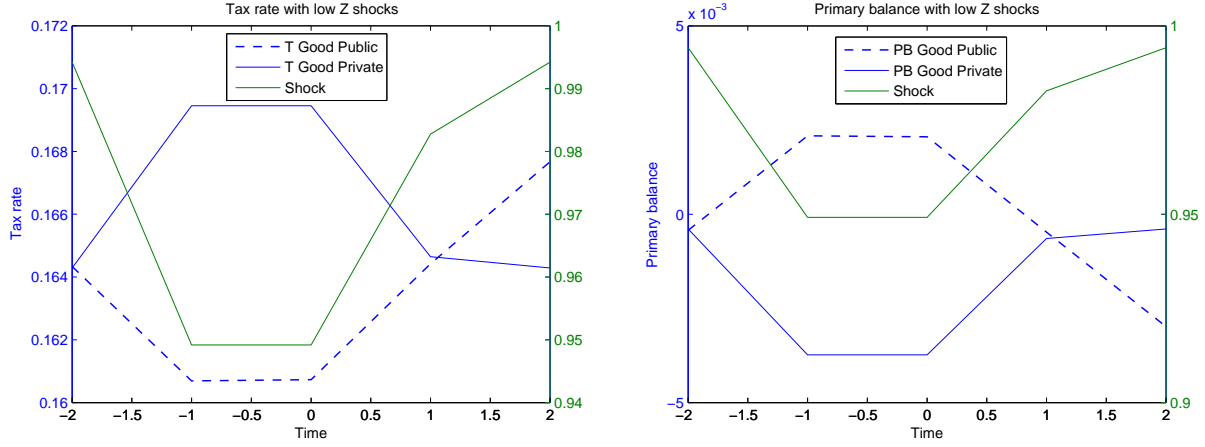


Figure 8 reports the evolution of the tax rate (left panel) and the cyclical primary balance (right panel) two periods before and two periods after a negative shock.

The Good government, independently of the information setting, follows his first best fiscal policy and, following a good shock, increases taxation and reduces borrowing.

It is important to note that the results of the three period model are valid also in the infinite period model. In particular, they remain valid although the formulation of the GHH utility function implies a very positive fiscal multiplier, as we can infer using the household FOC.¹⁹ The GHH functional form implies a labour supply function given by:

$$L^* = \left(\frac{Z}{(1+T)} \right)^{\frac{1}{\Psi}}$$

When the household faces a higher marginal tax, it reacts by optimally lowering the labor supply and thus reducing output Y . The effect of the tax on output is easily understood by looking at the first derivative of output Y with respect to the tax rate T .

$$- (1/\Psi) * (Z/(1+T))^{1+\frac{1}{\Psi}} \tag{34}$$

Equation (34) quantifies the entity of output reduction following a unitary increase in the tax rate. In principle, the effect on output depends on the productivity shocks and on the tax rate. However, the

¹⁹This condition is the same as in the three period model, since the household problem does not change.

Figure 9: Tax rate and Primary Balance with High shock

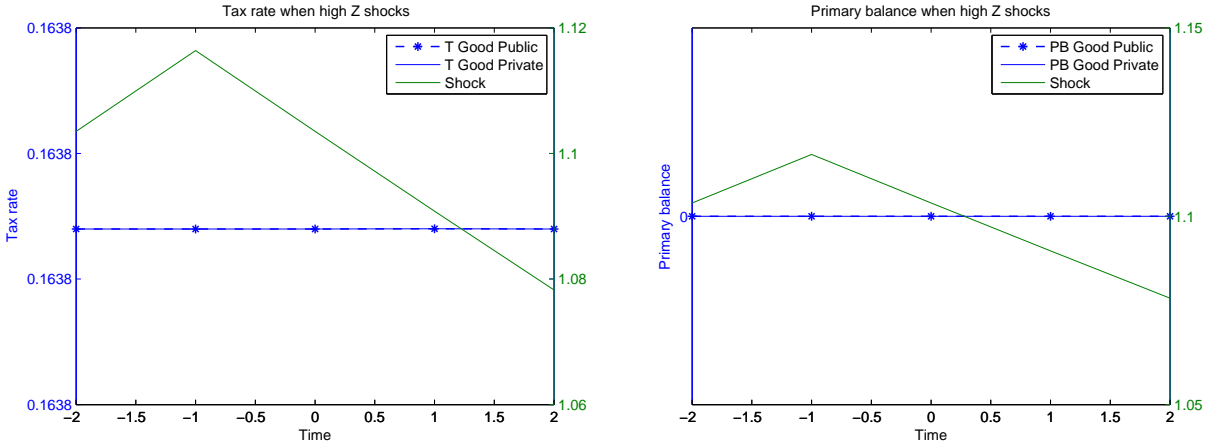


Figure 9 reports the evolution of the tax rate (left panel) and the cyclical primary balance (right panel) two periods before and two periods after a positive shock.

dependence on the productivity shock Z is minor. The tax multiplier implied by the model ranges from 1.11 when the tax rate is already high, to 2.19 when the tax rate is low. This range for the fiscal multiplier is coherent with those empirical estimates that find the highest impact of fiscal policy on output²⁰. In this sense, we are not choosing a parametrization that favours austerity in our model, since the negative impact of a tax increase in terms of output is remarkable. Nonetheless, the Good government finds optimal to tighten its fiscal policy in a recession.

4.1 Robustness

In this section we perform a robustness analysis. In particular we study the role of political turnover and the role of the degree of substitutability between private consumption and public spending. Finally we analyse the case where the tax is levied on labour instead that on consumption.

The results reported in the previous section were obtained setting the probability of a change in government (π) equal to zero. Here we show how the correlation coefficients of the simulations change when π is different from zero, in particular with $\pi = 5\%$. This value represents an unstable economy, implying an average government tenure of 5 years. Table 4 reports the corresponding results. The higher π generates an decrease in the degree of procyclicality of the Good government with private information. Following Equation (32), the interest rate schedule of the Good type is, *ceteris paribus*,

²⁰See for instance Ramey (2011), Blanchard and Leigh (2013).

higher with respect to the case where $\pi = 0\%$. For the Bad type, at the opposite extreme, it is lower. The reduced difference in the interest rate schedule of the Good and Bad type reduces the gains from mimicking for the Bad government, which has fewer incentives to copy the Good government policy. This allows the Good government to follow more closely its own countercyclical policy.

