Rotten Parents and Disciplined Children: A Politico-Economic Theory of Public Expenditure and Debt.*

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Abstract

This paper proposes a politico-economic theory of debt and government expenditure. Agents have preferences over a private and a government-provided public good, financed through labor taxation. Subsequent generations of voters choose taxation, government expenditure and debt accumulation through repeated elections. Debt raises a conflict of interest between young and old voters as well as between current and future generations. We characterize the Markov Perfect Equilibrium of the dynamic voting game. If taxes do not distort labor supply, the economy progressively depletes its resources through debt accumulation, leaving future generations "enslaved". However, if tax distortions are sufficiently large, the economy converges to a stationary debt level which is bounded away from the endogenous debt limit. The current fiscal policy is disciplined by the concern of young voters for the ability of future government toprovide public goods. The steady-state and dynamics of debt depend on the voters' taste for public consumption. As such taste increases, the economy accumulates less debt.

We test the predictions of the theory in the presence of political shocks affecting the taste for public consumption. Government debt should be mean reverting and should increase more under right-wing governments. Data from the US and from a panel of 21 OECD countries confirm these theoretical predictions.

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Keywords: Government debt, Fiscal policy, Fiscal discipline, Intergenerational conflict, Left- and right-wing governments, Markov equilibrium, Political economy, Repeated voting.

*PRELIMINARY AND INCOMPLETE. The discussion of the related literature and the list of references are especially preliminary. We would like to thank Andreas Müller for research assistance.

1 Introduction

There are large differences in fiscal policies and government debt across countries and across time. In countries like Belgium, Greece, Italy and Japan, the debt-GDP ratios have exceeded 100% for most recent years, while on the opposite tail of the distribution, those of Australia, Ireland, Korea and Norway have been less than 30%.[1] Within countries, budgetary policies are subject to major political conflict, and different governments appear to pursue very diverse debt policies. For instance, under the republican administrations of Reagan and Bush senior, the debt-GDP ratio in the US grew uninterruptedly from 26% to 49%. Clinton's administrations reversed this trend, and brought the ratio down to 35%. Thereafter, the debt has been again rising under George W. Bush. Despite the strong public interest in these controversial changes in US fiscal policy, we still have a limited theoretical understanding of the politico-economic forces determining public debt.

Public debt breaks the link between taxation and expenditure, allowing governments to shift the fiscal burden to future generations. In a world where Ricardian equivalence does not hold, this raises a conflict of interest between current and future generations. As future generations are naturally under-represented in democratic decision making, there is a politico-economic force pushing towards debt accumulation. A fundamental question is, then: what prevents the current generations from passing the entire bill for current spending to the future generations?

Financial markets could be part of the explanation; markets must believe that government liabilities will be honored, and public debt may increase local interest rates. Yet, debt remains significantly below levels threatening solvency in industrialized countries. Moreover, despite the large cross-country heterogeneity in debt-GDP ratios, interest rates respond little to the size of debt.[2] In this paper, we abstract from effects working through changes in interest rates, and explore a complementary explanation, focusing on the dynamic game between successive generations of voters who care about public good provision. We construct a theory where fiscal policy is set through repeated elections, so that current governments cannot bind future governments' choice of taxation, debt, and public-good provision. The theory shows that

[1] When including their pension trust fund, the Norwegian government has a net financial wealth (negative debt) of about 130% of GDP.

[2] For instance, the interest rate is almost uniform within the Euro area, although the debt ratios are very different across member countries. In the same vein, Japan has been the OECD country with the highest debt-to-GDP ratio and the lowest interest rate in the last decade.

the inter-generational political conflict combined with lack of commitment can endogenously discipline fiscal policy, even in a world where agents have no concern for future generations. The extent of this discipline depends on the intensity of voters' and governments' preference over public good provision. This variation provides empirical predictions that we test.

To describe the theoretical mechanism, we model a small open economy populated by two-period-lived agents who work when young and consume a private and a government-provided public good both periods of life. The government can issue debt up to the natural borrowing constraint and is committed to repay it. Every period agents vote on public-good provision, distortive labor taxation, and debt accumulation. The intergenerational conflict plays out as follows. The old voters wish to maximize current public good consumption, and thus support the maximum attainable deficit. Young voters, however, are more averse to debt, because they care about both current and future public good provision. In particular, they anticipate that future governments inheriting a large debt will cut spending on public goods. The political process, represented as a probabilistic-voting model a la Lindbeck and Weibull (1987), generates a compromise between these two desired policies.

The forward-looking behavior of the young is key. When voting on debt policy today, they think strategically about how the debt left to the future generation affects tomorrow's political incentives for public-good provision. A large inherited debt can trigger three different adjustments: higher taxes, lower expenditure, and further debt expansion. The more future governments respond by cutting expenditure, the stronger discipline the young voters will impose on today's fiscal policy. Conversely, the more future governments are prepared to increase taxes, the less disciplined today's fiscal policy. Thus, the expectations about future governments' response to inherited debt determine the political support for current debt accumulation. We embed such expectations into a dynamic-voting Markov-perfect equilibrium where the strategies of current voters can be conditioned only on pay-off-relevant state variables. In our model, the only such state variable is the debt level, which greatly simplifies the analysis. Along the equilibrium path, the conduct of future governments depends crucially on the extent of tax distortions. Intuitively, the more distortionary future taxation, the less future governments will be tempted to increase taxes, and the more instead they will cut public good provision in response to a larger inherited debt. Therefore, the fiscal discipline becomes stronger as taxes become more distortionary, i.e., the more concave is the Laffer curve.[3]

[3] International tax competition provides a simple example. Suppose that at some level of taxation, labor supply became infinitely elastic due to international tax competition. Then, future governments could not increase taxes beyond that level, and any marginal adjustment to a larger debt must be in the form of a reduction in expenditure. This strengthens the fiscal discipline as the tax competition kicks in.

We show that, in the absence of labor supply distortions, the economy would deplete its resources through a progressive debt accumulation. In the long run, future generations are "enslaved", i.e., they are forced to work to service the outstanding debt, while their consumption, both private and public, tends to zero. Instead, if tax distortions are sufficiently large, the economy converges to an "interior" debt level which is bounded away from the endogenous debt limit. In this steady-state, both private consumption and public good provision are positive. In other words, tax distortions provide future generations with a credible threat that prevents fiscal abuse by their rotten parents.[4]

This endogenous discipline hinges on the lack of commitment. In fact, in a Ramsey problem when the first generation of voters can commit the entire future fiscal policy, debt is systematically larger than under repeated voting.[5] This shows an interesting property of our theory. On the one hand, the lack of commitment reduces the welfare of the first generation of voters compared with the Ramsey allocation. On the other hand, future generations are better off in the political equilibrium than under Ramsey. In this sense, our time inconsistency has a *benign* nature; it redistributes resources from earlier to later generations.[6]

Our political equilibrium features a determinate debt level. We show that an unexpected fiscal shock, such as a war, will be financed partly by a short-term increase in debt, and partly by an increase in taxation and a reduction in (non-military) public-good provision. When the war is finished, debt, taxes, and public goods revert back smoothly to their steady state levels. This prediction contrasts with the tax-smoothing implication of Barro (1979). He shows that if the distortionary costs of taxation are convex, governments should use debt to absorb fiscal shocks, and spread the tax burden evenly over future periods. Thus, debt should not be mean-reverting; after the war, there is no reason to reduce debt unless new shocks occur. Interestingly, the same result holds in our model under commitment. The data support the prediction of our politico-economic theory. Bohn (1998) shows that a short-lived increase in US government expenditures implies an increase in debt with a subsequent reversion in debt. In our empirical section we show that this stylized fact holds up for a panel data set of OECD countries. Moreover, as noted by Barro (1986), non-military spending is crowded out during wars in the US– exactly as our model predicts.

[4] The point that, in the presence of commitment problems, government expenditure may be higher when the tax base is more elastic echoes the analysis of Krusell, Quadrini and Rios-Rull (1997).

[5] Since the political outcome is always influenced by the forward-looking young voters, such fiscal discipline is a persistent force in the model.

[6] In standard formulations, the planner only attaches a positive weight to the welfare of the first generations, while future generations enter the planner's preferences indirectly through the altruism of the first generation. For an exception, see Farhi and Werning (2005) where the planner attaches a positive weight on the welfare of all generations, resulting in an effective social discount factors exceeding the private one.

A testable prediction of our theory concerns the response of fiscal policy to political shocks. We introduce cohort-specific preference shocks affecting the agents' taste for public goods. Our theory predicts that an increase in the appreciation for public consumption will strengthen fiscal discipline, inducing an increase in taxation and a reduction in debt. In order to identify such preference shifts empirically, we follow Persson and Svensson (1989), and assume that governments differ in their weights on public good provision: left-wing (right-wing) governments care more (less) for public goods. In other words, young right-wing voters are less concerned with future public-good provision, so their fiscal discipline is weaker than that of left-wing voters. Changes in the political color of governments are then associated with changes in fiscal policy regime: right-wing governments should run larger deficits and accumulate more debt, in spite of no difference in intergenerational altruism between left-wing and right-wing voters.

We test these predictions using both US time series and OECD panel data. The results confirm the prediction of our theory. For instance, in the US we find that a shift from a democrat president to a republican one induces an increase in the debt-output ratio of between 1.7% and 2% per year. These results are statistically significant and robust to a number of control variables. The long-run effects are sizable. According to our estimates, an infinite sequence of republican presidents would imply a 2.7 times larger debt-output ratio than a sequence of democrat presidents (15% versus 41%). Similar results obtain in a panel of 21 OECD countries. We estimate a regression including country and time fixed effects, and a number of control variables. We use various alternative measures of the political orientation of governments, and find that right-wing governments accumulate significantly more debt than left-wing governments, although the quantitative effects are smaller than for the US.

Our paper contributes to a broad literature on the politico-economic determinants of government debt. The most related contributions are the strategic-use-of-debt literature. Two important forebears are Persson and Svensson (1989)**??** and Alesina and Tabellini (1990), who were among the first to emphasize political conflict as a driving factor for public debt (see also the discussion above). Different from us, these papers focus on two-period models without any inter-generational conflict. They therefore miss the dynamic game between generations, which in our model gives rise to fiscal discipline and limits the debt accumulation.

Our paper is also related to a growing politico-economic literature on time-consistent dynamic fiscal policy, where heterogeneous agents vote repeatedly on redistribution and taxation, see e.g. Krusell, Quadrini and Ríos-Rull (1996)**?**, Krusell and Ríos-Rull (1999)**?**, Hassler, Rodríguez-Mora, Storesletten and Zilibotti (2003)**?**, Hassler, Krusell, Storesletten and Zilibotti (2005)**?**, Song (2005a, 2005b), and Azzimonti Renzo (2005)**?**. A common feature of these papers is that government deficits and debt are ruled out. One exception is Krusell, Martin and Ríos-Rull (2005)**?**, who investigate debt policies in a representative-agent Lucas-Stokey model without commitment. They find that the time-consistent policy resembles closely the time-inconsistent Ramsey plan where the debt is used to manipulate the interest rate.

Future pension liabilities are a form of government debt. Several authors have examined the poltical economy of pensions. The paper most closely related to ours is Tabellini (1990), who argues that pensions are driven by a coalition between young poor voters who want redistribution and retirees who want transfers. A large literature focus on the politico-economic forces that would create and sustain the pension system.[7] We have abstracted from such repudiation of debt, and emphasize instead on the intergenerational conflict of timing of public-good consumption and taxation.

Our paper is not the only one predicting autoregressive debt dynamics following a fiscal shock. In particular, Ayiagari, Marcet, Seppälä, and Sargent (2002) find that with commitment and non-contingent debt, government debt should be stationary, albeit with a high persistence. The reason is the same as why individual wealth is stationary in an Aiyagari-Huggett economy.[8] We view our paper as complementary to Ayiagari et al. (2002), emphasizing a quite different mechanism for mean reversion of debt.

A number of papers have investigated the *empirical* determinants of government deficits and government debt. As discussed above, Barro (1986) and Bohn (1998) examine the debt response to fiscal shocks in the US, and we extend this analysis to a panel of OECD countries. Several authors have tested the implications of the strategic debt models, albeit with mixed success. For example, Lambertini (2003) find little support in OECD panel data, while Pettersson-Lidbom (2003) find significant support for the Persson-Svensson model in data on Swedish municipalities. Our theoretical predictions are somewhat different from Persson and Svensson (1989) and Alesina and Tabellini (1990), and we find it interesting that the panel data give robust support to our theoretical implications.

The paper is organized as follows. In section 2 we describe the model environment and derive the Generalized Euler Equation which is key to the characterization of the political

[7] For example, in Chen and Song (2005)**?** and Gonzalez Eiras and Niepelt (2004)**?** show that the pension system can be sustained as a Markov equilibrium where young voters stick to a pension system in order to lower aggregate savings and thereby increase the interest rate. Other authors focus on explanations based on implicit contracts between generations, i.e., history-dependent (trigger) strategies in infinite-horizon games (see e.g. Cooley and Soares, 1999, and references therein).**?**

[8] In these economies agents have a precautionary savings motive due to stochastic income. Wealth is bounded below by a borrowing constraint. Due to the equilibrium interest rate being smaller than the discount rate and that the absolute risk aversion is falling in consumption, the intertemporal incentive to reduce wealth will dominate when wealth becomes sufficiently large. Therefore, individual wealth will be stationary if the income process is stationary.

equilibrium. Section 3 provides two examples that admit an analytical solution. Section 4 analyzes the general case. Section 5 and 6 discuss, respectively, fiscal and political shocks. Section 7 discusses some empirical evidence, and section 8 concludes.

2 Model Economy

The model economy is populated by overlapping generations of two-period lived agents who work in the first period and live off their savings in the second period. The population size is constant. Agents consume two goods: a private good (c) and a public good (g) which is provided by the government.

Private goods can be produced via two technologies – market and household production. Market production is subject to constant returns, and agents earn an hourly wage w. The household production technology is represented by the following production function;

$$y_H = F(h - h_M), \ F'(\cdot) > 0, \ F''(\cdot) \leq 0,$$

where h is the total individual time endowment, h_M is the market labor supply, and $h - h_M \geq 0$ is the household activity. Since the government cannot tax household production, taxation distorts the time agents work in the market. Agents choose the allocation of their time so as to maximize total labor income, denoted by $A(\tau)$;

$$A(\tau) = \max_{h_M} \{(1-\tau) w h_M + F(h - h_M)\}. \tag{1}$$

This program defines the optimal market labor supply as a function of the tax rate, τ;

$$h_M = h_M(\tau), \ h_M'(\cdot) \leq 0. \tag{2}$$

Consider the preferences of a young agent in dynasty i, born in period t;

$$U_{Y,i,t} = \log(c_{Y,i,t}) + \theta \log(g_t) + \beta (\log(c_{O,i,t+1}) + \theta \log(g_{t+1}) + \lambda U_{Y,i,t+1}), \tag{3}$$

where the subscript Y and O stand for "young" and "old", respectively. β is the discount rate, θ is a parameter describing the intensity of preferences for public good consumption, and λ is the altruistic weight on the utility of the agent's child (denoted by $U_{Y,i,t+1}$). In the rest of the paper, we omit time and dynasty subscripts when there is no source of confusion.

We assume throughout that λ is insufficiently large to induce private bequests. This implies that the Ricardian equivalence does not hold, and that there exists an inter-generational conflict about the timing of taxation and public debt policy. Given labor supply $h_M(\tau)$, agents choose private consumption to maximize utility, (3), subject to their lifetime budget constraint;

$$c_{Y,i} + c_{O,i}/R = A(\tau), \tag{4}$$

where R is the gross interest rate, and τ is the tax rate prevailing in the first period of the agent's life. This yields

$$c_{Y,i} = c_Y = \frac{A(\tau)}{1+\beta},\ c_{O,i} = c_O = \frac{\beta R A(\tau)}{1+\beta}. \tag{5}$$

Fiscal policy is determined period by period through repeated elections. We model electoral competition as a two-candidate political model of probabilistic voting à la Lindbeck and Weibull (1987),**?** which is extensively discussed in Persson and Tabellini (2000)**?**. In this model, agents cast their votes on one of two office-seeking candidates. Voters' preferences may differ not only over fiscal policy, but also over some policy dimensions that are orthogonal to fiscal policy and about which the candidates cannot make binding commitments. In a probabilistic voting equilibrium, both candidates propose the same fiscal policy, which turns out to maximize a weighted sum of individual utilities. The weights are the same for all agents of a given age but may differ between young and old agents. Thus, the equilibrium policy maximizes a "political objective function" that is a weighted average utility for all voters.

Given an inherited debt b, the elected government chooses the tax rate ($\tau \in [0,1]$), the public good provision ($g \geq 0$) and the debt accumulation (b'), subject to the following dynamic budget constraint[9]

$$b' = g + Rb - \tau w h_M(\tau). \tag{6}$$

Both private agents and governments have access to an international capital market providing borrowing and lending at the gross interest rate $R > 1$. The government is committed to not repudiate the debt. This implies that debt cannot exceed the present discounted value of the maximum tax revenue that can be collected;

$$b \leq \frac{\max_\tau \{\tau w h_M(\tau)\}}{R-1} \equiv \bar{b}, \tag{7}$$

where $\bar{b}$ denotes the endogenous debt ceiling. This constraint rules out government Ponzi schemes.