Table 4: Correlation coefficients, when $\pi = 5\%$

Public Information			Private Information		
	$\rho(T, Y)$	$\rho(PB, Y)$		$\rho(T, Y)$	$\rho(PB, Y)$
Good	0.26	-0.26	Good	-0.17	0.21
Bad	-0.37	0.40	Bad	-0.37	0.40

Private Information, Good		
	$\rho(T, Y)$	$\rho(PB, Y)$
Good, when $Y > 0$	0.18	-0.19
Good, when $Y < 0$	-0.45	0.50

Table 4 reports the same information as Table 3, calculated when $\pi = 0.05$.

Next, to study the influence of the functional form of the utility function, we consider a CES aggregation function for preferences in private consumption and public spending

$$X = \left[\delta G^{-\mu} + (1 - \delta) \left(C - \frac{L^{1+\psi}}{1 + \psi} \right)^{-\mu} \right]^{-\frac{1}{\mu}} \quad (35)$$

The utility function in this case is given by

$$U(C, 1 - L, G) = \frac{X^{1-\sigma}}{1 - \sigma} \quad (36)$$

When the parameter μ is close to -1, C and G are close to being perfect substitutes. When $\mu = 0$ we have a Cobb-Douglas aggregator, while μ towards infinity implies that private consumption and public spending are close to being perfect complements. We solve the model for values of μ equal to -0.9, 0 and 50. The results in terms of the equilibria that the model delivers are virtually identical. The only difference is in the magnitudes. As μ increases, the amount of public spending compared to private consumption increases, bringing the ratio C/G closer to 1. Table 6 in Appendix B reports the results in terms of correlation coefficients for the case of μ equal to -0.9, 0 and 50.

Finally, we consider the case where the tax T is levied on labour, instead of consumption. The budget constraint of the household is now

$$C_t = (1 - T_t)A_tL_t$$

The optimal level of labour, $L^* = ((1 - T)Z)^{\frac{1}{\psi}}$, depends in the same manner on the tax rate as in the case of the consumption tax. The derivative of output with respect to the tax rate is given by $-\frac{1}{\psi}((1 - T)Z)^{\frac{1}{\psi}-1}Z^2$ and implies very similar fiscal multipliers as in the benchmark case. The implication for fiscal policy is exactly the same, both in qualitative and quantitative terms.

5 Empirical evidence

Here we provide some empirical evidence to support the intuitions proposed in the previous section. Despite not formally testing the model, we show that the model main implications are consistent with the empirical findings. In particular, we illustrate how on average fiscal policy is procyclical in a recession characterized by high debt and uncertainty about the type of government that financial markets are lending to, meaning a period characterized by private information issues. After discussing how to identify such periods, we show that for the OECD countries in the period 1995-2009²¹, fiscal policy in this type of recession correlates positively with the cycle, as predicted by the model.

To proxy for the presence of private information in debt markets, we use the distance in time from the general elections for a newly elected government. We argue that a new government taking power, if elected for the first time, is not trusted by financial markets. We consider the first year of the mandate of this government as a period characterized by private information. In this case, the dummy $PI_{i,t}$ takes value one, otherwise zero.

In order to identify a recession, we consider a dummy $R_{i,t}$, which takes value one when the output gap is negative and zero otherwise. Finally, the dummy $HD_{i,t}$ identifies the periods characterized by high debt, defined as periods where the debt-to-GDP ratio is higher than 60%. We interact the three dummies and we create the dummy

$$D_{i,t} = PI_{i,t} * R_{i,t} * HD_{i,t}$$

which proxies a period characterized by private information, recession and high public debt. In such

²¹We do not consider the years 2010-2014, so as to be confident that our results are not driven by the fiscal policy developments of the last few years in Europe

periods the model predicts that governments will invert the cyclicity of fiscal policy and implement austerity.

To measure the cyclicity of fiscal policy we propose two approaches. The first one calculates sample correlations between the output gap and the fiscal policy indicators chosen, dividing the sample according to the dummy $D_{i,t}$. The second approach follows the methodology proposed by Alesina, Campante and Tabellini (2008) and uses regression analysis.

The two panels of Table 5 provide the correlations between the output gap and four indicators of fiscal policy: the change in the cyclically adjusted primary balance ($\Delta CAPB$), the change in budget balance (ΔGB), the ratio of primary government spending to GDP (G/Y) and the ratio of primary discretionary government spending to GDP²², (G^D/Y). Panel A calculates the correlation coefficients dividing the sample according to the dummy $D_{i,t}$. The correlations show that there is a dramatic change in the degree of cyclicity of fiscal policy, when calculated with $D_{i,t} = 1$ and with $D_{i,t} = 0$. $\Delta CAPB$ and ΔGB correlate positively with the cycle in normal times, meaning that the government follows a countercyclical fiscal policy. However, the correlations change abruptly in the case of a recession characterized by private information and high debt. The same behaviour is observed for G/Y and G^D/Y . The negative correlation of G/Y and G^D/Y with the output gap in normal times represent a countercyclical policy while the positive correlation in the recession period represent a procyclical fiscal policy. Panel B calculates the same correlations dividing the sample according to the recession dummy indicator $R_{i,t}$, without distinguishing between recessions which are characterized by private information and those which are not. The fiscal policy cyclicalities in the two states of the economy are similar to each other. This suggests that it is the joint presence of private information, recession and high debt that drives governments to change their fiscal policy behaviour, and not simply the presence of a recession.

The second approach that we propose, to measure the cyclicity of fiscal policy in different economic conditions, refers to the approach followed by Alesina, Campante and Tabellini (2008), which in turn adapt the Gavin and Perotti (1997) method. We measure the cyclicity of fiscal policy estimating the following regression:

$$\Delta F_{i,t} = \beta OutputGap_{i,t} + \alpha D_{i,t} + \Psi(OutputGap_{i,t} * D_{i,t}) + \lambda_1 F_{i,t-1} + \lambda_2 X_{i,t} + \epsilon_{i,t} \quad (37)$$

where $F_{i,t}$ is the fiscal policy indicator chosen, $OutputGap_{i,t}$ is a measure of the business cycle,

²²Discretionary government spending is calculated by subtracting all fiscal transfers and benefits in kind from government total expenditure.

Table 5: Correlations: Panel A and B

	$\rho(\Delta CAPB, Gap)$	$\rho(\Delta GB, Gap)$	$\rho(\frac{G}{Y}, Gap)$	$\rho(\frac{G^D}{Y}, Gap)$
$D_{i,t} = 1$	-0.58	-0.34	0.17	0.04
$D_{i,t} = 0$	0.13	0.15	-0.30	-0.19
$R_{i,t} = 1$	-0.10	0.07	-0.2	-0.13
$R_{i,t} = 0$	-0.15	-0.08	-0.01	-0.12

Table 5 reports the correlation coefficients between the different fiscal indicators and output. The top panel calculates these correlations dividing the sample according to the dummy variable $D_{i,t}$. The bottom panel does likewise, according to the dummy variable $R_{i,t}$.

$D_{i,t}$ is the dummy variable in question, while the term $(OutputGap_{i,t} * D_{i,t})$ represents the interaction between the output gap and the recession dummy. $X_{i,t}$ includes all the single, double and triple interaction terms.

Table 6 reports the results. Because Equation (37) involves a quadruple interaction, it is difficult to interpret the coefficients of the regressions. We report the results in terms of the average semi-elasticity of fiscal policy with respect to the output gap, for all the possible states of the economy. The semi-elasticities are calculated from the regression coefficients, adding among themselves the coefficients of the interaction terms relevant to defining each state of the economy. Once obtained, we test whether the semi-elasticities are statistically different from zero. The results show that, independently of the fiscal policy indicator chosen, governments implement a very procyclical policy in the states of the economy characterized by private information. The semi-elasticities relating to the periods with private information and high debt are all very significant and indicate a positive co-movement between fiscal policy and the economic cycle. This contrasts with the general behaviour of fiscal policy in the other cases, where governments follow mainly a countercyclical or an acyclical policy.

Table 6: Semi-elasticity of fiscal policy w.r.t. the output gap

	$\Delta CAPB$	ΔGB	G/Y	G^{discr}/Y
Private+Recession+HDebt	-0.79***	-0.8***	0.72***	0.82***
Recession	0.23	0.69	-0.88***	-0.56
HDebt	-0.56***	-0.01	-0.07	-0.05
Private	-0.07	0.11	-0.09	0.06
Private+Recession	0.53	0.53	-0.71	-0.38
Recession+HDebt	-0.26	-0.08	0.04	0.24
Private+HDebt	-0.4***	0.43***	-0.58***	-0.51***

Table 5 reports the average semi-elasticity of fiscal policy with respect to the output gap, for the different possible states of the economy. The first row captures the case when jointly there is: 1) a recession, 2) a high level of public debt, 3) the presence of private information. The remaining rows of Table 5 report the remaining combinations among cases 1) to 3).

6 Conclusions

This paper investigates why a government might want to implement an austerity programme in an economic downturn, as opposed to a countercyclical response. The question is highly topical in the light of current events and holds several policy implications. Many countries around the world have been implementing restrictive fiscal policies despite a weak economic environment. These policies have been strongly criticized, both by economists and by the general public. It is therefore important to understand a possible rationale for these choices.

We showed that, when financial markets do not have perception about the type of government they are lending to, non-myopic governments optimally implement austerity in a recession. Austerity avoids the consequences of a possible loss in reputation, which would bring about very high interest rates. In a deep recession, the government implements austerity for budgetary considerations, while in a milder recession austerity conveys a signal to financial markets about the creditworthiness of the government.

The results of the model are useful in interpreting the current fiscal policy developments around the world. There is a general consensus that the European debt crisis was triggered by a loss of confidence in the market participants towards governments, starting when Greece revealed the true state of its national accounting in February 2010. In this sense we can think of the crisis as a factor that shifted financial markets from a situation in which they were able to recognize the type of government in charge, to a situation in which there was uncertainty about the type of government markets were lending to, i.e. a situation of private information. The model provides a rationale to explain

the procyclical fiscal policies implemented by many European countries, as documented in section 1.2. Current European governments are Good types, truly countercyclical, which are experiencing a particular type of recession, characterized by private information. On the one hand, we can think of the Euro Periphery countries as those countries that experienced the most severe recession. Because the state of the recession was too deep, they did not manage to signal their good credit standing. Nonetheless, they had to implement fiscal austerity to avoid an unsustainable rise in the interest rate caused by the inevitable loss in reputation. The effect of the fiscal retrenchment on the economy has been negative, but, any alternative option would have resulted in worse outcomes. On the other hand, we can think of the UK as a country that experienced a milder recession. We can explain why the UK introduced austerity measures even if it was not hit by turbulence in the sovereign debt market. The UK government, anticipating the effect of private information, implemented fiscal austerity to send a credible signal to financial markets about its high creditworthiness. The austerity plan was adopted promptly and the UK maintained its reputation and obtained low interest rates.

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Appendix A: Proofs

Proposition 1: The default set of the Bad type includes the default set of the Good type. (i.e. $D^{Bad}(B_1) \supset D^{Good}(B_1)$).