Since agents vote twice in their life, the first step to characterize the political equilibrium is to compute the indirect utility of young and old agents. In the case of the young, substituting (1) and (5) into (8) yields:

$$U_Y(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}) = (1+\beta)\log\left(\frac{(1+\beta R)A(\tau)}{1+\beta}\right) + \theta\log(g) + \beta\left(\theta\log(g') + \lambda U_Y(\boldsymbol{b}', \boldsymbol{\tau}', \boldsymbol{g}')\right), \tag{8}$$

[9] Hereafter, we switch to a recursive notation with primes denoting next-period variables.

where the primes denote next period's variables and boldface variables are vectors, defined as follows:

$$\boldsymbol{x} = \begin{bmatrix} x \\ x' \\ x'' \\ \dots \end{bmatrix} = \begin{bmatrix} x \\ \boldsymbol{x}' \end{bmatrix}.$$

Similarly, the indirect utility of old voters is given by[10]

$$U_O(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}) = \log\left(\frac{(1+\beta R) A(1-\tau_{-1})}{1+\beta}\right) + \theta \log(g) + \lambda U_Y(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}), \tag{9}$$

where τ_{-1} denotes the tax rate in the period when the current old were young. Note that the old care about their children who are alive with them, so the children's utility, U_Y, is not discounted.

The equilibrium of a probabilistic voting model can be represented as the choice over time of τ, g and $b\prime$ maximizing a weighted average indirect utility of young and old households, given b. We denote the weights of the old and young as ω and $1-\omega$, respectively. Then the "political objective function" which is maximized by both political candidates is

$$U(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}) = (1-\omega) U_Y(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}) + \omega U_O(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g}), \tag{10}$$

subject to (6) and (7).

2.1 The commitment solution

We will now show that the equilibrium fiscal policy is in general not time consistent. The source of time inconsistency is, to the best of our knowledge, novel. It stems from the fact that each agent votes more than once and can influence the fiscal policy choice at different stages of life.[11] We start by characterizing the policies that would be chosen by the first generation of voters if they could commit the entire future path of fiscal policy.

We consider, first, a special case in which there is no time inconsistency. Suppose that the first generation of old agents can dictate its preferred policy ($\omega = 1$). Using equations (8)-(9), the problem admits the following recursive formulation;

$$V_O^{comm}(b) = \max_{\{\tau, g, b'\}} v(\tau, g) + \beta \lambda V_O(b') \tag{11}$$

subject to (6) and (7), where

$$v(\tau, g) \equiv (1+\lambda) \theta \log g + (1+\beta) \lambda \log A(\tau) \tag{12}$$

[10] With some abuse of notation, we write $U_O(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g})$ instead of $U_O(\boldsymbol{b}, \tau_{-1}, \tau, \boldsymbol{g})$ since τ_{-1} is not relevant for the political choice, due to the focus on Markov equilibrium and because prefereces are separable.

[11] For instance... (DISCUSS LUCAS-STOKEY AND THE LITERATURE ON CAPITAL TAXATION).

is the flow utility accruing to the initially old agents from the current public and private consumption, either directly or through their altruism for their children.

This is a standard recursive program whose solution is unique and independent of whether the entire sequence is dictated by the initial generation of old agents or is chosen sequentially through elections where only the old participate. To solve the program, note that the intratemporal first-order condition linking g and τ in problem (12) is;[12]

$$\frac{1+\beta}{\left(1+\frac{1}{\lambda}\right)\theta} g = A(\tau)(1-e(\tau)), \tag{13}$$

where $e(\tau) \equiv -(\partial h_M(\tau)/d\tau)(\tau/h_M(\tau))$ is the elasticity of labor supply. The intertemporal first-order condition leads to a standard Euler equation for public consumption;

$$\frac{g'}{g} = \beta\lambda R. \tag{14}$$

If $\beta\lambda R = 1$, the solution is stationary, so debt, taxes, and consumption remain constant at their initial levels. Moreover, an unexpected temporary fiscal shock (e.g., a war) would trigger a permanent increase of debt, financed by a constant stream of future taxes, as in Barro (1979).

Next, we generalize the commitment solution to the case where the policy maximizes the weighted average discounted utility of all agents who are alive in the initial period, with $\omega < 1$ being the weight of the initial young. In this case, a standard recursive formulation does not exist. However, the program admits a two-stage recursive formulation formalized in the following lemma;

Lemma 1 *The commitment problem admits a two-stage recursive formulation where;*

(i) In the initial period, policies are such that

$$\{\tau_0, g_0, b_1\} = \arg\max_{\{\tau_0, g_0, b_1\}} v(\tau, g) - (1-\psi\lambda)\theta\log g + \beta\lambda V_O^{comm}(b_1),$$

subject to (6) and (7), where the function $V_O(.)$ is given by (11), and the constant ψ is

$$\psi \equiv \frac{\omega}{1-\omega(1-\lambda)} \in \left(0, \frac{1}{\lambda}\right).$$

(ii) After the first period, the problem is equivalent to (11).

[12] The first-order condtions with respect to τ and g are;

$$\begin{aligned} \frac{(1+\beta)\lambda}{A(\tau)} \frac{\frac{\partial A(\tau)}{\partial \tau}}{\left(wh_M(\tau) + \tau w \frac{\partial h_M(\tau)}{\partial \tau}\right)} &= -\beta\lambda \hat{V}_O'(b'), \\ -\frac{(1+\lambda)\theta}{g} &= -\beta\lambda \hat{V}_O'(b'), \end{aligned}$$

These equations, plus the fact that $A'(\tau) = -wh(\tau)$, lead to (13).

Proof in the Appendix.

Lemma 1 implies that the first-period policy is different from the policy rule in the subsequent periods. Thus, the commitment solution is time inconsistent, except in the particular case when $\omega = 1$.[13] However, aside from the differences in the first period, the commitment solution features the tax-smoothing property of Barro (1979). In particular, equation (14) governs the government expenditure dynamics from the second period onwards. Whether debt increases, decreases or remains constant over time depends only on the term $\beta\lambda R$.

Proposition 1 *The "commitment" solution is such that (i) if $\beta\lambda R < 1$, then $\lim_{t\to\infty} b_t = \bar{b}$, (ii) If $\beta\lambda R > 1$, then $\lim_{t\to\infty} b_t = -\infty$, (iii) if $\beta\lambda R = 1$, $b_{t+1} = b_t$ for $t \geq 1$.*

2.2 The political equilibrium

We now characterize the political equilibrium without commitment. This is the main contribution of our paper. In general, a dynamic game between successive generations of voters arises, and the set of equilibria is potentially large. We restrict attention to Markov-perfect equilibria where agents condition their choices on only pay-off-relevant state variables. In principle, consecutive periods are linked by two state variables: the government debt, b, and the private wealth of the old. However, since preferences are separable between private and public goods consumption, the wealth of the old does not affect their preference over fiscal policies.[14] Therefore, b is the only pay-off-relevant state variable. Our Markov equilibria thus feature policy rules as functions of b only.

Definition 2 *A (Markov perfect) political equilibrium is defined as a 3-tuple of functions $\langle B, G, T\rangle$, where $B : (-\infty, \bar{b}] \to (-\infty, \bar{b}]$ is a debt rule, $b' = B(b)$, $G : (-\infty, \bar{b}] \to R^+$ is a government expenditure rule, $g = G(b)$ and $T : (-\infty, \bar{b}] \to [0,1]$ is a tax rule, such that the following functional equations hold:*

1. *$\langle B(b), G(b), T(b)\rangle = \arg\max_{\{b'\leq\bar{b}, g\geq 0, \tau\in[0,1]\}} U(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g})$, subject to (6) and (7), where*

$$\boldsymbol{\tau} = \begin{bmatrix} \tau \\ T(b') \\ T(B(b')) \\ T(B(B(b'))) \\ \cdots \end{bmatrix}, \boldsymbol{g} = \begin{bmatrix} g \\ G(b') \\ G(B(b')) \\ G(B(B(b'))) \\ \cdots \end{bmatrix} \text{ and } \boldsymbol{b} = \begin{bmatrix} b \\ b' \\ B(b') \\ B(B(b')) \\ \cdots \end{bmatrix}$$

   and $U(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{g})$ is defined as in (10).

[13] When $\omega = 1$, then $\lambda\psi = 1$ and there is no difference between the first-period policy and the continuation policy rule.

[14] Recall that taxes are only levied on labor income and that the old do not work.

2. $B(b) = G(b) + Rb - T(b) \cdot h_M(T(b)$.

In words, the government chooses the current fiscal policy (taxation, expenditure and debt accumulation) subject to the budget constraint, and under the expectation that future fiscal policies will follow the equilibrium policies rules, $\langle B(b), G(b), T(b)\rangle$. Furthermore, the vector of policy functions must be a fixed point of the system of functional equations in part 1 and 2 of the definition, where part 2 requires the equilibrium policy to be consistent with the resource constraint.

The following Lemma (proof in the appendix) is a useful step to characterize the Markov equilibrium.

Lemma 2 *The first functional equation in Definition 2 admits the following two-stage recursive formulation:*

$$\langle B(b), G(b), T(b)\rangle = \arg \max_{\left\{b' \leq \bar{b}, g \geq 0, \tau \in [0,1]\right\}} \left\{v(\tau, g) - (1 - \psi\lambda)\,\theta \log g + \beta\lambda V_O\left(b'\right)\right\}, \qquad (15)$$

where $v(.)$ *is defined as in (12), subject to (6) and (7), and where* V_O *satisfies the following functional equation;*

$$V_O\left(b'\right) = v\left(T\left(b'\right), G\left(b'\right)\right) + \beta\lambda V_O\left(B\left(b'\right)\right). \qquad (16)$$

The difference between the commitment solution and the political equilibrium can be seen by comparing the expressions of V_O^{comm} in (11) and that of V_O in (16). In the political equilibrium, the first generation of voters cannot choose the entire future policy sequence, but take the mapping from the state variable into the (future) policy choices as given. For this reason, there is no max operator in the definition of V_O. However, the two programs are identical when $\omega = 1$ (only the old vote), as in this case fiscal policy is time consistent.

What is the source of time inconsistency? When $\omega < 1$, the young, who care directly (i.e., not only through their altruism) about next-period public expenditure, want more public savings than the old. Hence, the young want more fiscal discipline than their parents. In the commitment solution, the effect of the conflict between "rotten parents" and "disciplined children" is limited to the first-period fiscal policy. Since the altruistic preferences of the initial parents and children are aligned, they agree on the continuation fiscal policy rule from the second period onwards. In contrast, the conflict is persistent in the political equilibrium, as a new generation of young voters enters the stage in each election. Since the young want more fiscal discipline, the political equilibrium features, as we shall see, less debt accumulation.

We characterize the political equilibrium as follows. First, the intratemporal first-order condition linking g and τ in problem (15) is;

$$\frac{1+\beta}{(1+\psi)\,\theta}g = A(\tau)\,(1-e(\tau))\,. \tag{17}$$

The only difference between (17) and (13) in the commitment solution lies in the denominator of the term on the left-hand side, where λ^{-1} is replaced by ψ.

Next, applying standard recursive methods to the first-order conditions of (15)-(16), together with (17), leads to the following generalized Euler equation (GEE) describing the equilibrium dynamics of public good provision;

$$\frac{G(B(b))}{G(b)} = \beta\lambda R - \underbrace{\beta\lambda G'(B(b))\left(\frac{1+\lambda^{-1}}{1+\psi}-1\right)}_{\text{the disciplining effect}}. \tag{18}$$

This is a key equation to characterize the political equilibrium. Compare equation (18) with its counterpart in the commitment solution, (14). The "disciplining" effect is absent in the commitment solution. When all power lies in the hands of the old ($\omega = 1$), the two GEEs coincide, since in this case $\psi = \lambda^{-1}$ and the disciplining effect is also absent in the political equilibrium.

As we showed above, in the commitment solution the dynamics of government expenditure are linear. In contrast, the GEE in the political equilibrium imply that the dynamics of g (and, hence, of b) may be non-linear. Nevertheless, it is still possible that the GEE admits a linear equilibrium solution. In the next section, we study a particular case where the political equilibrium is linear and can be fully characterized analytically.

Some additional properties can be inferred from the GEE. Suppose that a steady-state debt level b^* exists. Since, in steady state, $G(B(b^*)) = G(b^*)$, then

$$G'(b^*) = -\frac{(1+\psi)(1-\beta\lambda R)}{\beta(1-\lambda\psi)} \equiv \zeta < 0, \tag{19}$$

which is constant and independent of the value of b^*. Thus, in the neighborhood of any steady state $G'(.)$ is negative; higher debt is associated with lower public spending. Plugging in $G'(b^*)$ into (18) shows that in the neighborhood of b^*, the growth rate of public spending is higher than it would be under commitment. The difference is proportional to ζ. In addition, if an interior steady state ($b^* < \bar{b}$) exists and b converges monotonically to b^* in a neighborhood of b^*, then $G(b)$ must be concave around b^*.[15]

[15] Intuitively, when debt is above (below) the steady state, the fiscal dicipline must be stronger (laxer) in order to reduce (increase) public consumption and move debt back towards steady state.

3 Two Analytical Examples

In the rest of the paper we parameterize the household production technology as follows:

$$F(1-h_M) = X(h-h_M)^{\xi},$$

where $\xi \in ([0,1]$ and we assume that $X < w$. In this section we study two special cases that we can solve analytically. In the first case, we set $\xi = 0$, implying that agents cannot substitute market hours with household activity. Due to the logarithmic preferences, labor taxation does not distort labor supply. We will see that in this case, a linear equilibrium exists, and the dynamics of debt resemble qualitatively the commitment solution. In the second case, we set $\xi = 1$. This implies that market hours are supplied inelastically as long as $\tau \leq \bar{\tau} \equiv 1 - X/w$. However, if taxation exceeds $\bar{\tau}$, market hours and tax revenue fall to zero. In this case, the equilibrium expenditure function G is concave, and a stable interior steady state with positive public good provision may exist.

3.1 Example I: $\xi = 0$

With $\xi = 0$, market hours are equal to h, irrespective of taxes. Hence, $A(\tau) = (1-\tau)wh$ and $e(\tau) = 0$. Furthermore, tax revenue is maximized as $\tau \to 1$, so the maximum debt is $\bar{b} = wh/(R-1)$. The FOC (17) can be expressed as

$$1-\tau = \frac{1+\beta}{(1+\psi)\theta wh} g. \tag{20}$$

Substituting (20) into the government budget constraint (6) yields;

$$b' = \left(1 + \frac{1+\beta}{\theta(1+\psi)}\right) g + Rb - wh. \tag{21}$$

To obtain a solution, we guess that G is linear; $G(b) = \gamma\left(\bar{b} - b\right)$. Then, the GEE, (18), yields:

$$\frac{\gamma\left(\bar{b} - B(b)\right)}{\gamma\left(\bar{b} - b\right)} = \beta\lambda R - \beta\lambda\gamma\left(\frac{1+\lambda^{-1}}{1+\psi} - 1\right). \tag{22}$$

Next, using (22), the budget constraint, (21), the equilibrium condition $b' = B(b)$, and the expression for $\bar{b}$ given above, yields the following solution for γ;

$$\gamma = \frac{(1-\beta\lambda)\theta(1+\psi)R}{(1+\theta)(1+\beta) + (1-\beta\lambda)\theta\psi}.$$

The formal argument for the concavity of G is as follows. Consider a small perturbation of debt from the steady state; $\tilde{b} = b^* + \varepsilon$, $\varepsilon > 0$. The monotone convergence implies that $B\left(\tilde{b}\right) \in \left(b^*, \tilde{b}\right)$. Due to the negative slope of $G(b)$ around b^*, $G\left(B\left(\tilde{b}\right)\right) > G\left(\tilde{b}\right)$, which implies that $G'\left(B\left(\tilde{b}\right)\right) < \zeta$ according to (18). Since $B\left(\tilde{b}\right) > b^*$, this establishes that $G'(b) < \zeta$ for $b > b^*$. A similar argument establishes that $G'(b) > \zeta$ for $b > b^*$, by letting $\varepsilon < 0$. So, $G(b)$ must be concave around b^*.

Finally, substituting g by its equilibrium expression, $g = \gamma \left(\bar{b} - b\right)$, into (20) and (21), yields a complete analytical characterization, summarized in the following Proposition (proof in the text).[16]

Proposition 3 *Assume that $\xi = 0$. Then, the time-consistent equilibrium is given by the following policy functions*

$$\tau = T(b) = 1 - \frac{1}{wh} \frac{(1-\beta\lambda)(1+\beta)R}{(1+\theta)(1+\beta) + (1-\beta\lambda)\theta\psi} \left(\bar{b} - b\right), \tag{23}$$

$$g = G(b) = \frac{(1-\beta\lambda)\theta(1+\psi)R}{(1+\theta)(1+\beta) + (1-\beta\lambda)\theta\psi} \left(\bar{b} - b\right), \tag{24}$$

$$b' = B(b) = \bar{b} - \frac{\theta + \lambda(1+\beta+\theta)}{(1+\theta)(1+\beta) + (1-\beta\lambda)\theta\psi} \beta R \left(\bar{b} - b\right), \tag{25}$$

where $\bar{b} \equiv wh/(R-1)$.

Note that $G'(.) = -\gamma < 0$, implying that the disciplining effect in (18) increases the growth rate of public spending, as discussed above. Due to the linearity of $G(.)$, however, the disciplining effect does not change with the debt level. For this reason, the dynamics cannot lead to a stable interior steady state. If the interest rate is sufficiently low, the economy converges asymptotically to the maximum debt level $\bar{b}$. Else, the government surplus will be ever increasing and the economy will accumulate foreign assets.

The slope of the debt function $B(b)$ is always steeper in the political equilibrium than under commitment, so that debt accumulation is slower in the political equilibrium. In fact, there exists a range of parameters such that, under commitment, the economy would accumulate debt till the maximum level ($b \to \bar{b}$), while the political equilibrium leads to an ever-growing surplus ($b \to -\infty$). This illustrates that future generations benefit from political empowerment.

Figure 1 illustrates a political equilibrium when debt converges to $\bar{b}$. Panel a shows that the equilibrium tax rate increases linearly with debt. Panel b shows that the equilibrium public-good provision declines linearly with debt. Finally, Panel c shows the law of motion of debt converging to $\bar{b}$.