Proof: For each type, the default decision is made comparing the value function of defaulting $V^d(0, Z_2)$ with the value function of not-defaulting $V^{nd}(B_1, Z_2)$.

$$d(B_1, Z_2) = \begin{cases} 1 & \text{if } V^{nd}(B_1, Z_2) < V^d(0, Z_2) \\ 0 & \text{if } V^{nd}(B_1, Z_2) \geq V^d(0, Z_2) \end{cases}$$

We can expand the inequality $V^d(0, Z_2) > V^{nd}(B_1, Z_2)$ as $U^2(0, Z_2) + \beta U^3(B_2, \alpha Z_3) > U^2(B_1, Z_2) + \beta U^3(B_2, Z_3)$. Re-arranging, the government defaults when

$$F(Z_2, B_2, Z_3, B_1) = U^2(0, Z_2) + \beta U^3(B_2, \alpha Z_3) - U^2(B_1, Z_2) - \beta U^3(B_2, Z_3) > 0 \quad (38)$$

Function $F(Z_2, B_2, Z_3, B_1)$ is decreasing in β . Taking the derivative of $F(Z_2, B_2, Z_3, B_1)$ w.r.t. β , $F_\beta = U^3(B_2, \alpha Z_3) - U^3(B_2, Z_3)$. Since $\alpha < 1$, $F_\beta < 0$. The lower β , the higher $V^d(0, Z_2)$, meaning that, for given B_1 and Z_2 , the impatient government has more incentives to default than the patient government. This implies that $D^{Bad}(B_1) \supset D^{Good}(B_1) \neq \emptyset$

Lemma A1: $\frac{\partial q(B_1, Z_1)}{\partial B_1} \leq 0$.

Proof: Deriving equation (38) w.r.t. B_1 , $F_{B_1} = -U_{B_1}^2(B_1, Z_2) > 0$, because the marginal utility of having higher repayment B_1 in the second period is always negative. Ceteris paribus, when B_1 increases, the benefit of defaulting increases. This means the probability of default $\frac{\partial P(B_1, Z_1)}{\partial Z_1} > 0$. As $q(B_1, Z_1) = q^{risk-free} * (1 - P(B_1, Z_1))$, we have $\frac{\partial q(B_1, Z_1)}{\partial B_1} < 0$. Only when $q(B_1, Z_1)$ is constant do we have $\frac{\partial q(B_1, Z_1)}{\partial B_1} = 0$

Proposition 2: The optimal tax policy for the Good type is an acyclical policy (i.e. $\frac{\partial T_1^*}{\partial Z_1} = 0$). The optimal tax policy for the Bad type is a countercyclical tax policy (i.e. $\frac{\partial T_1^*}{\partial Z_1} < 0$)

Proof: Using the Intra-temporal condition, we can write $G^* = \frac{\pi}{1-\pi} \frac{Z}{2(1+T^*)} \cdot \frac{\partial(\frac{G}{Y})^*}{\partial Z} = -\frac{\pi}{1-\pi} \frac{\frac{\partial T^*}{\partial Z}}{(1+T^*)}$. When $\frac{\partial(\frac{G}{Y})^*}{\partial Z} = 0$, then $\frac{\partial T^*}{\partial Z} = 0$. When $\frac{\partial(\frac{G}{Y})^*}{\partial Z} > 0$, then $\frac{\partial T^*}{\partial Z} < 0$. #

Proposition 3: The spending policy of the Good type is acyclical (i.e. $\frac{\partial(\frac{G}{Y})^*}{\partial Z} = 0$), while for the Bad type it is procyclical (i.e. $\frac{\partial(\frac{G}{Y})^*}{\partial Z} > 0$)

Proof: The optimal spending policy is found through the Inter-temporal condition (19), where $\frac{\partial l}{\partial v} = 0$ with logarithmic utility function. For the Good government, Equation (19) simplifies to $G_1^* = \frac{q^{risk-free}}{\beta E_1 \left(\frac{1}{G_2}\right)}$. When the autoregressive parameter $\rho \rightarrow 1$, we can consider approximately that $Z_1 \simeq Z_2 \simeq Z_3$. Substituting the Inter-temporal condition for the second period, $\left(\frac{G_1}{Y_1}\right)^* = \left(\frac{q^{risk-free}}{\beta}\right)^2 \frac{\pi}{1-\pi} \frac{1}{(1+T_3^*)Y_3}$. After algebraic manipulations, we can show how $\frac{\partial(\frac{G}{Y})^*}{\partial Z} \simeq 0$. For the bad government, $G_1^* = \frac{q(B_1, Z_1) + B \frac{\partial q(B_1, Z_1)}{\partial B_1}}{\beta \int_{Z \notin D(B)} \left(\frac{1}{G}\right) H(dZ'|Z)}$. Given that for the Bad government an improvement in the productivity state increase G not only through the resource constraint, but also through a relaxation in the borrowing constraint, we can argue that G^{Bad} increases faster than G^{Good} . As for the Good government $\frac{\partial(\frac{G}{Y})^*}{\partial Z} \simeq 0$, and $Y^{Bad} = Y^{Good}$ (with logarithmic utility function $L^* = \frac{1}{2}$), this implies that $\frac{\partial(\frac{G}{Y})_{Bad}^*}{\partial Z} > 0$ #

Proposition 4: The borrowing policy of the Good type is countercyclical (i.e. $\frac{\partial q^*(B_1, Z_1) B_1^*}{\partial Z_1} < 0$), the borrowing policy of the Bad type is procyclical (i.e. $\frac{\partial q^*(B_1, Z_1) B_1^*}{\partial Z_1} > 0$)

Proof: From (16) we obtain: $q(B, Z)B = G_1 + B_0 - TC$. $\frac{\partial B^* q(B, Z)}{\partial Z} = -\left(\frac{T+T^2+Z\frac{\partial T}{\partial Z}}{2(1+T)^2}\right) + \frac{\partial G_1}{\partial Z_1}$. For the Good government, as $\frac{\partial T^*}{\partial Z} = 0$, we have that $\frac{\partial B^* q(B, Z)}{\partial Z} < 0$ when $\frac{\partial G_1}{\partial Z_1}$ is sufficiently small. For the Bad government, $\frac{\partial B^* q(B, Z)}{\partial Z} > 0$ when $\frac{T}{1+T} \frac{1}{2} - \frac{\partial G_1}{\partial Z_1}$ is sufficiently small. #

Proposition 5: For the Good government, for every Z , $q^{*Good} = q^{risk-free}$. For the Bad government, for $Z < \bar{Z}$, $q^{*Bad} = q^{risk-free}$. For $Z > \bar{Z}$, $q^{*Bad} < q^{risk-free}$. \bar{Z} is the productivity shock identified by Lemma A.

Proof: See Lemma A.

Lemma A: \bar{Z} is the highest productivity shock that satisfies the following condition:

$$\lim_{B \rightarrow \bar{B}^+} \frac{\partial [q^{Bad}(B, Z) * B]}{\partial B} \leq 0 \quad (39)$$

Proof: $\lim_{B \rightarrow \bar{B}^+} \frac{\partial [q^{Bad}(B, Z) * B]}{\partial B} = \lim_{B \rightarrow \bar{B}^+} \frac{1}{1+r} \left([1 - P^{Bad}(B, Z)] - \frac{\partial P^{Bad}(B, Z)}{\partial B} B \right)$. For $Z \rightarrow -\infty$ $P(B, Z) \rightarrow 1$ and $\frac{\partial P(B, Z)}{\partial B} B$ is a positive number, implying on the one hand that

$\lim_{B \rightarrow \bar{B}^+} \frac{1}{1+r} \left(\left[1 - P^{Bad}(B, Z) \right] - \frac{\partial P^{Bad}(B, Z)}{\partial B} B \right) \leq 0$. On the other hand, for $Z \rightarrow +\infty$ $P^{Bad}(B, Z) \rightarrow 0$ and $\frac{\partial P^{Bad}(B, Z)}{\partial B} B < 1$, implying that $\lim_{B \rightarrow \bar{B}^+} \frac{1}{1+r} \left(\left[1 - P^{Bad}(B, Z) \right] - \frac{\partial P^{Bad}(B, Z)}{\partial B} B \right) > 0$. Indeed, there exists a Z low enough to satisfy condition (39). We call \bar{Z} the highest Z that satisfies this condition. Every $Z < \bar{Z}$ satisfies condition (39) as well, as $\lim_{B \rightarrow \bar{B}^+} P(B, Z)$ and $\lim_{B \rightarrow \bar{B}^+} \frac{\partial P(B, Z)}{\partial B}$ are decreasing in Z . #

Lemma B: For each level of borrowing B there is a univocal correspondent level of spending G and a level of taxation T . Furthermore, $\frac{\partial(q(B_1, Z_1)B)}{\partial B} > 0 \Leftrightarrow \frac{\partial T}{\partial B} < 0 \Leftrightarrow \frac{\partial G}{\partial B} > 0$.

Proof: B , G and T are determined by Equations (19), (6) and (16). For a given $q * B$, the corresponding level of the tax rate T is the solution of the following equation: $\left[\frac{T_t Z_t}{2(1+T_t)} - \left(\frac{\pi}{1-\pi} \right) \frac{Z_t}{2(1+T_t)} \right] + q(B, Z)B - B_0 = 0^{23}$. The corresponding level of government spending is then found from the government budget constraint $G_1 = T_1 C_1^* + q(B_1, Z_1)B - B_0$. Using the implicit function theorem, $\frac{\partial T}{\partial B} = -\frac{F_T}{F_B} = -\frac{Z_t}{2 \frac{\partial(q(B_1, Z_1)B)}{\partial B}}$. If $\frac{\partial(q(B_1, Z_1)B)}{\partial B} > 0$, it implies that $\frac{\partial T}{\partial B} < 0$. Substituting in the budget constraint this implies that $\frac{\partial G}{\partial B} = -\frac{\pi}{1-\pi} \frac{Z \frac{\partial T}{\partial B}}{2(1+T)^2}$ and therefore $\frac{\partial G}{\partial B} > 0$. #

Proposition 6: With private information, the Bad government can choose to mimic the Good government. For all the states (B_0, Z_1) where $G_1^{*bad} < G_1^{*good}$ ²⁴, the value function of mimicking $V^{Bad}(mimic)$ is greater than the value function of non-mimicking $V^{Bad}(\neg mimic)$. However, when $G_1^{*bad} > G_1^{*good}$, $V^{Bad}(mimic) < V^{Bad}(\neg mimic)$. We call Z^* the productivity shock such that for $Z > Z^*$ we have $G_1^{bad} > G_1^{good}$ and for $Z < Z^*$ $G_1^{bad} < G_1^{good}$.

Proof: We provide the formal proof for $\beta^{bad} = 0$. Given this assumption, the value function V coincides with the per-period utility U . For $Z < Z^*$ by construction we have that $T_1^{good} < T_1^{bad}$, $G_1^{good} > G_1^{bad}$ and $q^{*bad} B_1^{*bad} < q^{*good} B_1^{*good}$. As U is increasing in G and decreasing in T , we have that $U^{Bad}(mimic) > U^{Bad}(\neg mimic)$. For $Z > Z^*$, the opposite holds and $U^{Bad}(mimic) < U^{Bad}(\neg mimic)$. #

Proposition 6.1: There always exists a productivity state Z^* such that, for $Z < Z^*$ $G_1^{Bad} < G_1^{Good}$ and for $Z > Z^*$, $G_1^{Bad} > G_1^{Good}$.

²³The equation is found by combining Equations (6) and (16)

²⁴By lemma B, $G_1^{*bad} < G_1^{*good}$ implies that $T_1^{*bad} > T_1^{*good}$, $q^{*bad} B_1^{*bad} < q^{*good} B_1^{*good}$

Proof: By assumption, $G_1^{*Good} = \frac{q^{risk-free}}{\beta^{Good} E_1\left(\frac{1}{G_2}\right)}$, while $G_1^{Bad*} = \frac{q(B_1, Z_1) + B \frac{\partial q(B_1, Z_1)}{\partial B_1}}{\beta^{Bad} E_1\left(\frac{1}{G_2}\right)}$. When Z is very negative, $G^{Bad} \sim 0$ while $G^{Good} > 0$, with $G^{Good} > G^{Bad}$. When Z is very positive, $G_1^{*Bad} = \frac{q^{risk-free}}{\beta^{Bad} E_1\left(\frac{1}{G_2}\right)}$, with $G_1^{*Bad} < G_1^{*Good}$, as $\beta^{Bad} < \beta^{Good}$. #

Proposition 7: Pooling Equilibrium. For $Z \leq \bar{Z}$ the model generates a set of pooling equilibria. The two types pool on a level of spending $G^P = G^{Bad}$, tax rate $T^P = T^{Bad}$ and borrowing $B^P = B^{Bad}$. The pooling interest rate $q(B^P, Z)$ is equal to $q^{risk-free}$. \bar{Z} is the productivity shock identified by Lemma A.