FIGURE 1 (THREE PANELS) HERE

In this example, the economy depletes its resources over time. Generation after generation, agents find their private and public consumption progressively crowded out by debt repayment

[16] The results of Proposition 3 extend to economies with population growth and technical change. Details are available upon request.

to foreign lenders. This occurs gradually, even in a model without altruism ($\lambda = 0$). Under commitment and no altruism, debt converges to $\bar{b}$ in only two periods. In contrast, the political equilibrium features

$$\bar{b} - b' = \bar{b} - B(b) = \frac{\theta}{(1+\theta)(1+\beta) + \theta\psi}\beta R(\bar{b} - b),$$

where $\psi = \omega/(1-\omega)$. In spite of the lack of concern for future generations, voters do not support a "big party" which would consume the present value of the entire future income stream. Such big party would be supported by the old, but is opposed by the young since it crowds out public expenditure when they become old. The concern for *public* consumption is crucial to prevent the big party; if $\theta = 0$, the initial young and old voters would agree to set $b = \bar{b}$, and the young would secure their private consumption in old age through savings.

As the discipline on fiscal policy stems from the young voters, a larger political influence of the old (i.e., larger ω) increases debt accumulation and taxes and decreases current public-good provision in every period. If the young had no influence on the political process ($\omega = 1$), the maximum debt would be attained in the first period.

Finally, we note that the political equilibrium and the commitment solution are identical in the first period (proof available upon request). Namely, the disciplining effect in the political equilibrium is of the same size as in the first period of the commitment solution, despite the fact that the first generation of young voters anticipates different future levels of public expenditure across the two regimes. This surprising result is due to cancellation of an income and a substitution effect that occurs under logarithmic preferences, given that future public goods are linear in $(\bar{b} - b)$. If public funds were to be spent more lavishly in future, the return on public savings – in terms of next-period public expenditures – would be higher. This substitution effect implies more public saving, i.e. less debt. However, with a large return it is not necessary to save as much, so the income effect suggests more debt.[17]

3.2 Example II: $\xi = 1$

We now present our second tractable case, assuming constant returns to labor in the household production technology, i.e., $\xi = 1$. In this case, taxation does not distort labor supply as long as $\tau \leq \bar{\tau} \equiv 1 - X/w$, namely, agents only work in the market. If $\tau > \bar{\tau}$, however, agents stop working in the market, and the tax revenue falls to zero. Thus, $\bar{\tau}$ is the top of the Laffer curve.

[17] To see this result technically, note that whenever the policy rule is on the following form $G(b) = \gamma(\bar{b} - b)$ for some γ, the cross derivative $\frac{\partial^2 V_Y(b)}{\partial b \partial \gamma}$ is always equal to zero. This means that the future lavishness, i.e. γ, will not impact on current political decisions.

Thus, the Markov-perfect political equilibrium necessarily features $\tau \leq \bar{\tau}$.[18]

Under a parametric condition, the equilibrium is qualitatively different from the linear case of Section 3.1; an economy starting from low initial debt converges in finite time to a steady state where steady-state taxes are maximized ($\tau = \bar{\tau}$) but steady-state debt is strictly below $\bar{b}$ and public-good provision is strictly positive. In a neighborhood of the steady state, the equilibrium dynamics of the fiscal variables and the steady-state debt level are given by[19]

$$b' = B(b) = b_0^* \equiv \bar{b}\left(1 - \frac{\theta(1+\psi)(1-\bar{\tau})}{\bar{\tau}(1+\beta)}\right) \tag{26}$$

$$\tau = T(b) = \bar{\tau} - \frac{R(1+\beta)}{wh(1+\beta+\theta(1+\psi))}(b_0^* - b) \tag{27}$$

$$g = G(b) = \frac{wh\theta(1+\psi)(1-\bar{\tau})}{1+\beta} + \frac{\theta(1+\psi)R}{1+\beta+\theta(1+\psi)}(b_0^* - b) \tag{28}$$

Figure 2 provides a geometric representation of the equilibrium. Panel a shows the equilibrium tax policy: taxes increase linearly with the debt level as long as $b \leq b_0^*$. Thereafter, T is flat at $\tau = \bar{\tau}$. Panel b shows the equilibrium expenditure: public good provision declines linearly with the debt level as $b \leq b_0^*$. To the right of b_0^*, the government loses the ability to adjust taxes, and thus the government expenditure function becomes steeper. Panel c, finally, shows that the debt policy is flat around b_0^*. Therefore, if the initial debt level were sufficiently close to b_0^*, the debt would converge to b_0^* in one period and then remain at b_0^*. In other words, debt is strongly mean-reverting after a shock. The figure also shows that the debt and expenditure policy function feature discontinuous dynamics for high initial debt levels. Moreover, there are multiple steady states. The multiple steady states are a fragile feature of this particular example which vanishes once one considers a smooth labor supply distortion (i.e., $\xi < 1$). However, as we will show in the next section, the existence of a internal and locally stable steady-state debt level is robust to a smoother labor distortion ($\xi < 1$).

We now discuss the intuition for the dynamics in the neighborhood of b_0^* focusing, for simplicity, on the case of no altruism ($\lambda = 0$). In the linear equilibrium of example I, the concern of young voters for next period's public-good provision did not prevent the debt from increasing in every period, progressively impoverishing future generations. Why? Because future generations could not issue credible threats to current voters that public-good provision

[18] The cases with sufficiently high or sufficiently low interest rates are easy to analyze. We have nevertheless omitted them since they yield debt dynamics qualitatively similar to the linear case of Section 3.1. With R sufficiently low, debt converges asymptotically to its maximum level, $\bar{b} = \bar{\tau}wh/(R-1)$, and the economy features public poverty in the long run, i.e. $\lim_{t\to\infty} g_t = 0$. However, since taxes are bounded from above by $\bar{\tau}$, private consumption does not fall to zero, but converges to $(1-\bar{\tau})\,wh > 0$. Second, when the interest rate is sufficiently high, the equilibrium is, after the first period, identical to the linear case above.

[19] A formal Proposition with a complete characterization of the equilibrium and its proof are provided in the appendix.

would be drastically cut should they inherit a large debt. Along the linear equilibrium path, current voters know that the next government will respond to a larger debt by not only cutting expenditure, but also by increasing taxes and debt proportionally. This punishment is too weak, and as a result, each generation of voters "passes the bill" to the next generation by only suffering a partial sacrifice of public consumption. Passing the bill to future generations becomes harder, however, when taxation is increasingly distortionary. In example II, this effect is particularly stark. As the debt approaches b_0^* and taxes approach $\bar{\tau}$, voters anticipate that future generations will not be able to increase taxes over $\bar{\tau}$. The expenditure response to a larger debt is then sharper, and the disciplining effect is stronger. Note that $G(.)$ is concave around the steady state b_0^*. To the right of b_0^*, the disciplining effect is so strong that debt falls and reverts to b_0^* in just one period. In contrast, to the left to b_0^*, $G(b)$ is less steep, implying a smaller disciplining effect. Consequently, voters support an increasing debt, and b_0^* is a steady state.[20]

FIGURE 2 (THREE PANELS) HERE

4 The General Case: $\xi \in (0,1)$

The intuition behind the result of example II carries over to the general case with $\xi \in (0,1)$, with smooth labor supply distortions. In this case, however, the equilibrium policy functions are non-linear, and the model does not admit an analytical solution. We must therefore resort to numerical analysis.[21]

We calibrate the parameters as follows. Since agents live for two periods, we let a period correspond to thirty years. Accordingly, we set $\beta = 0.98^{30}$ and $R = 1.025^{30}$. implying a 2% annual discount rate and a 2.5% annual interest rate. This value of β is standard in the macroeconomics literature, and the value of R is consistent with the average real long-term U.S. government bond yields (2.5%) between 1960 and 1990. We do not have strong priors on ω and λ, so we simply assume equal political weights on the young and old ($\omega = 0.5$) and

[20] A related intuition explains why there is no internal steady state when the interest rate is low. The reason is that G' is bounded from below by ζ. Since the function G is continuous, the GEE (18) implies an ever-decreasing sequence of public goods. Hence, with a low interest rate, the disciplining effect is not strong enough to generate falling debt for any $b \leq \bar{b}$, so $b \to \bar{b}$, irrespectively of the initial b.

[21] We adopt a standard projection method with Chebyshev collocation (Judd, 1992) to approximate T and G, exploiting the first-order conditions (17) and (18).

that the weight on children's utility is $\lambda = 0.75$.[22] We use the results from our example II to calibrate the weight on public goods θ and the top of the Laffer curve $\bar{\tau}$. In particular, we choose parameters so as to match, in the $\xi = 1$ case, the average debt-GDP ratio (0.30) and the government expenditure-GDP ratio (0.18) in the U.S. from 1960 to 1990. This yields $\bar{\tau} = 0.51$ and $\theta = 0.37$.[23]. Finally, we normalize wh to unity in this tractable case. Table X-1 summarizes the parameters.

Table X-1

$\beta = 0.98^{30}$	$R = 1.025^{30}$	$\omega = 0.50$	$\lambda = 0.75$	$\theta = 0.37$	$\bar{\tau} = 0.51$	$wh = 1$

In addition, we must assign values to w, X and ξ. To this end, we normalize $w = 1$ in the tractable case with $\xi = 1$ and we let $h = 1$ in all cases. Then, to make it easier to compare the simulated economy with the tractable case in which $\xi = 1$, we set w and X in a sequence of economies with different ξ according to the following two conditions. First, the top of the Laffer curve is constant across experiments at $\tau = \bar{\tau}$, and second, the tax revenue at the top of the Laffer curve is also constant and equal to the one in the tractable case with $\xi = 1$. The details are discussed in the appendix.

Figure 3 describes the equilibrium dynamics of two simulated economies, with respectively $\xi = 0.90$ and $\xi = 0.50$.[24] In both cases, the tax policy function is increasing in b (panel a) while the public expenditure function is a decreasing in b (panel b). The debt policy is an increasing convex function of b which crosses the 45-degree twice: first at an interior steady-state level, and then at the maximum debt. Only the interior steady-state is stable. Thus, for any initial debt level $b < \bar{b}$, the economy converges to the internal steady state with no public poverty.[25]

[22] We must also assume $\lambda \in (\lambda_{\min}, \lambda_{\max})$, where $\lambda_{\min}$ and $\lambda_{\max}$ are implied by the conditions $R > 1 + (1+\psi)/\zeta$ and $\beta\lambda R < 1$. Given the parameter values of β, R and ω, $\lambda_{\min}$ and $\lambda_{\max}$ are equal to 0.68 and 0.87, respectively.

[23] More precisely, we use the steady-state expressions of g and b in (28)-(26), each divided by wh, as proxies for the debt-GDP ratio. Thus, we set

$$\begin{aligned} \frac{\theta(1+\psi)(1-\bar{\tau})}{(1+\beta)} &= 0.30, \\ \frac{1}{R-1}\left(\bar{\tau} - \frac{\theta(1+\psi)(1-\bar{\tau})}{1+\beta}\right) &= 0.18. \end{aligned}$$

Given the other parametrs, these two equations identify $\bar{\tau}$ and θ.

[24] In the internal steady state of the two simulated economies with $\xi = 0.90$ and $\xi = 0.50$, the elasticities of market labor supply with respect to w, denoted by $\chi(h_M^*) = \frac{\partial h_M^*/h_M^*}{\partial w/w}$, are equal to 0.231 and 0.488, respectively. These elasticities lie in the rage of or slightly above estimates from labor economics, and in the range of or slightly below labor elasticities used in macroeconomics.

[25] Clearly, simulations do not establish that these equilibria are unique. However, we have run many simulations and never found more than one equilibrium for each parameter configuration, qualitatively similar to those displayed in the figure.

FIGURE 3 (THREE PANELS) HERE

To gain intuition, it is useful to compare with the analytical examples. In all cases, the tax function is non-decreasing and concave (strictly concave if $\xi > 0$), while the expenditure function is decreasing and concave (strictly concave if $\xi > 0$). In example II, the policy functions are piece-wise linear with a kink at the steady state. This is because taxation is non-distortionary to the left of $\bar{\tau}$ and infinitely distortionary to the right of it. In the general case of $\xi \in (0, 1)$, the tax-revenue function becomes less steep as b approaches the top of the Laffer curve. At high debt levels, governments tend to react to further debt increases by cutting expenditure more than by increasing taxes. This shows up in the concave shape of the and T functions. In example II, the slope of the G function changes discontinuously, whereas in the numerical examples the derivative of G falls smoothly. In example I ($\xi = 0$), taxation is not distortionary. Thus, a larger debt is matched by a proportional increase in taxation and cut in expenditure.

Table X-2 reports steady state values of variables of interests under different values of ξ.

Table X-2

	$\chi(h_M^*)$	τ^*	g^*	b^*	g^*/wh_M^*	b^*/wh_M^*
$\xi = 1.000$	0.0000	0.5100	0.1843	0.2967	0.1843	0.2967
$\xi = 0.975$	0.0488	0.4724	0.1935	0.2639	0.1892	0.2580
$\xi = 0.950$	0.1150	0.4562	0.1938	0.2566	0.1859	0.2463
$\xi = 0.900$	0.2309	0.4388	0.1901	0.2551	0.1775	0.2381
$\xi = 0.700$	0.4373	0.4032	0.2139	0.2235	0.1878	0.1963
$\xi = 0.500$	0.4878	0.3696	0.2998	0.1277	0.2519	0.1073

5 Financing a Surprise War

In this section, we introduce fiscal shock. To fix ides, assume that the country is forced to fight a "war" requiring an exogenous spending of Z units per year. War is a metaphor for fiscal shocks increasing the marginal value of government spending. During the war, the government's budget constraint (6) changes to

$$b' = g + Rb - \tau w h_M(\tau) + Z, \tag{29}$$

while during peace it reverts to (6). The shock occurs at the beginning of the period, before the government sets g, τ and b'. For simplicity, we focus on a surprise one-period war that hits an economy in a steady state. Appendix A extends the analysis to recurrent fiscal shocks that occur with a positive probability.[26]

In Barro (1979), the government would finance the war through issuing debt, while tax and non-war expenditure would only adjust to guarantee a smooth repayment of the excess debt. In contrast, in our model the war is only partially financed through debt. Part of the cost is absorbed by a cut in current non-war government expenditure and an increase in current taxation. In addition, contrary to Barro's tax smoothing, debt, taxes and expenditure converge back to their original steady-state levels after the war.

The local dynamics around the steady state determine the fiscal policy adjustment to the shock. Example II ($\xi = 1$) in Section 3.2 provides a useful illustration. Consider a "small" fiscal shock hitting an economy starting at b_0^*. The war is identical to an exogenous increase in the debt level from b_0^* to $b_0^* + Z/R$ (where, by assumption, $b_0^* + Z/R < b_1^*$). Since the tax constraint ($\tau \leq \bar{\tau}$) was already binding before the war, taxes cannot increase and remain at $\bar{\tau}$. Moreover, as the analysis of Section 3.2 shows, a government inheriting a(n effective) debt of $b_0^* + Z/R$ sets $b' = b_0^*$. Thus, also the debt remains constant at its steady-state level. Consequently, the war must be financed entirely by a reduction in non-war expenditure, such that total government spending stays constant during wartime. More formally, the government sets $g = g_0^* - Z/R$. The period after the war, the economies moves back to the steady state (see the dotted lines of Figure 4). The case of $\xi = 1$ is extreme insofar as the government does not smooth at all non-war expenditure, and the debt (as well taxes) remains flat throughout.

The solid line of Figure 4 illustrates the general case of $\xi < 1$. In this case, both taxes and non-war expenditure respond: the former shoot up and the latter shoots down.[27] Public debt also increases to help finance the war, so there is some extent of tax and non-war-expenditure smoothing. However, after the shock debt reverts to its original steady-state level.

FIGURE 4 (THREE PANELS) HERE

Appendix A extends the analysis to recurrent wars, assuming that the state of the economy (war or peace) evolves following a first-order stationary Markov process. The results are similar to those of a surprise war. However, the positive probability of future wars induces an additional

[26] In the example I of Section 3.2, an economy would be unable to finance a surprise war in steady state ($b = \bar{b}$). This case can be analyzed by either assuming that the economy is not initially in the steady state, or considering a benign fiscal shock (Z<0) such as a windfall oil discovery.

[27] Barro (1986) notes that non-military spending is crowded out during wars in the US, consistently with the prediction of our model.

precautionary motive for public savings in times of peace. Such motive is also present in the commitment solution, which also features some mean reversion in debt.

6 Political Shocks

In this section, we introduce preference shifts in the form of cohort-specific shocks affecting agents' appreciation for public goods relative to private consumption. For simplicity, we assume the realization of the shock to be identical across all agents in the same cohort. In particular, we let $\theta_Y \in \{\theta_r, \theta_l\}$ and $\theta_O \in \{\theta_r, \theta_l\}$ denote the preference over public goods of the young and the old, respectively, where $\theta_r < \theta_l$ (R and L stand for right-wing and left-wing, respectively). The leftist wave of the 1960's and the neo-cons revolution of the 1980's are examples of such preference shifts.

Preference shocks are assumed to follow a first-order Markov process. We denote by $p_{l,r}$ ($p_{r,l}$) the probability that, conditional on the current generation being rightist (leftist), the next generation will be leftist (rightist). We define $p_{l,l}$ and $p_{r,r}$ likewise. Thus, $p_{l,l} + p_{r,l} = p_{l,r} + p_{r,r} = 1$.

The equilibrium definition must be generalized to include the preferences over public goods of the young and old agents as additional state variables. We denote by $T(b|\theta_Y, \theta_O), G(b|\theta_Y, \theta_O)$ and $B(b|\theta_Y, \theta_O)$ the equilibrium policy functions. We focus our main discussion on the case of no altruism, $\lambda = 0$, and then discuss separately the effect of altruism. We start from characterizing the tractable case where $\xi = 0$ (example I of Section 3).