Proof: Because of Lemma A, since $B^P \leq \bar{B}$, then $q(B^P, Z) = q^{risk-free}$. We prove that for each $Z \leq \bar{Z}$ there are no incentives to choose either a lower or a higher level of borrowing than the pooling equilibrium level, for both types. For a given $Z < \bar{Z}$, take $B' < B^P$. For Proposition A, as $B' < B^P$, the interest rate $q(B', Z) = q^{risk-free}$. According to Lemma B, given a constant q , for each B' there corresponds a certain T' and G' , with $T' > T^P$ and $G' < G^P$. As utility U^i is increasing in G and decreasing in T , for $i = Good, Bad$ $U^i(B', T', G') < U^i(B^P, T^P, G^P)$, given that $T' > T^P$, $G' < G^P$ and $q(B', Z) = q(B^P, Z)$. Thereby there are no incentives to choose $B' < B^P$, for both types. Take $B'' > B^P$. Because of 23 $q(B'', Z) = q^{BAD}(B'', Z)$. We have that $B'' > B^P = B^{BAD}$, $G'' > G^P = G^{BAD}$, $T'' < T^P = T^{BAD}$, where $B^{BAD}, G^{BAD}, T^{BAD}$ are the optimal levels of borrowing, spending and taxation in public information. As $B^{BAD}, G^{BAD}, T^{BAD}$ are the solutions of the maximization problem (15) – (18), by construction $U^{BAD}(B'', T'', G'') < U^{BAD}(B^{BAD}, T^{BAD}, G^{BAD})$. This also implies that $U^{GOOD}(B'', T'', G'') < U^{GOOD}(B^{BAD}, T^{BAD}, G^{BAD})$. Thereby, there are no incentives to choose $B'' > B^P$, for both types. #

Proposition 7.1: The pooling equilibrium is resistant to the Intuitive Criterion, as developed by Cho and Kreps (1987)

Proof: Testing that the pooling B^P is resistant to the Intuitive Criterion requires the following. Suppose $\exists \hat{B}$ s.t. Good type, deviating to \hat{B} is perceived as Good with probability 1. If $U^{Good}(\hat{B}) > U^{Good}(B^P)$ and if \exists a belief for the Bad type s.t if the Bad type deviates towards \hat{B} then $U^{Bad}(\hat{B}) > U^{Bad}(B^P)$, then B^P survives the Intuitive criterion, in the case the previous holds for every possible \hat{B} .

Suppose that $\hat{B} < B^P$. The Good type, choosing a $\hat{B} < B^P$, does not increase its utility, because the interest rate does not change and U is increasing in B . There is no profitable deviation for the

Good type in the first place. Suppose $\hat{B} > B^P$. Deviating to a $\hat{B} > B^P$ the Good type, perceived as Good with probability one, increases its utility, but so does the Bad type for beliefs γ close to 1. Because of the lower discount factor, the Bad type increases its utility even more than the Good type when it deviates toward a higher level of borrowing. In this case there is a profitable deviation for the Good type, but at the same time there are beliefs for the Bad type that allow both types (not only the Good type) to strictly increase their utility. This shows that the pooling equilibrium does not fail the Intuitive Criterion.

Proposition 7.2: Given the productivity shock, each pooling equilibrium is unique.

Digression: In the pooling equilibrium region, there cannot be no separating equilibrium, nor a different pooling equilibrium where both types pool on a different level of borrowing.

A separating equilibrium in which the Good type borrows more than the Bad type cannot exist, because the Bad would want to deviate and follow the Good type. There cannot be a separating equilibrium in which the Good type borrows less than the Bad type, which instead sticks to its public information plan. In fact, the Good type would find it profitable to increase its borrowing up to the Bad type's level, because it derives no benefits from reduced borrowing. Furthermore, there cannot be a pooling equilibrium on a different level of borrowing. If both types pool below B^P they can increase utility deviating to a higher B because, despite the beliefs, they would still borrow in the risk-free region. They cannot pool above B^P because the Good type would receive a higher interest rate than the risk-free one and it would prefer, given the out-of-equilibrium beliefs, to reduce borrowing by ϵ and reach the risk-free interest rate.

Proposition 8: Separating equilibrium. For $\bar{Z} < Z < Z^*$ the model generates a set of separating equilibria. The Good type chooses a level of borrowing B^S , a level of taxation T^S and a level of spending G^S . It obtains the risk-free interest rate. The Bad type chooses its public information plan, B^{Bad} , T^{Bad} and G^{Bad} and obtains the corresponding public information interest rate $q(B^{Bad}, Z)$, with $q(B^{Bad}, Z) < q^{risk-free}$.

Proof: We prove that for $\bar{Z} < Z < Z^*$ there are no incentives to deviate from the separating equilibrium. For a given Z , suppose a type deviates towards $B'' > B^S$. According to (24) the deviating agent is perceived as Bad with probability 1 and is charged the Bad type's public information schedule $q^{Bad}(B'', Z)$. For the Bad type, because B^{Bad} , G^{Bad} , T^{Bad} derive from the public information maximization problem, $U^{Bad}(B'', T'', G'') < U^{Bad}(B^{Bad}, T^{Bad}, G^{Bad})$. For the Good type, since by construction $U^{Good}(B^{Bad}, T^{Bad}, G^{Bad}) < U^{Good}(B^S, T^S, G^S)$, we have that $U^{Good}(B^S, T^S, G^S) > U^{Good}(B'', T'', G'')$. Hence, there are no profitable deviations towards $B'' > B^S$ for both types.