Proposition 4 *Assume that $\xi = 0$ and $\lambda = 0$. Then, the equilibrium with cohort-specific preference shocks is given by the following policy functions.*

$$T(b|\theta_Y, \theta_O) = 1 - \frac{(1-\omega) R (1+\beta)}{wh((1-\omega)(1+\theta_Y)(1+\beta) + \omega\theta_O)} (\bar{b} - b),$$

$$G(b|\theta_Y, \theta_O) = \frac{((1-\omega)\theta_Y + \omega\theta_O) R}{\omega\theta_O + (1-\omega)(1+\theta_Y)(1+\beta)} (\bar{b} - b),$$

$$B(b|\theta_Y, \theta_O) = \bar{b} - \frac{(1-\omega)\theta_Y \beta R}{\omega\theta_O + (1-\omega)(1+\theta_Y)(1+\beta)} (\bar{b} - b),$$

where $\bar{b} \equiv wh/(R-1)$, and $\theta_Y \in \{\theta_r, \theta_l\}$ and $\theta_O \in \{\theta_r, \theta_l\}$ denotes, respectively, the preferences of the young and old voters over public good provision.

Proof in the appendix.

Note that the probabilities $p_{j,i}$ do not enter the equilibrium functions $T(.)$, $G(.)$ and $B(.)$, which only depend on the state of debt and on the current distribution of preferences. This implies that neither the variance nor the persistence of preference shocks have any effect on the political equilibrium. In particular, a permanent change in preferences has the same effect as a temporary one. This surprising result depends on the cancellation of an income and a substitution effect. Suppose, for example, that all current voters are leftist, but anticipate the next generation to be rightist. This could in principle affect the preference for fiscal policy of the current young voters. However, a substitution and an income effect offset each other. On the one hand, a disciplined fiscal policy today has a lower return since the next generation is rightist and will spend a smaller share of $\bar{b} - b'$ in public good provision. The substitution effect induces therefore an increasing desire of debt accumulation. On the other hand, the marginal utility of future public goods consumption is larger precisely because the next generation has a lower propensity to their provision. Thus, the income effect induces more fiscal discipline from the young leftist voters. Under logarithmic preferences and no altruism the two effects cancel out exactly.

This result is of independent interest. In an influential article, Persson and Svensson (1989)(**?**) argued that when governments are subject to a positive non-reelection probability debt policy is affected by strategic considerations. For instance, a right-wing government issues more debt when it anticipates to be replaced by a left-wing government with a stronger taste for public expenditure. They derive their results in a two-period model. In our infinite-horizon environment, the sign of the strategic effects is ambiguous, being exactly zero under logarithmic preferences and non-distortionary taxation. This may explain why the empirical literature has found mixed support to this prediction [**...**].

Proposition 4 provides some interesting comparative statics. As expected, both T and G are increasing in both θ_O and θ_Y. However, the effects of θ_O and θ_Y on B have opposite signs. If the old are more eager to consume public goods, they exert a stronger political influence on fiscal policy, resulting in more debt accumulation ($\partial B / \partial \theta_O > 0$). In contrast, the more the young care for public consumption the more they demand fiscal discipline ($\partial B / \partial \theta_Y < 0$), since debt crowds out future public good provision.

Consider the two-period transition from a society where all agents have left-wing preferences ($\theta_Y = \theta_O = \theta_L$) to one where all agents have have right-wing preferences ($\theta_Y = \theta_O = \theta_R$). In the first period, θ_Y falls and θ_O does not change, whereas in the second period θ_O falls and θ_Y remains low. The tax policy, T, shifts down in the first period, and shifts further down in the second period. The policy function G shifts down in the first period, and shifts up in the second period. Finally, the policy function B shifts up in the first period, and shifts down in the second period. The net two-period effects are unambiguous: $G(b|\theta_r, \theta_r) < G(b|\theta_l, \theta_l)$, and

$B(b|\theta_r, \theta_r) > B(b|\theta_l, \theta_l)$. Thus, a shift from left to right leads to more debt accumulation and less public good provision.

Similar results obtain when the labor supply is elastic. In this case preference shocks also affect the steady-state debt level. To illustrate this case, we calibrate the model as in Table X-1, with two exceptions. First, since here we set $\lambda = 0$, we reparameterize R so as to have interior steady states under all preference configurations. Second, we set $\omega = 0$, i.e., we assume all political power to lie in the hands of the young. This is for simplicity, as in this case θ_O has no effect on the equilibrium and the transition to the new steady state is attained in just one period.[28] Finally, we set $\theta_L = 0.407$ and $\theta_R = 0.333$, implying an average $\theta = 0.37$, as in Table X-1. We consider alternative levels of persistence of the preference shocks ranging from $p_{l,l} = p_{r,r} = 1$ (perfectly persistent and unanticipated shocks) to $p_{l,l} = p_{r,r} = 0.5$ (i.i.d. shocks). The values of parameters are summarized in Table X-4.

Table X-4

$\beta = 0.98^{30}$	$R = 1.06^{30}$	$\omega = 0$	$\lambda = 0$	$\bar{\tau} = 0.51$
$\theta_L = 0.40$	$\theta_R = 0.33$	$p_{l,l} = 0.5/1$	$p_{r,r} = 0.5/1$	$wh = 1$

Figure 7 plots the equilibrium policy rules for the two realizations of preferences (θ_l and θ_r) in the case of permanent and unanticipated shocks, $p_{l,l} = p_{r,r} = 1$. Dotted lines are for the left-wing regime, while solid lines are for the right-wing regime. The arrows illustrate the dynamic adjustment of an economy starting in a left-wing steady state and converging to a right-wing steady state. As the figure illustrates, though the movement to the right leads unambiguously to less public good provision and more public debt, the evolution of tax rates can be non-monotonic. This is because the growing debt is a burden on the government budget, forcing future right-wing governments to raise taxes. Figure 8 plots the time-series dynamics of g, τ and b under the political regime shift. The solid lines correspond the case described in Figure 7 ($p_{l,l} = p_{r,r} = 1$). The dashed lines correspond to persistent shocks ($p_{l,l} = p_{r,r} = 0.9$) and the dotted lines correspond to the i.i.d. case ($p_{l,l} = p_{r,r} = 0.5$). All cases feature similar qualitative dynamics; public spending decreases monotonically, public debt increases monotonically, while the tax rate falls in the first period, and increases thereafter. Noticeably, the size of all changes in fiscal policy is increasing with the persistence of the shock. This result goes in the opposite direction to the strategic debt literature: a larger probability of re-election makes governments behave more extremely under our calibration. However, this is not a robust prediction of the theory.

[28]Details of simulations with $\omega = 0.5$ are available upon request.

FIGURE 7 (Three Panels) HERE

FIGURE 8 (Three Panels each with two cases) HERE

Finally, we discuss altruism. Since dynasties are subject to preference shocks, one must take a stand on whether parents value future public consumption according to their own taste ("paternalistic" preferences), or they do respect their offspring's preferences ("non-paternalistic" preferences). In the former case, the analysis above remains by-and-large unchanged. Under non-paternalistic altruism, however, preference shocks induce some intertemporal substitution effects whereby dynasties want to consume more (and issue more debt) in times of strong preferences for public consumption. For instance, a right-wing agent expecting most of his offspring to have left-wing preferences is now induced to more fiscal discipline as he expects the future members of his dynasty to care more than himself about public-good consumption. If political shocks are highly persistent, this intertemporal substitution effect is small. For instance, if we take the calibration of Table X-4 but assume $\lambda = 0.75$ and highly persistent shocks, ($p_{r,r} = p_{l,l} < 0.75$), the dynamics of Figure 8 are qualitatively unchanged. However, the intertemporal substitution effect may dominate for combinations of high altruism and a lowly persistent shocks. In this case, left-wing governments may issue more debt than right-wing governments.

FIGURE 9 (Three Panels) HERE

7 Empirical Analysis

In this section, we test the main prediction of the theory concerning the effect of political (preference) shocks on debt accumulation. A robust prediction of our theory is that right-wing governments are more prone to issue public debt than left-wing governments. Although our theory also has implications about taxation, these are less clear-cut. In particular, our theory predicts that left-wing governments tax less than right-wing governments in the long-run. However, our model ignores other rationales for taxation. For instance, countries spend a large share of their tax revenue on intragenerational transfers (unemployment benefits, welfare subsidies, sick and parental leave, etc.). Since left-wing governments have a stronger taste for transfers, the net effect on taxes may be ambiguous. Transfer motives would instead strengthen the predictions of our theory about debt policy: left-wing voters would dislike public debt insofar as it crowds out future transfers as well as public goods. In addition, the theory predicts the short-run effect of political shocks to be ambiguous even in the model without transfers. Therefore, we restrict attention to debt policy.

We first consider the time-series evidence for the United States. The advantage of focusing on post-war US data is that this is a two-party presidential system where the definition of "left" and "right" is not controversial. In addition, the debt is measured consistently, and there are neither world wars nor special episodes such as the Great Depression in the sample period. The only disadvantage is the limited number of observations. We use annual data for the period 1948-2005 from the Economic Report of the President. We run the following regression

$$\Delta d_t = \alpha_0 + \alpha_1 DEM_t + \alpha_2 d_t + \alpha_3 \left(U_t - \bar{U}\right) + \varepsilon_t.$$

The dependent variable, Δd_t, is the annual change in the debt-GDP ratio. Coherently with the timing of our theory, we define $\Delta d_t \equiv D_{t+1}/Y_{t+1} - D_t/Y_t$, namely, the government in office at t sets (through its budget law) the surplus or deficit in the following year. The explanatory variables include the debt-GDP ratio ($d_t = D_t/Y_t$), intended to capture the autoregressive component of debt (see Bohn, 1998); an indicator of the party affiliation of the president in office, and unemployment. The latter is intended to capture cyclical components of debt policy that are independent of politics.[29] We net unemployment of its sample average in order to ease the interpretation of the coefficients. The main variable of interest is DEM_t. This a dummy variable that takes on the value one when the president is a Democrat and the value zero when the president is a Republican. Our theory predicts α_1 to be negative, namely, debt growth should be lower under Democrat administrations. Note that α_0 measures the conditional mean of debt growth under Republicans, whereas $\alpha_0 + \alpha_1$ measures the conditional mean of debt growth under Democrats.

[29] One might argue that the ideology of governements may affect their response to business cycle fluctuations. However, an interaction between unemployment and the political measure has an insignificant effect in the regression.

TABLE 1 HERE

Table 1 summarizes the results. The baseline regression (column 1) shows that Republican administrations, controlling for the autoregressive component only, induce an average increase in the debt-GDP ratio of 3.8 percentage points per year. Given the autocorrelation coefficient (-0.088), an infinite sequence of Republican governments would lead to a steady-state debt-GDP ratio of 42.7%. In contrast, Democrat administrations induce an average increase in the debt-GDP ratio of 1.7 percentage points, implying a steady-state debt-GDP ratio of 19.3%. The estimated difference is both large and statistically significant. The autoregressive coefficient is significant and has the expected negative sign. Controlling for unemployment (column 2) has no major effects on the results. The difference between Republicans and Democrats remains highly significant (well above 99%). The steady-state debt-GDP ratios become, respectively, 40.7% (Republicans) and 15.1% (Democrats).[30] The autoregressive coefficient remains negative but drops to -0.067, becoming marginally insignificant. Interestingly, this estimate is very similar to that of Bohn (1998) who finds – after controlling for cyclical components in output and government expenditures – an autoregressive coefficient of -0.064 for the period 1948-95 (see Table II, p. 956). We also checked the sample stability by allowing the effect of Democrats to be different before and after 1980 (column 3). This test addresses the concern that the political effect may be driven by the policy of the Reagan and Bush administrations. We find no significant difference between the early and late part of the sample (the test that the two coefficients are identical is not rejected). In both subperiods Republicans have a higher propensity to accumulate debt.

We next extend the analysis to a sample of 21 OECD countries. A complete description of the data is provided in the appendix. Here we note that the major issue concerns measuring the political color of governments across countries and over time. Many countries have parliamentary systems and frequent coalition governments that are difficult to classify precisely. We will avoid problems of cross-country comparability between governments' political ideologies by including country-specific fixed effects in the regressions. In addition, we will filter out shocks common to all countries by including time effects. Nevertheless, defining the character of changes in government over time remains difficult. To address this problem, we use

[30] We have tested the stationarity of the unemployment series, and could reject the null hypothesis of a unit root. Adding a linear-quadratic time trend to the regression does not change the result of interest: the difference between Democrat and Repubblican administrations remain significant above 99%.

three different (though not independent) measures of the color of governments. Two measures are taken "off-the-shelf" from other studies. The first measure (POL_{FR}) was constructed by Franzese (2003), henceforth FR. It codes all parties in government from 1948 to 1997 from far left (value 0) to far right (value 10). The second measure (POL_{WKB}) is constructed by Woldendorp, Keman and Budge (1993, 1998), henceforth WKB. They assign scores for government and parliament from "right-wing dominance" (value 1) to "left-wing dominance" (value 5). The criterion for "dominance" is set by the share of seats in government and parliament. The third measure (POL), which is our most preferred one, is constructed by extending and simplifying the data of WKB (see the appendix for details). It assigns the value -1 for RIGHT, 0 for CENTRE and 1 for LEFT.

We run the following basic specification for the panel regressions

$$\Delta d_{ct} = f_c + f_t + \alpha_1 POL_{ct} + \alpha_2 d_{ct} + \alpha_3 U_{ct} + \varepsilon_{ct},$$

where f_c and f_t are country and time fixed effects, respectively. In some specifications, we run this regression with some additional control variables including GDP per capita, openness, Gini coefficient and two measures of the age structure of the population (proportion below 14 and above 65). Our preferred specification uses POL as the measure of political color (Table 2) over the sample period 1948-2005. The results with the alternative measures, POL_{FR} and POL_{WKB}, are reported in Table 3. In all regressions we exclude non-democratic governments.

TABLE 2 HERE

Table 2 summarizes the results. In the baseline specification (column 1) the coefficient of interest (POL) is negative and significant. Since this measure is increasing as governments move to the left, the regression confirms the theoretical implication that right-wing governments run larger debt as it was the case for the US. The quantitative effect is sizeable: a shift from a left-wing (+1) to a right-wing (-1) government increases the debt-GDP ratio by 0.62-0.84 percentage points per year. This is between one third and one half of the effect that was estimated for the US. We should note however that common political shocks are absorbed by the time dummies in the panel regressions, and this could explain the smaller effects. The autoregressive coefficient (d_t) is insignificant in columns 1 and 2, where no control variables other than unemployment are included. This would suggest that debt is not mean reverting. However, the apparent lack of mean reversion is driven by an outlier, Japan, whose debt has risen sharply in recent years. If we introduce an interaction between d_t and a dummy variable for Japan (namely, we allow the autoregressive coefficient of Japan to be different), the process is significantly mean reverting (see column 4 and 5), and the Japanese dummy is positive and highly significant. Moreover, once the full set of control variables is included, the autoregressive coefficient is again negative and highly significant both with and without the Japanese dummy. Unemployment has in all cases the expected positive effect on debt accumulation.[31]

TABLE 3 HERE

In Table 3 we check the robustness of the results to the alternative political measures. These have the disadvantage that the sample ends in 1996. The results confirm the previous analysis. The political variable POL_{FR} is positive (recall that POL_{FR} takes on higher values for right-wing governments) and significant, and the debt process is significantly mean reverting. In this case, Japan is less important, since the main increase in Japanese debt occurred after 1995. The second set of regressions uses POL_{WKB} as the political measure (recall that POL_{WKB} takes on lower values for right-wing governments). The results are again in line with our theory. The political effects are quantitatively comparable to those in Table 2 (e.g., going from one to five implies 7.2 percentage point yearly decrease in the debt-GDP ratio), but the coefficients are estimated less precisely and are only significant at the 10% level.

In conclusion, the empirical confirm the main theoretical predictions: debt-GDP ratio is mean reverting and right-wing governments tend to increase debt.

[31] We have also run separate regressions for each country in the same way as we did for the United States. There are several limitations to this approach. For many countries the number of observations is very small. Canada, Japan and Switzerland have almost no variation in political variables, and were excluded. The results are in accordance with our theory for a large majority of the countries, although in four cases (Australia, Austria, Germany and Denmark) the political effect goes in the wrong direction.

We also tested for possible non-linearities. We found no significant difference between CENTRE and LEFT, whereas there is a large and significant difference between these and governments labelled as RIGHT (note that more than half of the observations are coded as RIGHT). The quantitative effects are about the same as in the benchmark specification.

8 Conclusion

In this paper, we have proposed a positive theory of fiscal policy under repeated voting. In the absence of commitment, which is a natural assumption in a politico-economic environment, the concern of voters for future public good provision can offset the desire of voters to pass the bill of their expenditure to future generations, and drive the economy to an interior steady-state debt level. This result holds even for economies in which agents have no altruistic concerns for future generations' welfare, local interest rates do not respond to the fiscal policy, and the commitment solution would converge the endogenous debt limit with zero public-good consumption. Tax distortions are crucial for the survival of the welfare state, as they make it credible that accumulating high debt will induce future governments to make large expenditure cuts. Thus, distortions discipline current voters. Perhaps paradoxically, an increase in the elasticity of the tax base, due, e.g., to tax competition may ultimately lead to more public good provision in the long run.

In our theory, left-wing governments accumulate less debt than right-wing governments, as the former care more for future public-good provision. We document empirical support for this prediction.

Our analysis is subject to many caveats. For instance, both left-wing and right-wing populism may reflect a decrease in the current voters' altruism to future generations, whereas altruism has been kept constant across political regimes in our analysis. Nor do we have a theory for the determination of public debt under coalition governments.

While our analysis aims to explain the effects of within-country shifts in political preferences, we do not view it as an explanation of cross-country differences (e.g., why Italy and Belgium have a larger debt than Switzerland or Sweden) which is left to future research. We conjecture that differences in the efficiency of public-good provision may affect voters' preferences for public savings. For instance, it is often argued that Italy, a country with one of the largest public debts, has an inefficient public administration, while the public sector is more efficient in Scandinavian countries which have a lower propensity to indebtedness.

Finally, we have maintained throughout that governments are committed to repay their debt and ruled out government Ponzi schemes. The analysis could be enriched by endogenizing the incentive of government to repay debt. For instance, in equilibria with immiseration there would be incentives for voters to support international default. Integrating our analysis with the insights of the sovereign debt literature may give rise to novel insights but requires non-trivial extensions which are also left to further research.

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9 Appendix A: Anticipated Fiscal Shocks

In this appendix, we extend the analysis of Section 5 to a case in which the probability distribution of fiscal shocks is non-degenerate. Since there is a positive probability that the country experiences a perpetual war, and the government must be solvent in all states of nature, the maximum debt level now becomes

$$b \leq \frac{\max_{\tau} \{\tau w h_M(\tau)\} - Z}{R-1} \equiv \bar{b}. \tag{30}$$

We denote by z^i the state of the economy, where $i \in \{P, W\}$ stands for peace and war, respectively. The state of the economy is assumed to evolve following a first-order Markov process, with transition probability matrix Π, whose elements we denote by p_{ij} (where $p_{i,i} + p_{j,i} = 1$, and $j \neq i$).

The political equilibrium is characterized formally by the following fixed-point problem;

$$\left\langle \begin{array}{c} B\left(b|z^i\right), \\ G\left(b|z^i\right), \\ T\left(b|z^i\right) \end{array} \right\rangle = \arg \max_{\left\{b' \leq \bar{b}, g \geq 0, \tau \in [0,1]\right\}} \left\{ \begin{array}{c} (1+\psi)\,\theta \log g + (1+\beta) \log A(\tau) \\ +\beta\left(p_{i,i} V_O\left(b'|z^i\right) + p_{j,i} V_O\left(b'|z^j\right)\right) \end{array} \right\},$$

subject to either (6) or (29), and (30). $V_O\left(b|z^i\right)$, denoting the utility of the old $V_O\left(b|z^i\right)$, is given by the following functional equation

$$\begin{aligned} V_O\left(b|z^i\right) &= (1+\lambda)\,\theta \log\left(G\left(b|z\right)\right) + (1+\beta)\,\lambda \log A\left(T\left(b|z\right)\right) \qquad (31) \\ &\quad +\beta\lambda\left(p_{z,z} V_O\left(b'|z\right) + p_{z',z} V_O\left(b'|z'\right)\right). \end{aligned}$$

The analysis leads to the following generalization of the GEE to a stochastic environment (see appendix for the derivation);[32]

$$E\left(\left.\frac{G\left(B\left(b\right)\right)}{G\left(b\right)}\right| z = z^i\right) = \beta\lambda R - \beta\lambda E\left(G'\left(B\left(b\right)\right)\right| z = z^i\left)\left(\frac{1+\lambda^{-1}}{1+\psi} - 1\right). \tag{32}$$

Figure 5 show the dynamics of a simulated economy where we assume the following transition Markov matrix

$$\Pi = \begin{bmatrix} p_{PP} = 0.9 & p_{PW} = 0.1 \\ p_{WW} = 0.75 & p_{WW} = 0.25 \end{bmatrix}.$$

This implies that war is less likely than peace, and that the state is characterized by some persistence.

[32] Note that the left hand-side of (32)is the conditional expectation of the marginal rate of substitution of public consumption between time t and t+1, given the state of nature (war or peace) at t.

FIGURE 5 (six panels) HERE

The first three panels represent, respectively, g, τ and b' as function of b and z.[33] Continuous (dotted) lines represent the level of the policy conditional on war (peace). The first panel shows that taxes are increasing in b and larger in war than in peace times. The second panel shows that expenditure (excluding war expenditure) is decreasing in b and larger in peace than in war times. Finally, the third panel show the dynamics of debt. In all panels, the continuous (dotted) line can be interpreted as the decisions rule associated with one particular history, namely when the economy experiences an infinite sequence of war (peace) times. The stationary distribution of debt is between the upper and lower steady states.

Panels 4-6 plot the evolution of policies. The results are qualitatively similar to those solid lines of Figure 4. The main differences are that in this case the anticipation of the possibility of future wars induces an additional precautionary motive for public savings in times of peace.

It is also useful to analyze the commitment solution in this stochastic environment. A simple generalization of Lemma 1 holds.[34] The analysis of the First Order Conditions leads to a stochastic version of the Euler equation under commitment, (14);

$$E\left(\frac{g'}{g}\middle| z = z^i\right) = \beta\lambda R, \qquad i \in \{P, W\}. \tag{35}$$

FIGURE 6 (3 panels) HERE

Figure 6 is the analogue of Figure 5. In particular, the third panel shows that an economy experiencing perpetual war converges to the debt limit, while an economy experiencing perpetual peace (but perceiving a positive probability that a war starts) settles down below the maximum debt. Note that an even under commitment there is some scope for the government to reduce debt in times of peace. However, such scope is limited to a precautionary motive: agents anticipate that some future generation may suffer war, and wish to limit the extent to

[33] We assume that a war costs 10% of maximum tax revenues.

[34] In particular, after the first period, the problem can be expressed by the following recursive programme;

$$V_O\left(b|z^i\right) = \max_{\{\tau,g,b'\}} v(\tau,g) + \beta\lambda\left(p_{i,i}V_O\left(b'|z^i\right) + p_{j,i}V_O\left(b'|z^j\right)\right) \tag{33}$$

subject to (6) or (29) and (30). The functional equation (33) is the stochastic analogue of (11).

The analysis of the First Order Conditions leads to the following generalization, state-by-state, of equation (13);

$$\frac{1+\beta}{\left(1+\frac{1}{\lambda}\right)\theta}g^i = A\left(\tau^i\right)\left(1-e\left(\tau^i\right)\right), \tag{34}$$

See the appendix for the details of the analysis.

which future government consumption must be cut. This effect is significantly smaller than in the politico-economic model. In Table X-3, we denote by b_P^* and b_R^* the steady-state debt levels with perpetual peace in the political equilibrium and the Ramsey allocation, respectively, for two different values of ξ. In all cases b_P^* is substantially lower than b_R^*, and is in fact rather close to $\bar{b}$, showing that the precautionary motive can only induce a limited amount of public saving.

Table X-3

	b_P^*	b_R^*
$\xi = 0.90$	0.2295	0.4047
$\xi = 0.70$	0.1883	0.4047
$\xi = 0.50$	0.0932	0.4046

10 Appendix B: proofs of Lemmas and Propositions.

10.1 Proof Lemma 1

We rewrite the political objective function (10) as follows:

$$\begin{aligned}
& \frac{U(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g})}{(1-\omega+\omega\lambda)} \\
= \ & \frac{(1-\omega)U_Y(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g})+\omega(\theta\log(g_0)+\lambda U_Y(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g}))}{(1-\omega+\omega\lambda)} \\
= \ & \frac{\omega\theta\log(g_0)+(1-\omega+\lambda\omega)U_Y(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g})}{(1-\omega+\omega\lambda)} \\
= \ & \frac{\omega}{(1-\omega+\omega\lambda)}\theta\log(g_0)+\sum_{t=0}^{\infty}(\lambda\beta)^t((1+\beta)\log(A(\tau_t))+\theta\log(g_t)+\beta\theta\log(g_{t+1})) \\
= \ & (1+\beta)\log(1-\tau_0)+(1+\psi)\theta\log(g_0)+\sum_{t=1}^{\infty}(\lambda\beta)^t\left((1+\beta)\log(A(\tau_t))+\left(1+\frac{1}{\lambda}\right)\theta\log(g_t)\right) \\
= \ & (1+\beta)\log(1-\tau_0)+(1+\psi)\theta\log(g_0)+\sum_{t=1}^{\infty}(\lambda\beta)^t v(g_t,\tau_t).
\end{aligned}$$

It follows that

$$\begin{aligned}
& \max_{\{\tau_t,g_t,b_{t+1}\}_{t=0}^{\infty}}\left\{\frac{U(...)}{(1-\omega+\omega\lambda)}\right\}|_{b_0} \\
= \ & \max_{\{\tau_0,g_0,b_1\}}\left\{(1+\beta)\log(A(\tau_0))+(1+\psi)\theta\log(g_0)+\max_{\{\tau_t,g_t,b_{t+1}\}_{t=1}^{\infty}|b_1}\left\{\sum_{t=1}^{\infty}(\lambda\beta)^t v(g_t,\tau_t)\right\}|_{b_1}\right\}|_{b_0} \\
= \ & \max_{\{\tau_0,g_0,b_1\}_{t=0}^{\infty}}\{(1+\beta)\log(A(\tau_0))+(1+\psi)\theta\log(g_0)+\beta\lambda V_O(b_1)\}|_{b_0},
\end{aligned}$$

where all maximizations are subject to (6), and the last step follows from equation (11).

10.2 Proof Lemma 2

Given policy rules $T(b)$, $G(b)$, and $B(b)$, the discounted utility of the young is defined by the function:

$$V_Y(b) \equiv \sum_{t=0}^{\infty} (\lambda\beta)^t \left((1+\beta)\log\left(A\left(T\left(B^t(b)\right)\right)\right) + \theta\log\left(G\left(B^t(b)\right)\right) + \beta\theta\log\left(G\left(B^{t+1}(b)\right)\right)\right).$$

When ignoring the predetermined term with $\log(1-\tau_{-1})$, the discounted utility of the old can be expressed as:

$$\begin{aligned}
V_O(b) &\equiv \theta\log G(b) + \lambda V^Y(b) \\
&= \theta\log G(b) + \lambda\sum_{t=0}^{\infty} (\lambda\beta)^t \left((1+\beta)\log\left(A\left(T\left(B^t(b)\right)\right)\right) + \theta\log\left(G\left(B^t(b)\right)\right) + \beta\theta\log\left(G\left(B^{t+1}(b)\right)\right)\right) \\
&= \lambda(1+\beta)\log(A(T(b))) + (1+\lambda)\theta\log G(b) \\
&\quad +\lambda\sum_{t=1}^{\infty} (\lambda\beta)^t \left((1+\beta)\log\left(A\left(T\left(B^t(b)\right)\right)\right) + \theta(1+\lambda)\log\left(G\left(B^t(b)\right)\right)\right).
\end{aligned}$$

Rewrite $V_O(b)$ in a recursive fashion:

$$V_O(b) = (1+\lambda)\theta\log(G(b)) + (1+\beta)\lambda\log(A(T(b))) + \beta\lambda V_O(B(b)).$$

It is straightforward that, due to the Contraction Mapping Theorem, $V_O(b)$ is the unique solution to the above functional equation.

Moreover, the political objective function can be expressed as

$$\begin{aligned}
&\frac{U(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g})}{(1-\omega+\omega\lambda)} \\
&= \psi\theta\log g + U_Y(\boldsymbol{b},\boldsymbol{\tau},\boldsymbol{g}) \\
&= (1+\beta)\log(A(\tau)) + (1+\psi)\theta\log g + \beta\theta\log\left(G\left(b'\right)\right) + \beta\lambda V_Y\left(b'\right) \\
&= (1+\beta)\log(A(\tau)) + (1+\psi)\theta\log g + \beta V_O\left(b'\right).
\end{aligned}$$

Now the political problem can be rewritten as

$$\begin{aligned}
&\max_{\{g,\tau\}} \left\{(1+\beta)\lambda\log(A(\tau)) + (\lambda+\lambda\psi)\theta\log g + \beta\lambda V_O\left(b'\right)\right\} \\
&\text{s.t.} \\
b' &= Rb + g - \tau w h_M(\tau).
\end{aligned}$$

10.3 Proof of the Generalized Euler Equation

The FOCs for problem (15) are

$$\begin{aligned}
\frac{(1+\beta)\lambda A'(\tau)}{A(\tau)} - \beta\lambda V_O'(b')\left(wh_M(\tau)+\tau wh_M'(\tau)\right) &= 0,\\
\frac{\lambda\theta(1+\psi)}{g} + \beta\lambda\hat{V}'(b') &= 0.
\end{aligned}$$

By the definition of $e(\tau)$ and the fact that $A'(\tau) = -wh_M(\tau)$, the FOCs can be rewritten as

$$\begin{aligned}
-\frac{(1+\beta)\lambda}{A(\tau)} - \beta\lambda V_O'(b')(1-e(\tau)) &= 0, && (36)\\
\frac{\lambda\theta(1+\psi)}{g} + \beta\lambda V_O'(b') &= 0. && (37)
\end{aligned}$$

Combining two FOCs delivers (17):

$$\frac{1+\beta}{(1+\psi)\theta}g = A(\tau)(1-e(\tau)).$$

. Then we can rewrite (16) and the government budget constraint (6) as

$$\begin{aligned}
V_O(b) &= ((1+\beta)\lambda+(1+\lambda)\theta)\log(G(b)) - (1+\beta)\lambda\log(1-e(T(b))) + \beta\lambda V_O(B(b)),\\
B(b) &= G(b) + Rb - T(b)\,wh_M(T(b)).
\end{aligned}$$

Differentiating $V_O(b)$ and $B(b)$ yields

$$\begin{aligned}
V_O'(b) &= ((1+\beta)\lambda+(1+\lambda)\theta)\frac{G'(b)}{G(b)} - \frac{-(1+\beta)\lambda e'(T(b))T'(b)}{1-e(T(b))} + \beta\lambda V_O'(B(b))B'(b),\\
B'(b) &= G'(b) + R - T'(b)\,wh_M(T(b))(1-e(T(b)))\\
&= \left(1+\frac{1+\beta}{\theta(1+\psi)}\right)G'(b) + R + e'(T(b))T'(b)A(T(b)).
\end{aligned}$$

The last equality comes from the fact that

$$-T'(b)\,wh_M(T(b))(1-e(T(b))) - e'(T(b))T'(b)A(T(b)) = \frac{1+\beta}{\theta(1+\psi)}G'(b),$$

as implied by (17) and $A'(\tau) = -wh_M(\tau)$. Plugging $V_O'(b)$ into the second FOC (37), we have

$$\frac{1}{G(b)} = \frac{\beta\lambda}{G(B(b))}\left(B'(B(b)) - \frac{1+\beta+\left(1+\frac{1}{\lambda}\right)\theta}{\theta(1+\psi)}G'(B(b)) - \frac{(1+\beta)G(B(b))\,e'(T(B(b)))\,T'(B(b))}{\theta(1+\psi)(1-e(T(B(b))))}\right).$$

Now substituting for $B'(B(b))$

$$\frac{1}{G(b)} = \frac{\beta\lambda}{G(B(b))}\left(\begin{array}{c} R+\left(1-\frac{1+\frac{1}{\lambda}}{1+\psi}\right)G'(B(b)) + e'(T(B(b)))\,T'(B(b))\,A(T(B(b)))\\ -\frac{(1+\beta)G(B(b))e'(T(B(b)))T'(B(b))}{\theta(1+\psi)(1-e(T(B(b))))}\end{array}\right).$$

The FOC (17) implies

$$A\left(T\left(B\left(b\right)\right)\right)\left(1-e\left(T\left(B\left(b\right)\right)\right)\right)=\frac{1+\beta}{\theta\left(1+\psi\right)}G\left(B\left(b\right)\right).$$

Tsherefore, we obtain the generalized Euler equation (18):

$$\frac{1}{G\left(b\right)}=\frac{\beta\lambda R}{G\left(B\left(b\right)\right)}-\frac{\beta\lambda G'\left(B\left(b\right)\right)}{G\left(B\left(b\right)\right)}\left(\frac{1+\frac{1}{\lambda}}{1+\psi}-1\right).$$

10.4 Analysis of Example II, Section 3

Proposition 5 *Suppose $R\in\left[1+\left(1+\psi\right)/\zeta,R_h\right]$, and let the initial debt level be $b=b^0\in\left[\underline{b},\bar{b}\right]\big)$, where $\bar{b}\equiv\bar{\tau}wh/\left(R-1\right)$ and $\zeta\equiv\left(1+\lambda\right)\beta/\left(1-\beta\lambda\right)$, and R_h and $\underline{b}$ are defined in the appendix. Then, the equilibrium is given by the following policy functions*

$$\tau=T\left(b\right)\equiv\begin{cases}\bar{\tau}-\frac{R(1+\beta)}{wh(1+\beta+\theta(1+\psi))}\left(b_0^*-b\right) & \text{if } b\in\left[\underline{b},b_0^*\right)\\ \bar{\tau} & \text{otherwise}\end{cases},$$

$$g=G\left(b\right)\equiv\begin{cases}g_0^*+\frac{\theta(1+\psi)R}{1+\beta+\theta(1+\psi)}\left(b_0^*-b\right) & \text{if } b\in\left[\underline{b},b_0^*\right)\\ b_n^*+\bar{\tau}wh-Rb & \text{if } b\in\left[b_n^*,b_{n+1}^*\right)\end{cases},$$

$$b'=B\left(b\right)\equiv\begin{cases}b_0^*\equiv\bar{b}\left(1-\frac{\theta(1+\psi)(1-\bar{\tau})}{\bar{\tau}(1+\beta)}\right) & \text{if } b\in\left[\underline{b},b_1^*\right)\\ b_n^* & \text{if } b\in\left[b_n^*,b_{n+1}^*\right]\end{cases},$$

where $g_0^*\equiv wh\theta\left(1+\psi\right)\left(1-\bar{\tau}\right)/\left(1+\beta\right)>0$, and the sequence $\{b_n^*\}_{n=0,1,2,..,\infty}$ is the unique solution to the difference equation

$$\left(b_n^*-b_{n+1}^*+\bar{\tau}wh\right)^{1+\psi}\left(b_n^*-Rb_n^*+\bar{\tau}wh\right)^{\zeta}=\left(b_{n+1}^*-Rb_{n+1}^*+\bar{\tau}wh\right)^{1+\psi+\zeta},$$

given b_0^*. The sequence $\{b_n^*\}_{n=0,1,2,..,\infty}$ is monotonically incresing in n and $\lim_{n\to\infty}b_n^*=\bar{b}$.