Now suppose the Good type deviates towards $B' < B^S$. As $q(B', Z) = q(B^S, Z) = q^{risk-free}$ because of (24), Lemma B implies $T' > T^S$ and $G' < G^S$. Thereby $U^{Good}(B', T', G') < U^{Good}(B^S, T^S, G^S)$. For the Bad type, since by construction $U^{Bad}(B^S, T^S, G^S) \leq U^{Bad}(B^{Bad}, T^{Bad}, G^{Bad})$, we have that $U^{Bad}(B', T', G') < U^{Bad}(B^S, T^S, G^S) \leq U^{Bad}(B^{Bad}, T^{Bad}, G^{Bad})$. Thus there are no profitable deviations towards $B' < B^S$, for either type. Finally, suppose that the Bad type deviates towards $B'' = B^S$, obtaining the risk-free interest rate. The two different β of the two types imply a **single crossing condition** (see below), meaning that for the Good type it is less costly to reduce the level of borrowing. This guarantees that there exists a B^S low enough to make $U^{Bad}(B^S, T^S, G^S) \leq U^{Bad}(B^{Bad}, T^{Bad}, G^{Bad})$ and $U^{Good}(B^S, T^S, G^S) > U^{Good}(B^{Bad}, T^{Bad}, G^{Bad})$. #

Single crossing condition. Ceteris paribus, the Bad type prefers higher spending and higher borrowing (and lower taxation) than the Good type. This implies that reducing borrowing is more costly for the Bad type than as it is for the Good type.

Proof: Consider the Inter-temporal condition $U_g(q + b' \frac{dq^i}{db'}) = \beta^i (1 - P^i) EU_{g(+1)}$, for $i = Good, Bad$. Re-arranging: $U_g^i = \frac{\beta^i (1 - P^i) EU_{g(+1)}^i}{(q + b' \frac{dq^i}{db'})}$. If they receive the same same interest rate, it means that the probability of default $P^{Good} = P^{Bad}$ and $(q + b' \frac{dq^i}{db'})$ is equal for the two types. Therefore, the difference between U_g^{Good} and U_g^{Bad} depends only on β^i , for a given $EU_{g(+1)}^i$. This implies that higher β determines higher U_g , which in turn generates a lower optimal G , since U_g is declining in G . Ceteris paribus, the Good type prefers lower spending in the first period, while the Bad type prefers higher spending. Using Lemma B, higher spending corresponds to higher borrowing and lower taxation. This implies that for the Bad type it is more costly to reduce its level borrowing than as it is for the Good type, since the Bad type values more borrowing and spending.

Proposition 8.1: The pooling equilibrium is resistant to the Intuitive Criterion, as developed by Cho and Kreps (1987)

Proof: In a similar way to Proposition 2.1, if the Good type chooses $\hat{B} < B^S$, it does not increase its utility, because the interest rate does not change and U is increasing in B . There is no profitable deviation for the Good type in the first place. Suppose $\hat{B} > B^S$. Deviating to $\hat{B} > B^P$ the Good type, perceived as Good with probability one, increases its utility, but so does the Bad type for beliefs γ equal to 1.

Proposition 8.2: Given the productivity shock, each separating equilibrium is not unique. A strategy that prescripts the Bad type to follow its public information plan, and the Good type to

reduce borrowing less than the level B^S identified by Proposition 3 is also a separating equilibrium, using out-of equilibrium beliefs as in 24. However these equilibria are not resistant to the Intuitive Criterion.

Digression: In the region $\bar{Z} < Z < Z^*$ there are other separating equilibria, different from B^S , in which the Bad type always follows its public information plan and the Good type chooses a lower level of borrowing than B^S . However, these equilibria are not resistant to the Intuitive Criterion. In fact, if we apply the reasoning of the Intuitive Criterion we can show that there are beliefs for which only the Good type would increase its utility by deviating from this new type of equilibrium, failing the Intuitive Criterion.

We can also argue that in the region $\bar{Z} < Z < Z^*$ the types cannot pool on the Bad type plan, because the Good type would find optimal to reduce the level of borrowing by ϵ and obtain a lower interest rate. There cannot be a pooling above the Bad type plan, because both would want to deviate. There cannot be a separating equilibrium where the Bad borrows more than its Public information plan, because such a level is the outcome of the maximization problem in public information. Hence, any higher level of borrowing obtained with the public information schedule for the interest rate, is less preferred by the Bad type. There cannot be a separating equilibrium where the Good type borrows more than the Bad type, otherwise the Bad type would try to mimic.

Appendix B:

Table 7: Parameters in the Three Periods Model

Parameter	Symbol	Value
Discount rate Good	β^{good}	0.95
Discount rate Bad	β^{bad}	0.60
Weight in Utility	ψ	0.30
Risk-free interest rate	$r^{risk-free}$	0.01
Output Cost	α	0.917
Risk aversion	σ	1
Elasticity of labor supply	$\frac{1}{\Psi}$	2.22
Autoregressive parameter	ρ	0.90

Table 7 reports calibration used to solve numerically the three-period model.

Figure 10: Full model: Default set

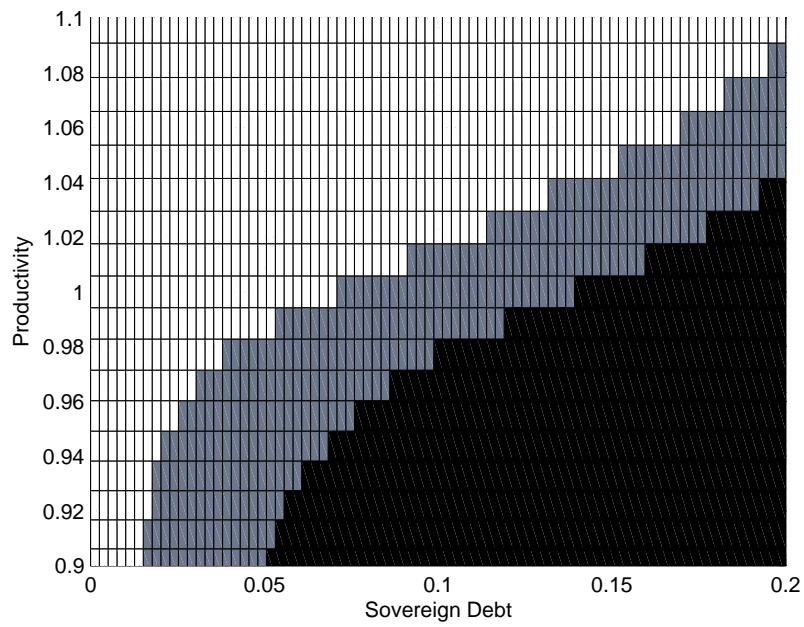


Table 3 reports the default set for the two types. The black area represents the combination of bond holding and productivity states such that both governments default. The black area represents the area where no government defaults. The grey area represents the combination of bond holding and productivity states such that only the Bad government defaults.