Proof: to be written.

10.5 Calibration of X and w

For $\xi\in\left(0,1\right)$, total tax revenue Y and its derivative are given by

$$\begin{aligned}Y\left(\tau\right) &= w\tau\left(h-\left(\frac{\left(1-\tau\right)w}{\xi X}\right)^{\frac{1}{\xi-1}}\right),\\ \frac{\partial Y}{\partial\tau} &= w\left(h-\frac{1-\xi\left(1-\tau\right)}{\left(1-\xi\right)\left(1-\tau\right)}\left(\frac{\left(1-\tau\right)w}{\xi X}\right)^{\frac{1}{\xi-1}}\right).\end{aligned}$$

We set X and w as follows:

$$
\begin{aligned}
w &= \frac{1-\xi\left(1-\bar{\tau}\right)}{\bar{\tau}}, && (38)\\
X &= \frac{\left(1-\bar{\tau}\right)^{2-\xi}}{\bar{\tau}}\frac{\left(1-\xi\right)^{1-\xi}}{\xi}\left(1-\xi\left(1-\bar{\tau}\right)\right)^{\xi}h^{1-\xi}. && (39)
\end{aligned}
$$

Note first that as $\xi \to 1$, then X and w converge to their respective values in the analytical example $\lim_{\xi\to1} X = (1-\bar{\tau})$ and $\lim_{\xi\to1} w = 1$ (we set w equal to 1 in the analytical case). Moreover, these choices for X and w yield that the top of the Laffer curve is at $\tau = \bar{\tau}$ and that maximal tax revenue is equal to $\bar{\tau}h$.[35]

10.6 Political Uncertainty

The value function (conditional on the political state θ_Y and θ_O) can be written as

$$
\left\langle \begin{array}{c} B\left(b|\theta_Y,\theta_O\right), \\ G\left(b|\theta_Y,\theta_O\right), \\ T\left(b|\theta_Y,\theta_O\right) \end{array} \right\rangle = \arg \max_{\left\{b'\le\bar{b},g\ge0,\tau\in[0,1]\right\}} \left\{ \begin{array}{c} \left(\lambda\theta_Y+\psi\lambda\theta_O\right)\log g+\left(1+\beta\right)\lambda\log\left(1-\tau\right) \\ +\beta\lambda L\left(\theta_Y\right)\left(p_{l,l}V_O\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O\left(b'|\theta_r,\theta_l\right)\right) \\ +\beta\lambda\left(1-L\left(\theta_Y\right)\right)\left(p_{l,r}V_O\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O\left(b'|\theta_r,\theta_r\right)\right) \end{array} \right\}, \tag{40}
$$

subject to (6) and (7), the utility of the old $V_O\left(b|\theta_Y,\theta_O\right)$ is given by the functional equation

$$
\begin{aligned}
V_O\left(b|\theta_Y,\theta_O\right) &= \left(\lambda\theta_Y+\theta_O\right)\log\left(G\left(b|\theta_Y,\theta_O\right)\right)+\left(1+\beta\right)\lambda\log\left(1-T\left(b|\theta_Y,\theta_O\right)\right)\\
&\quad +\beta\lambda L\left(\theta_Y\right)\left(p_{l,l}V_O\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O\left(b'|\theta_r,\theta_l\right)\right)\\
&\quad +\beta\lambda\left(1-L\left(\theta_Y\right)\right)\left(p_{l,r}V_O\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O\left(b'|\theta_r,\theta_r\right)\right) && (41)
\end{aligned}
$$

and

$$
\begin{aligned}
L\left(\theta_Y\right) &= 1 \text{ if } \theta_Y=\theta_l,\\
L\left(\theta_Y\right) &= 0 \text{ if } \theta_Y=\theta_r,\\
p_{l,l}+p_{r,l} &= p_{l,r}+p_{r,r}=1,
\end{aligned}
$$

[35] In particular:

$$
\begin{aligned}
0 &= \frac{\partial Y\left(\bar{\tau}\right)}{\partial\tau} = w\left(h-\frac{1-\xi\left(1-\tau\right)}{\left(1-\xi\right)\left(1-\tau\right)}\left(\frac{\left(1-\tau\right)w}{\xi X}\right)^{\frac{1}{\xi-1}}\right)\\
&= w\left(h-\frac{1-\xi\left(1-\tau\right)}{\left(1-\xi\right)\left(1-\tau\right)}\left(\frac{\left(1-\tau\right)}{\xi\frac{\left(1-\bar{\tau}\right)^{2-\xi}}{\bar{\tau}}\frac{\left(1-\xi\right)^{1-\xi}}{\xi}\left(1-\xi\left(1-\bar{\tau}\right)\right)^{\xi}h^{1-\xi}}\frac{1-\xi\left(1-\bar{\tau}\right)}{\bar{\tau}}\right)^{\frac{1}{\xi-1}}\right).\\
\bar{\tau}h &= Y\left(\bar{\tau}\right) = \bar{\tau}w\left(h-\left(\frac{\left(1-\bar{\tau}\right)w}{\xi X}\right)^{\frac{1}{\xi-1}}\right)\\
&= \bar{\tau}\frac{1-\xi\left(1-\bar{\tau}\right)}{\bar{\tau}}\left(h-\left(\frac{\left(1-\bar{\tau}\right)}{\xi\frac{\left(1-\bar{\tau}\right)^{2-\xi}}{\bar{\tau}}\frac{\left(1-\xi\right)^{1-\xi}}{\xi}\left(1-\xi\left(1-\bar{\tau}\right)\right)^{\xi}}\frac{1-\xi\left(1-\bar{\tau}\right)}{\bar{\tau}}\right)^{\frac{1}{\xi-1}}\right)
\end{aligned}
$$

We assume that all policy functions are continuous and differentiable. Consider the case in which in the current period both the young an the old are left. Then, the solution must satisfy the following First Order Conditions.

$$
\begin{aligned}
-\frac{(1+\beta)\lambda}{1-\tau} &= \beta\lambda L(\theta_Y)\left(p_{l,l}V_O'\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O'\left(b'|\theta_r,\theta_l\right)\right)wh &(42)\\
&+\beta\lambda\left(1-L(\theta_Y)\right)\left(p_{l,r}V_O'\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O'\left(b'|\theta_r,\theta_r\right)\right)wh\\
-\frac{\lambda\theta_Y+\psi\lambda\theta_O}{g} &= \beta\lambda L(\theta_Y)\left(p_{l,l}V_O'\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O'\left(b'|\theta_r,\theta_l\right)\right) &(43)\\
&+\beta\lambda\left(1-L(\theta_Y)\right)\left(p_{l,r}V_O'\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O'\left(b'|\theta_r,\theta_r\right)\right)
\end{aligned}
$$

The two equations, (42)-(43), together imply that

$$
T(b|\theta_Y,\theta_O)=1-\frac{(1+\beta)\,G(b|\theta_Y,\theta_O)}{(\theta_Y+\psi\theta_O)\,wh}.
$$

This allows us to obtain:

$$
\begin{aligned}
V_O(b|\theta_Y,\theta_O) &= \left((1+\beta)\lambda+\lambda\theta_Y+\theta_O\right)\log\left(G(b|\theta_Y,\theta_O)\right) &(44)\\
&+\beta\lambda L(\theta_Y)\left(p_{l,l}V_O\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O\left(b'|\theta_r,\theta_l\right)\right)\\
&+\beta\lambda\left(1-L(\theta_Y)\right)\left(p_{l,r}V_O\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O\left(b'|\theta_r,\theta_r\right)\right),\\
B(b|\theta_Y,\theta_O) &= \left(1+\frac{(1+\beta)}{(\theta_Y+\psi\theta_O)}\right)G(b|\theta_Y,\theta_O)+Rb-wh. &(45)
\end{aligned}
$$

Differentiating $V^O(b|\theta_Y,\theta_O)$ and $B(b|\theta_Y,\theta_O)$ yields, then,

$$
\begin{aligned}
V_O'(b|\theta_Y,\theta_O) &= \left((1+\beta)\lambda+\theta_Y+\lambda\theta_O\right)\frac{G'(b|\theta_Y,\theta_O)}{G(b|\theta_Y,\theta_O)}\\
&+\beta\lambda L(\theta_Y)\left(p_{l,l}V_O\left(b'|\theta_l,\theta_l\right)+p_{r,l}V_O\left(b'|\theta_r,\theta_l\right)\right)B'(b|\theta_Y,\theta_O)\\
&+\beta\lambda\left(1-L(\theta_Y)\right)\left(p_{l,r}V_O\left(b'|\theta_l,\theta_r\right)+p_{r,r}V_O\left(b'|\theta_r,\theta_r\right)\right)B'(b|\theta_Y,\theta_O)\\
B'(b|\theta_Y,\theta_O) &= \left(1+\frac{(1+\beta)}{(\theta_Y+\psi\theta_O)}\right)G'(b|\theta_Y,\theta_O)+R.
\end{aligned}
$$

Combining these with (43), we obtain

$$
\begin{aligned}
V_O'(b|\theta_Y,\theta_O) &= \left((1+\beta)\lambda+\lambda\theta_Y+\theta_O\right)\frac{G'(b|\theta_Y,\theta_O)}{G(b|\theta_Y,\theta_O)}-\frac{\lambda\theta_Y+\psi\lambda\theta_O}{G(b|\theta_Y,\theta_O)}B'(b|\theta_Y,\theta_O)\\
&= \left((1+\beta)\lambda+\lambda\theta_Y+\theta_O\right)\frac{G'(b|\theta_Y,\theta_O)}{G(b|\theta_Y,\theta_O)}\\
&\quad-\frac{\lambda\theta_Y+\psi\lambda\theta_O}{G(b|\theta_Y,\theta_O)}\left(\left(1+\frac{(1+\beta)}{(\theta_Y+\psi\theta_O)}\right)G'(b|\theta_Y,\theta_O)+R\right)\\
&= (1-\psi\lambda)\,\theta_O\frac{G'(b|\theta_Y,\theta_O)}{G(b|\theta_Y,\theta_O)}-\frac{(\lambda\theta_Y+\psi\lambda\theta_O)\,R}{G(b|\theta_Y,\theta_O)},
\end{aligned}
$$

Then, (43) leads to the GEE under political uncertainty

$$
\begin{aligned}
\frac{1}{G\left(b|\theta_Y,\theta_O\right)} &= \beta\lambda R\left(\begin{array}{c} p\left(\theta_Y'=\theta_Y,\theta_O'|\theta_Y,\theta_O\right)\frac{\frac{\theta_Y'+\psi\theta_Y}{\theta_Y+\psi\theta_O}}{G\left(B(b|\theta_Y,\theta_O)|\theta_Y'=\theta_Y,\theta_Y\right)} \\ +p\left(\theta_Y'\neq\theta_Y,\theta_O'|\theta_Y,\theta_O\right)\frac{\frac{\theta_Y'+\psi\theta_Y}{\theta_Y+\psi\theta_O}}{G\left(B(b|\theta_Y,\theta_O)|\theta_Y'\neq\theta_Y,\theta_Y\right)}\end{array}\right) \qquad (46) \\
&\quad -\beta\lambda\left(\frac{1+\lambda^{-1}}{1+\psi}-1\right)\left(\begin{array}{c} p\left(\theta_Y'=\theta_Y,\theta_O'|\theta_Y,\theta_O\right)\frac{G'\left(B(b|\theta_Y,\theta_O)|\theta_Y'=\theta_Y,\theta_Y\right)}{G\left(B(b|\theta_Y,\theta_O)|\theta_Y'=\theta_Y,\theta_Y\right)} \\ +p\left(\theta_Y'\neq\theta_Y,\theta_O'|\theta_Y,\theta_O\right)\frac{G'\left(B(b|\theta_Y,\theta_O)|\theta_Y'\neq\theta_Y,\theta_Y\right)}{G\left(B(b|\theta_Y,\theta_O)|\theta_Y'\neq\theta_Y,\theta_Y\right)}\end{array}\right),
\end{aligned}
$$

If $\lambda=0$, then the GEE becomes

$$\frac{1}{G\left(b|\theta_Y,\theta_O\right)}=-\frac{\beta}{1+\psi}\cdot E\left[\frac{G'\left(B\left(b|\theta_Y,\theta_O\right)|\theta_Y',\theta_O'\right)}{G\left(B\left(b|\theta_Y,\theta_O\right)|\theta_Y',\theta_O'\right)}\right],$$

Next, we guess that

$$G\left(b|\theta_Y,\theta_O\right)=\gamma\left(\theta_Y,\theta_O\right)\left(\bar{b}-b\right). \qquad (47)$$

Then (45) implies that

$$\bar{b}-B\left(b|\theta_Y,\theta_O\right)=\left(R-\left(1+\frac{(1+\beta)}{(\theta_Y+\psi\theta_O)}\right)\gamma\left(\theta_Y,\theta_O\right)\right)\left(\bar{b}-b\right).$$

Then, (46) establishes

$$R\frac{(\theta_Y+\psi\theta_O)}{\gamma\left(\theta_Y,\theta_O\right)}=\psi\theta_O+(1+\beta)\left(1+\theta_Y\right),$$

which gives

$$\gamma\left(\theta_Y,\theta_O\right)=\frac{(\theta_Y+\psi\theta_O)\,R}{\psi\theta_O+(1+\beta)\left(1+\theta_Y\right)}.$$

It follows that

$$
\begin{aligned}
b' &= \left(1+\frac{(1+\beta)}{(\theta_Y+\psi\theta_O)}\right)\gamma\left(\theta_Y,\theta_O\right)\left(\bar{b}-b\right)+Rb-(R-1)\,\bar{b} \\
&= \bar{b}-\frac{\beta R\theta_Y}{\psi\theta_O+(1+\beta)\left(1+\theta_Y\right)}\left(\bar{b}-b\right), \\
\tau &= 1-\frac{1}{wh}\frac{(1+\beta)\,R}{\psi\theta_O+(1+\beta)\left(1+\theta_Y\right)}\left(\bar{b}-b\right)
\end{aligned}
$$

Since $\psi=\frac{\omega}{1-\omega}$ for $\lambda=0$, this proves Proposition 4.

Table 1: Regression for U.S. Data

Dep. Variable	change in the debt-GDP ratio Δd_t		
	(1)	(2)	(3)
constant	0.0378**	0.0274	0.0272
	(2.51)	(1.61)	(1.62)
d_t	-0.0885**	-0.0675	-0.0670
	(-2.34)	(-1.60)	(-1.61)
DEMO	-0.0207***	-0.0172***	-
	(-4.02)	(-3.27)	
UNEMPL	-	0.0064***	0.0064***
		(2.92)	(2.84)
DEMO_PRE1980	-	-	-0.0182**
			(-2.61)
DEMO_POST1980	-	-	-0.0156***
			(-2.78)
Obs.	57	57	57
R^2	0.3974	0.4934	0.4942

Notes: DEMO is a dummy variable which equals one or zero when the president is a Democrat or Republican, respectively. UNEMPL stands for the unemployment rate subtracted by the mean of the unemployment rate. DEMO_PRE1980 is set equal to DEMO before 1980 and zero afterwards, while DEMO_POST1980 equals DEMO after 1980 and zero otherwise. Robust *t* statistics is in brackets. ***, ** and * is significant at 1%, 5% and 10%, respectively.

Table 2: Panel Regression

Dep. Variable	change in the debt-GDP ratio Δd_t					
	(1)	(2)	(3)	(4)	(5)	(6)
d_t	0.0050	0.0078	-0.0208**	-0.0205***	-0.0287***	-0.0375***
	(0.49)	(0.68)	(-2.01)	(-2.65)	(-3.16)	(-3.76)
d_t*JPN	-	-	-	0.1137***	0.1265***	0.1022***
				(6.81)	(7.25)	(5.39)
POL	-0.0031**	-0.0037***	-0.0041***	-0.0031**	-0.0039***	-0.0042***
	(-2.21)	(-2.59)	(-2.86)	(-2.26)	(-2.76)	(-2.93)
UNEMPL	-	0.0015**	0.0025***	-	0.0027***	0.0028***
		(2.33)	(4.10)		(4.31)	(4.57)
Control Variables	No	No	Yes	No	No	Yes
obs.	1005	948	931	1005	948	931
Ad. R^2	0.2996	0.2765	0.3320	0.3484	0.3364	0.3615

Notes: Country dummies and year dummies are included to control for the fixed effects and time effects. JPN is a dummy variable which equals one for Japan and zero otherwise. POL codes left-right positions of government through a three-point scale: -1 for the right-wing government, 0 for the coalition government and 1 for the left-wing government. UNEMPL stands for the unemployment rate. Control variables are the log of real GDP per capita, openness, the sizes of population over 65 and below 14. Robust *t* statistics is in brackets. ***, ** and * is significant at 1%, 5% and 10%, respectively.

Table 3: Robustness

Dep. Variable	change in the debt-GDP ratio Δd_t					
	(1)	(2)	(3)	(4)	(5)	(6)
d_t	-0.0354***	-0.0215**	-0.0206*	-0.0273***	-0.01689	-0.0186
	(-3.60)	(-1.98)	(-1.79)	(-2.78)	(-1.49)	(-1.55)
POL_FR	0.0023*	0.0027***	0.0027***	-	-	-
	(1.88)	(2.59)	(2.67)			
POL_EJPR	-	-	-	-0.0018*	-0.0018*	-0.0017*
				(-1.78)	(-1.74)	(-1.66)
UNEMPL	-	0.0018**	0.0034***	-	0.0015*	0.0035***
		(2.43)	(4.62)		(1.75)	(4.27)
Control Variables	No	No	Yes	No	No	Yes
obs.	835	769	752	749	692	672
Ad. R^2	0.2977	0.2850	0.3209	0.3410	0.2923	0.3325

Notes: Country dummies and year dummies are included to control for the fixed effects and time effects. POL_FR codes left-right positions of government at far left to 10 at far right. POL_EJPR assigns scores for government and parliament from 1, as "right-wing dominance", to 5, as "left-wing dominance". UNEMPL stands for the unemployment rate. Control variables are the log of real GDP per capita, openness, the sizes of population over 65 and below 14. Robust *t* statistics is in brackets. ***, ** and * is significant at 1%, 5% and 10%, respectively.

Figure 1: equilibrium policy rules when ξ=0

Figure 1-1

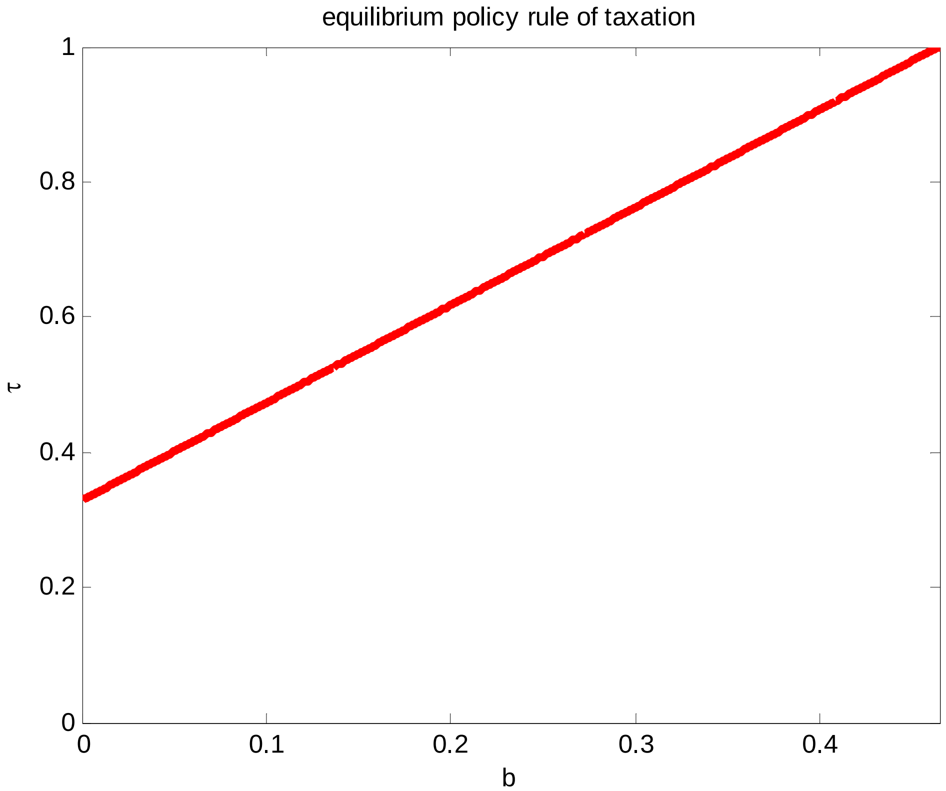


Figure 1-2

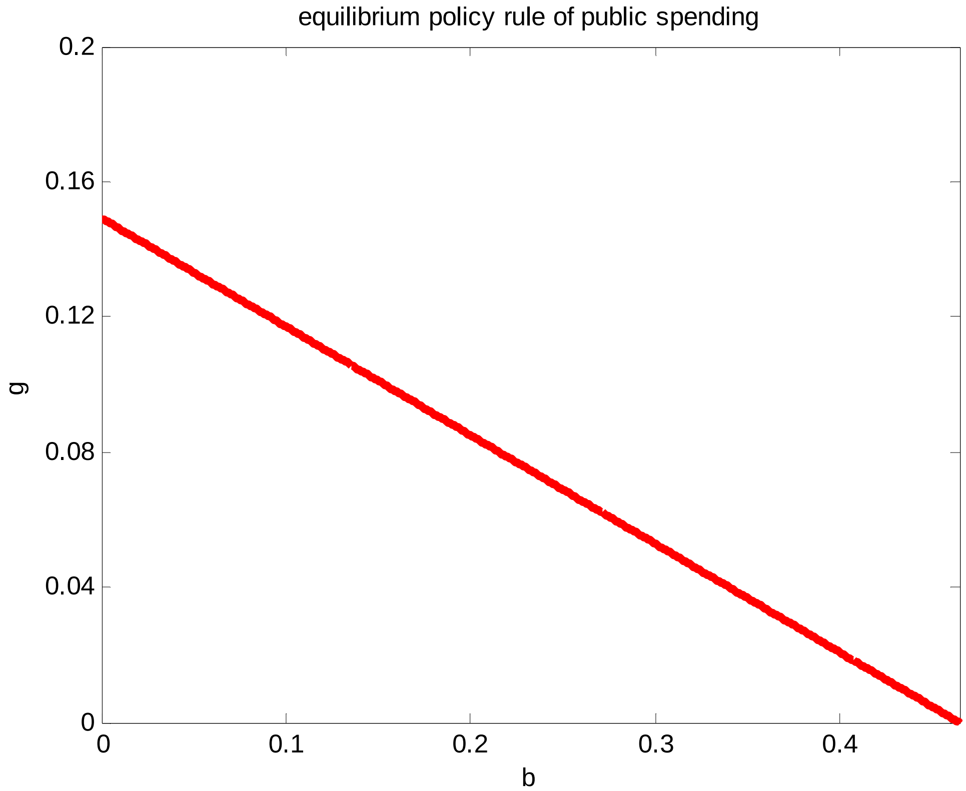

equilibrium policy rule of public spending
0.2
0.16
0.12
0.08
0.04
0
g
0
0.1
0.2
0.3
0.4
b

Figure 1-3

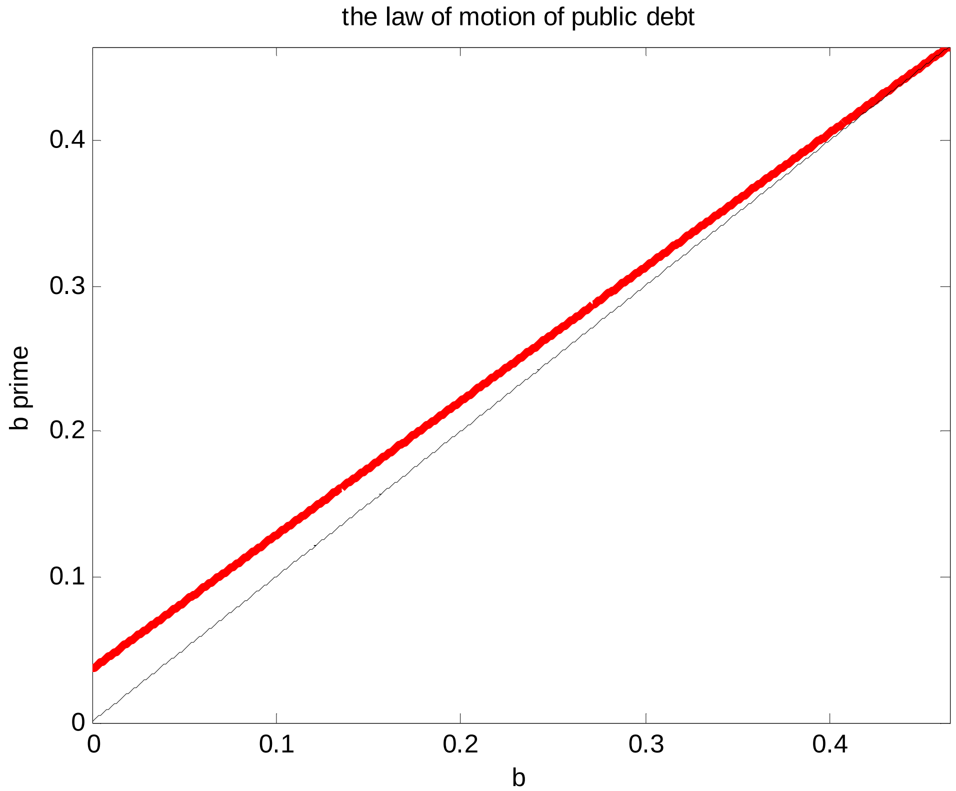

the law of motion of public debt
b prime
0
0.1
0.2
0.3
0.4
0
0.1
0.2
0.3
0.4
b

Figure 2: equilibrium policy rules when ξ=1

Figure 2-1

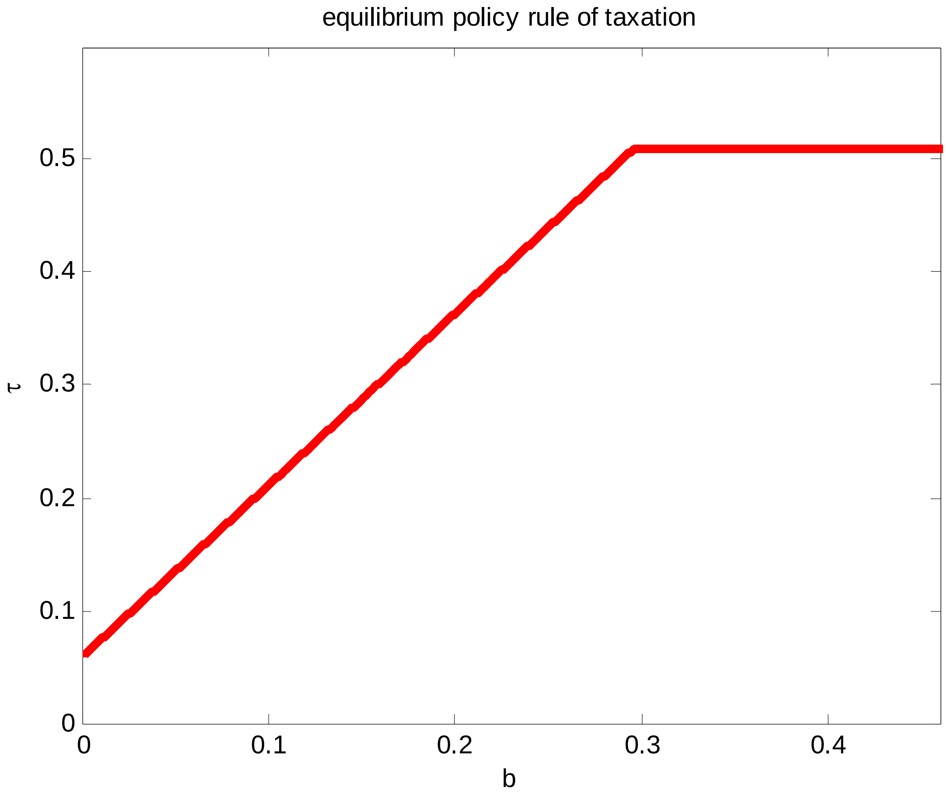
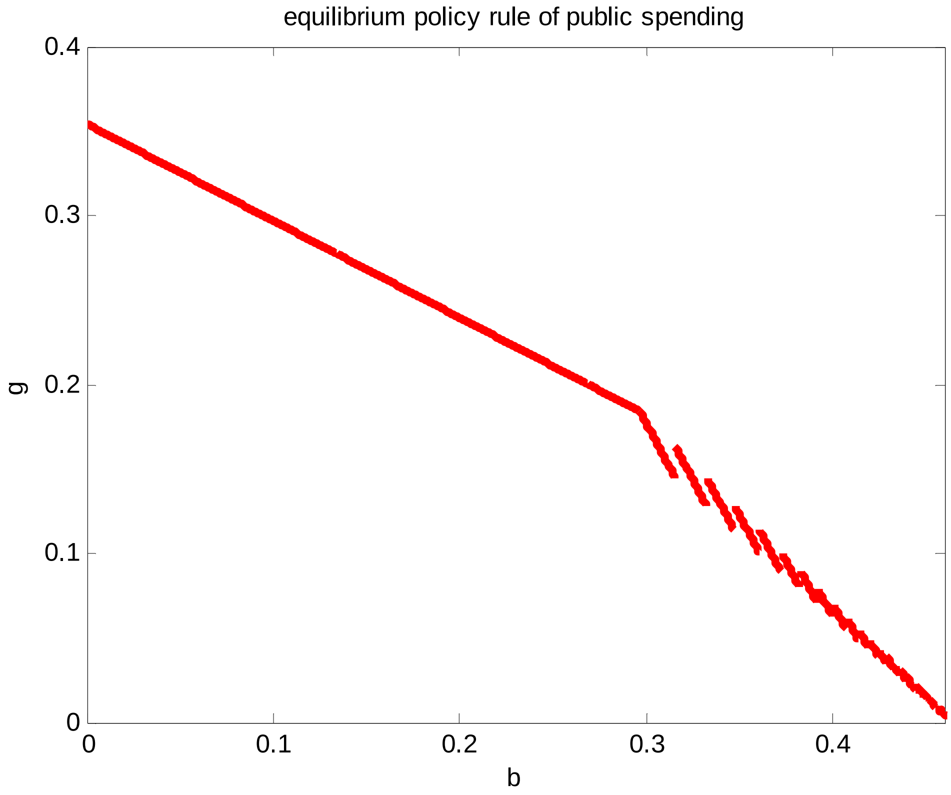


Figure 2-2



equilibrium policy rule of public spending
0.4
0.3
0.2
0.1
0
g
0
0.1
0.2
0.3
0.4
b

Figure 2-3

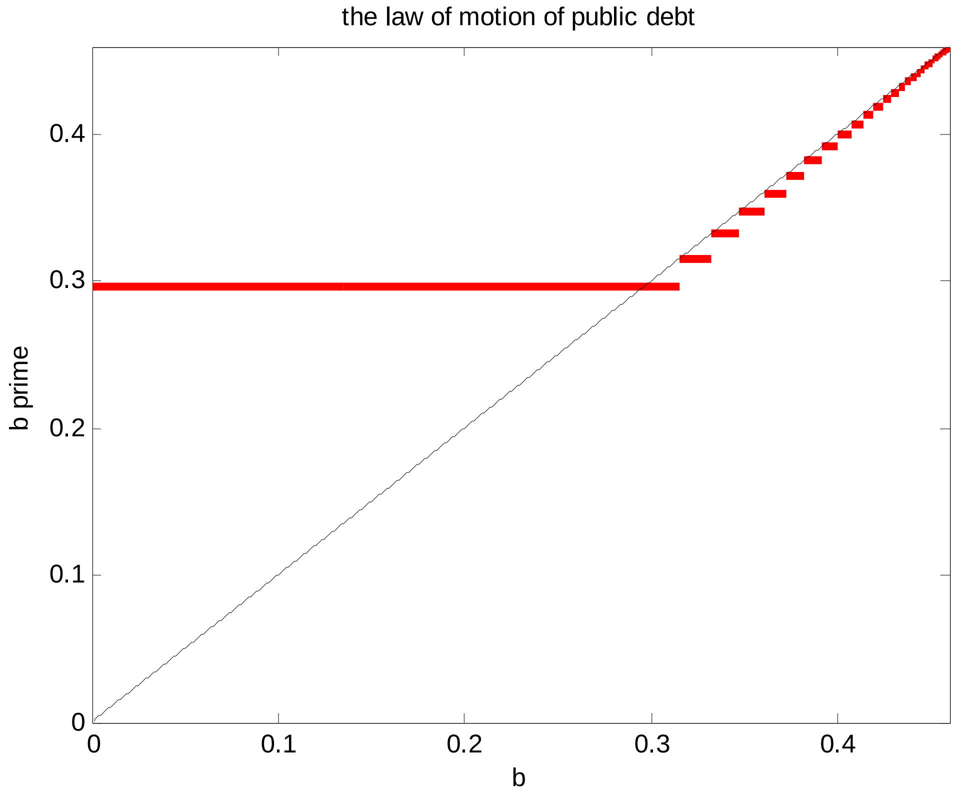

the law of motion of public debt
b prime
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
b

Figure 3: equilibrium policy rules when ξ (0,1)

(solid line and dotted line stand for ξ=0.90 and ξ=0.50, respectively)