Figure 11: Full model: T,G,B policies for the two types, conditional on no-default

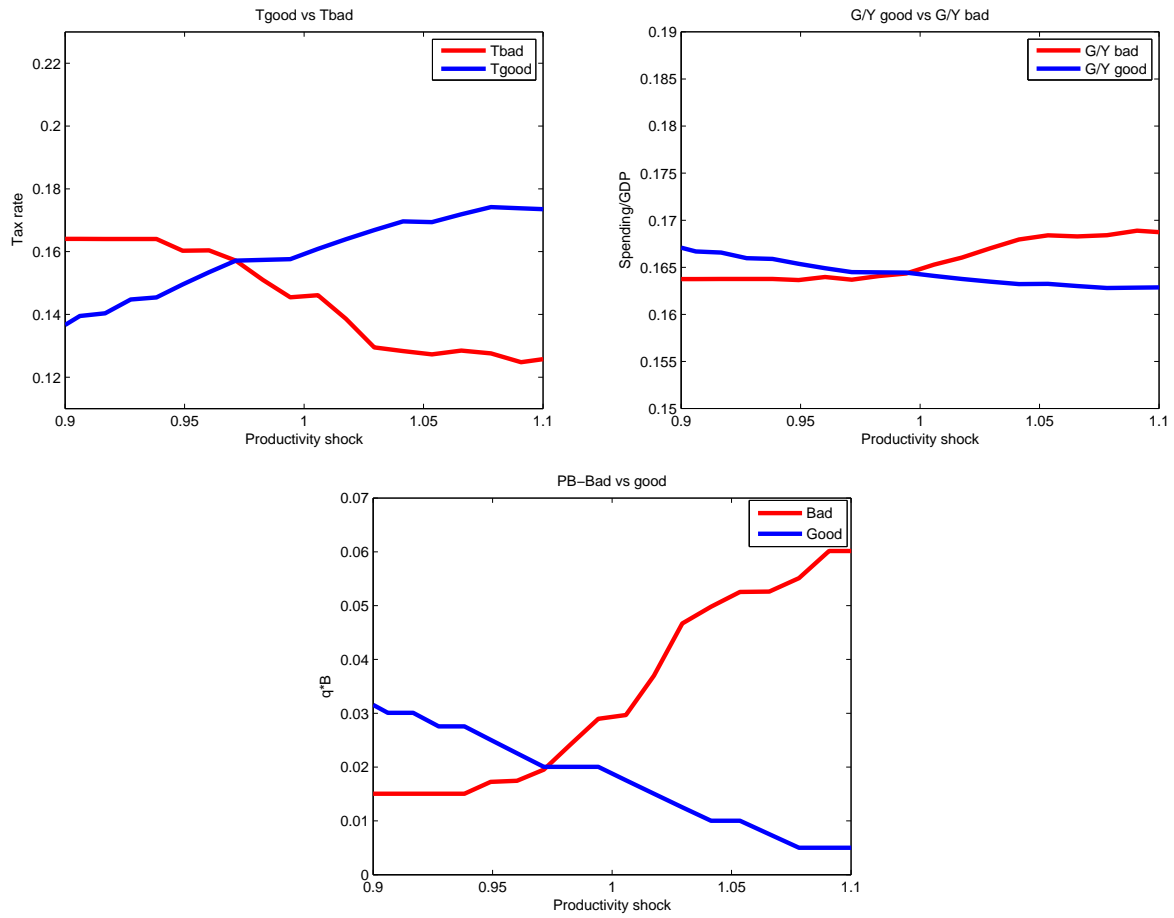


Figure 11 reports the policy functions of the two types, conditional on not defaulting at the beginning of the period. The first panel represents the tax policy, the second panel the spending policy, the third panel the primary balance policy.

Table 8: Correlation for $\mu = -0.9$ and $\mu = 50$

Public Information			Private Information		
	$\rho(T, Y)$	$\rho(PB, Y)$		$\rho(T, Y)$	$\rho(PB, Y)$
Good	0.24	-0.22	Good	-0.40	0.40
Bad	-0.38	0.41	Bad	-0.38	0.41

Private Information, Good		
	$\rho(T, Y)$	$\rho(PB, Y)$
Good, when $Y > 0$	0.12	-0.14
Good, when $Y < 0$	-0.58	0.60

Public Information			Private Information		
	$\rho(T, Y)$	$\rho(PB, Y)$		$\rho(T, Y)$	$\rho(PB, Y)$
Good	0.21	-0.21	Good	-0.35	0.36
Bad	-0.37	0.39	Bad	-0.37	0.39

Private Information, Good		
	$\rho(T, Y)$	$\rho(PB, Y)$
Good, when $Y > 0$	0.11	-0.13
Good, when $Y < 0$	-0.56	0.59

Table 6 reports the same results as Table 3. However, in this case the utility function used to solve the model is given by Equations (35) and (36). The parameter μ is set equal to 0.9 (top panel), while $\mu = 50$ (bottom panel).

Appendix C: Data

The following is a description of the data used for Section 5.

The countries considered in the empirical analysis are: Australia, Austria, Belgium Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, the United States. The data are annual and span from 1995 to 2013.

In order to measure political turnover we use the “Database of Political Institutions 2012”, by P.

Keefer. The data for the output gap are taken from the OECD Economic Outlook No 93, June 2013. The data on debt ratios are taken from the OECD database: the nominal debt of each country is divided by the nominal GDP, in order to obtain the Debt-to-GDP ratio. The government spending ratio (discretionary and non-discretionary) and the government budget balance are obtained from the OECD database. The government spending ratio is obtained by dividing total nominal government expenditures by nominal GDP. The discretionary government spending ratio is obtained by subtracting from total expenditure the total transfers in kind, and dividing this difference by the nominal GDP. Finally, we use the “Underlying government primary balance, as a percentage of potential GDP” in the OECD database, to measure the cyclically adjusted primary balance.