Figure 3-1

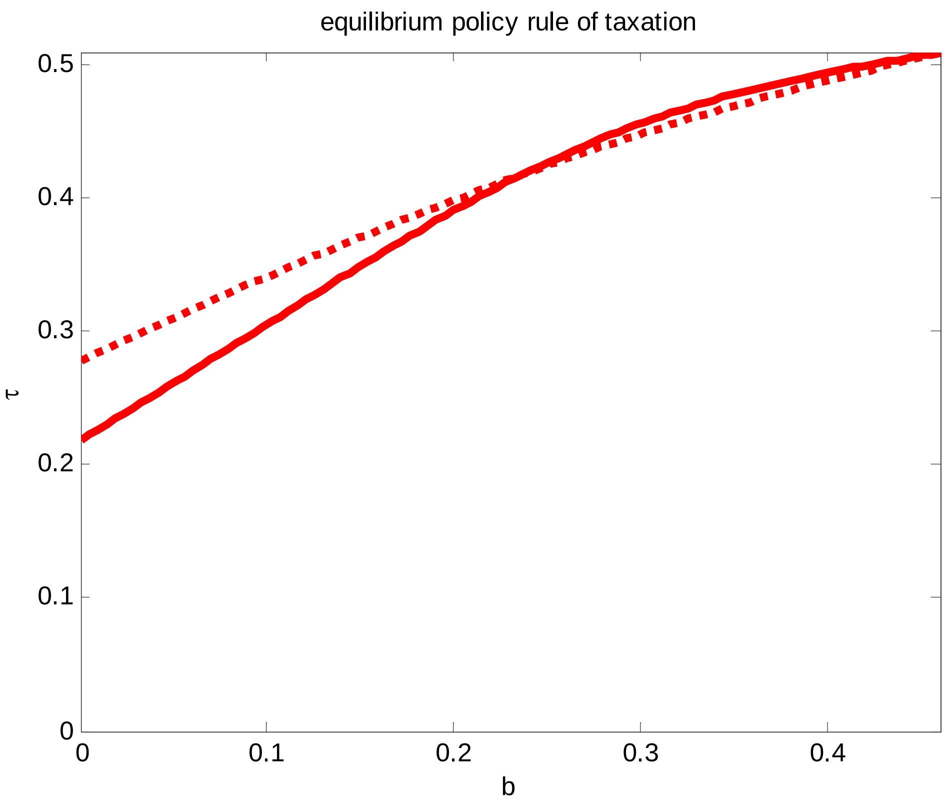
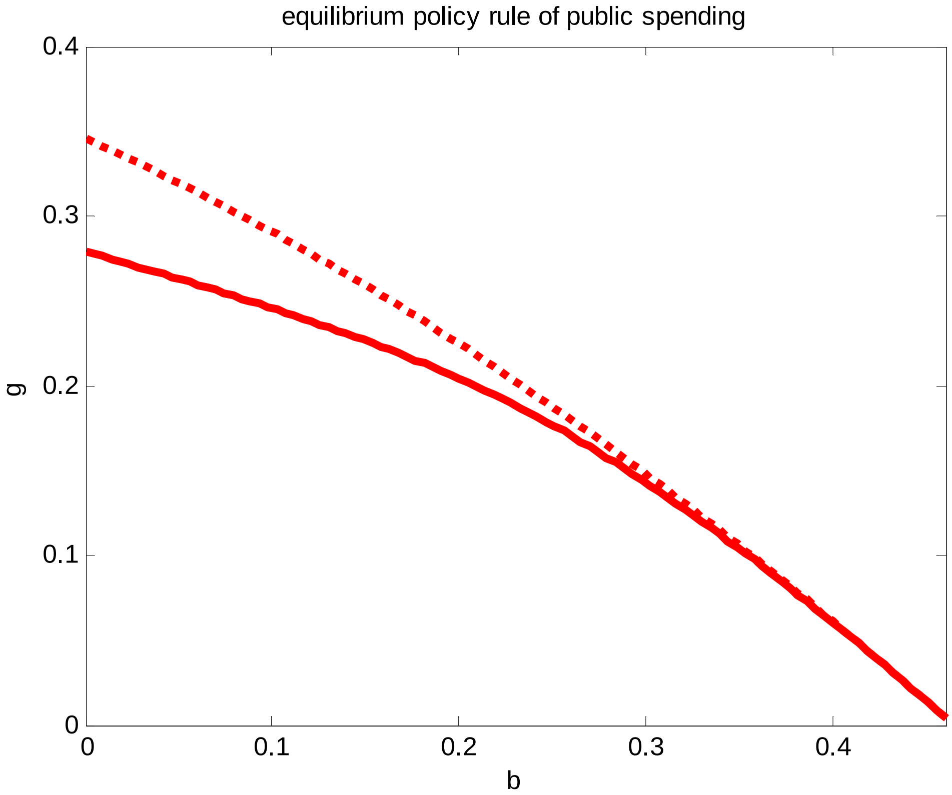
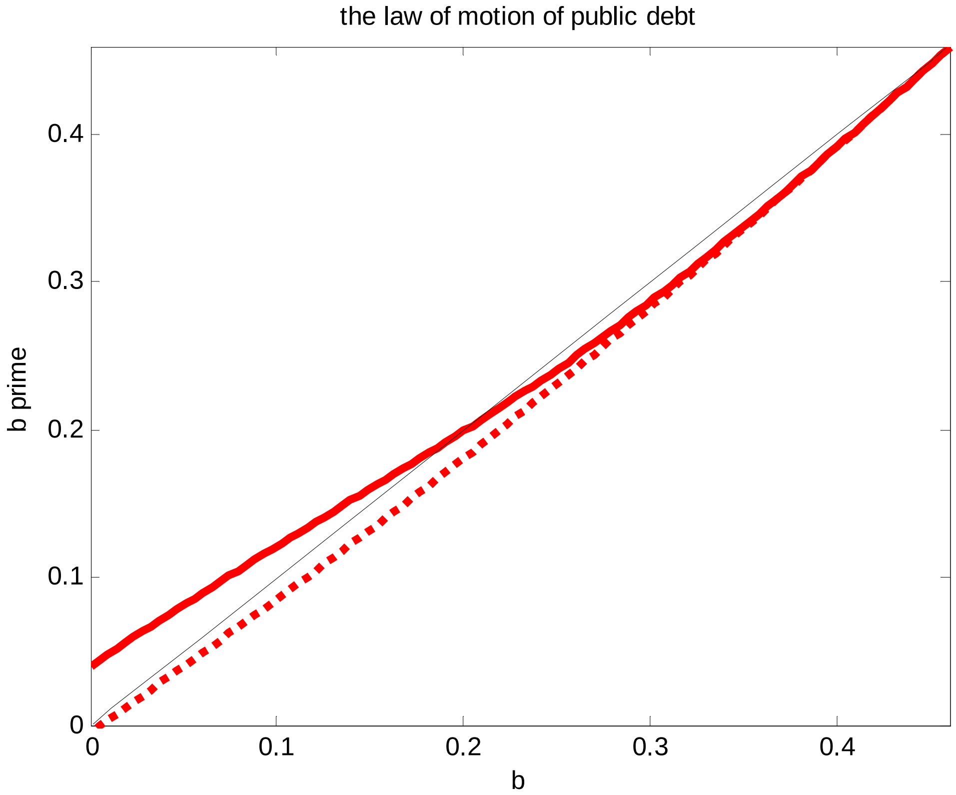


Figure 3-2



equilibrium policy rule of public spending
0.4
0.3
0.2
0.1
0
g
0
0.1
0.2
0.3
0.4
b

Figure 3-3



the law of motion of public debt
b prime
b
0
0.1
0.2
0.3
0.4
0
0.1
0.2
0.3
0.4

Figure 4: impulse response function for a unanticipated war

(solid line and dotted line stand for ξ=0.90 and ξ=1, respectively)

Figure 4-1

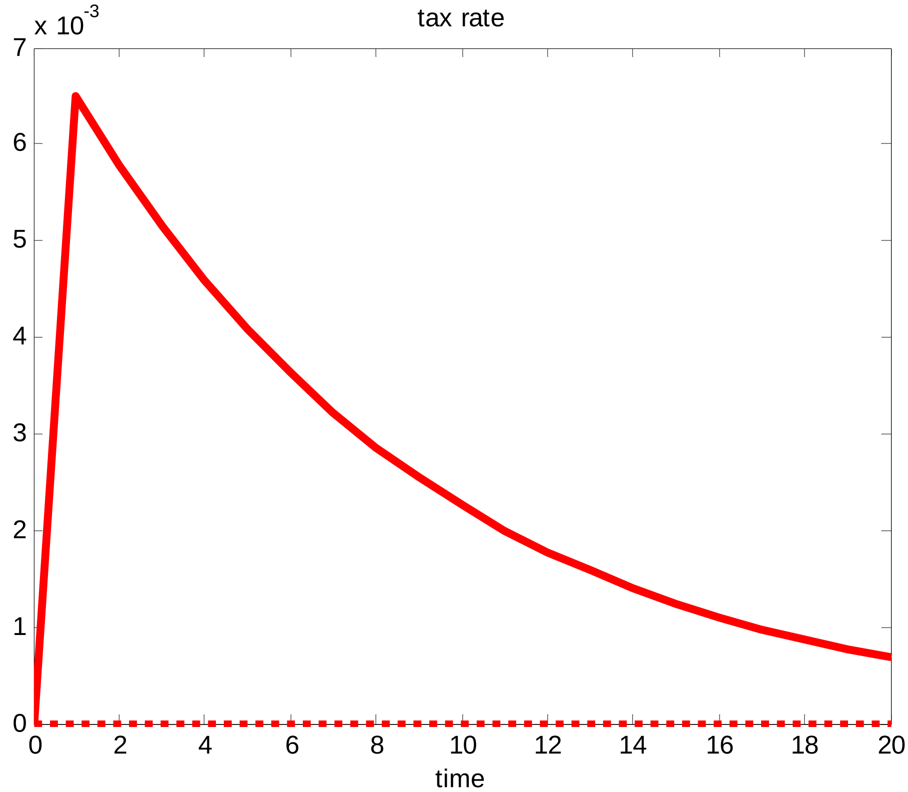
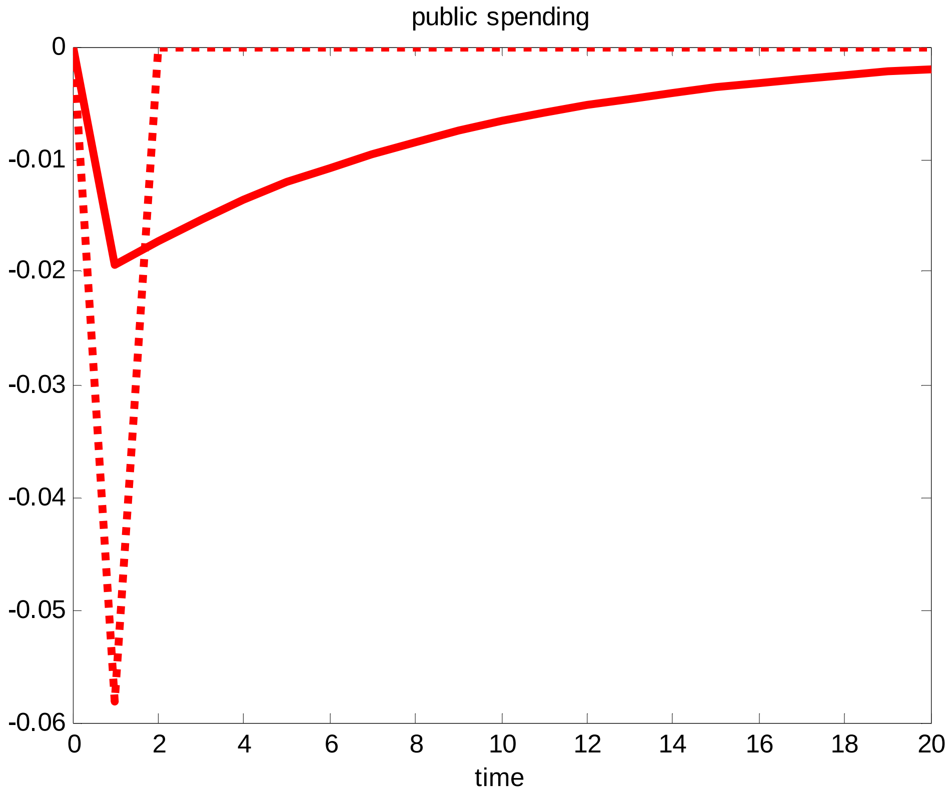


Figure 4-2



public spending
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
0
2
4
6
8
10
12
14
16
18
20
time

Figure 4-3

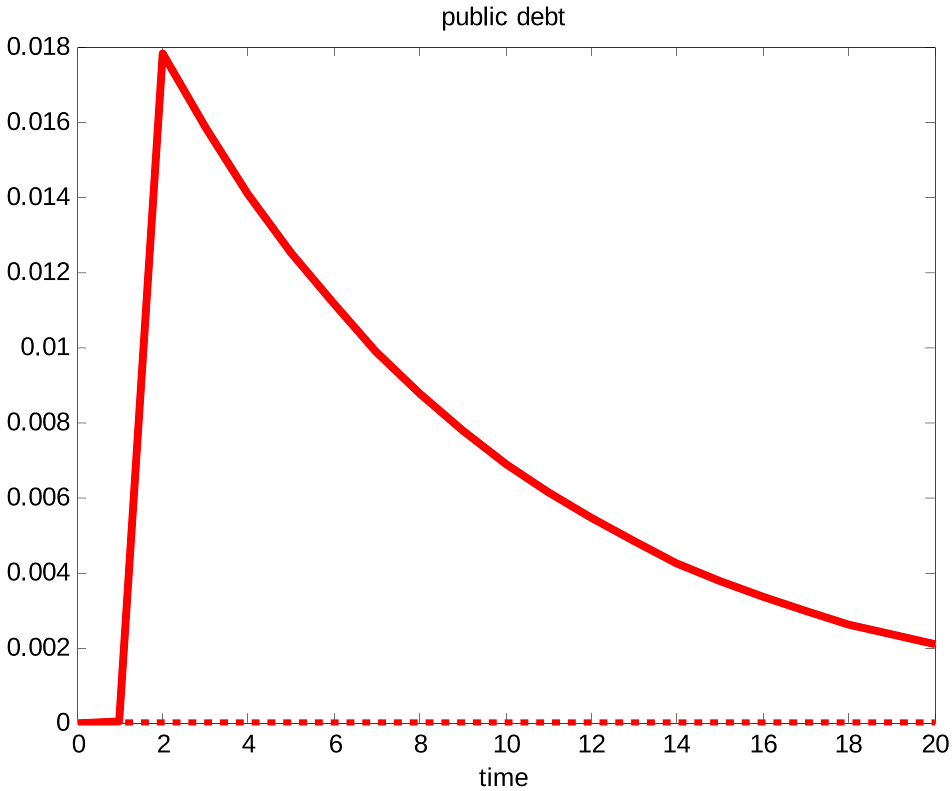

public debt
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
2
4
6
8
10
12
14
16
18
20
time

Figure 5: equilibrium policy rules with war

(dotted line stands for peace and solid line stands for war)

Figure 5-1

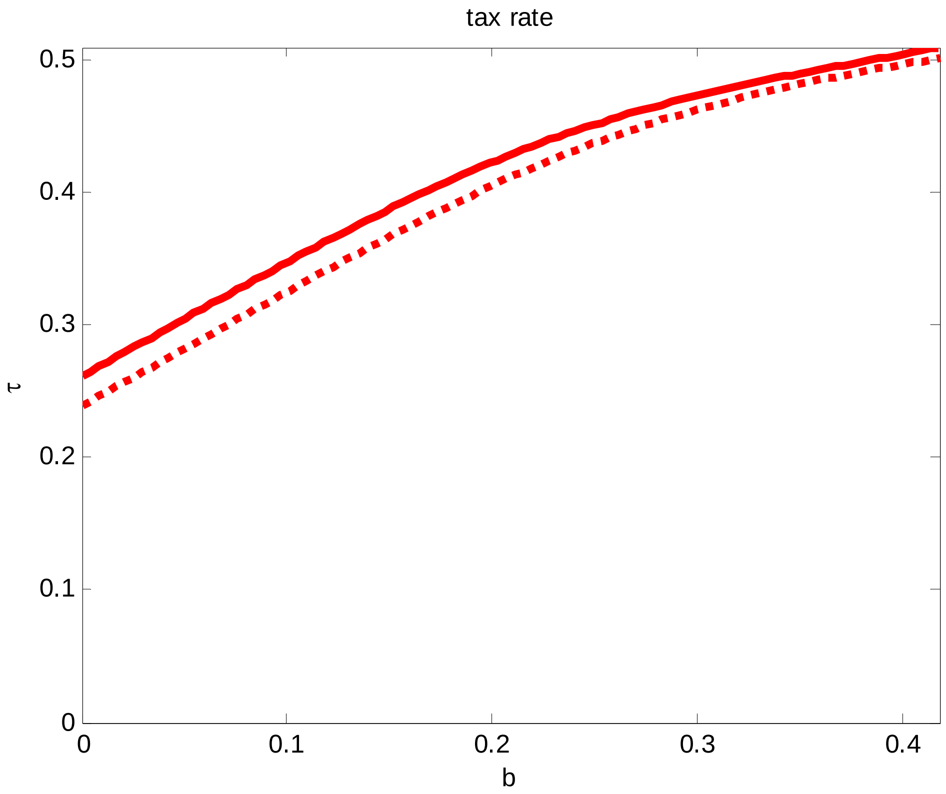


Figure 5-2

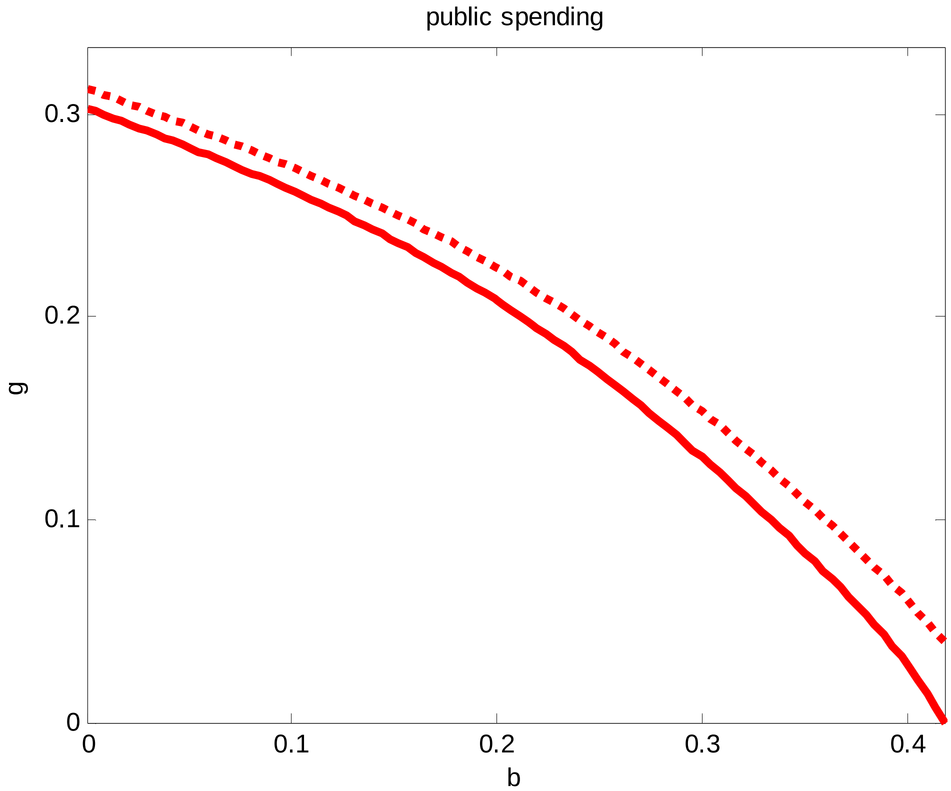
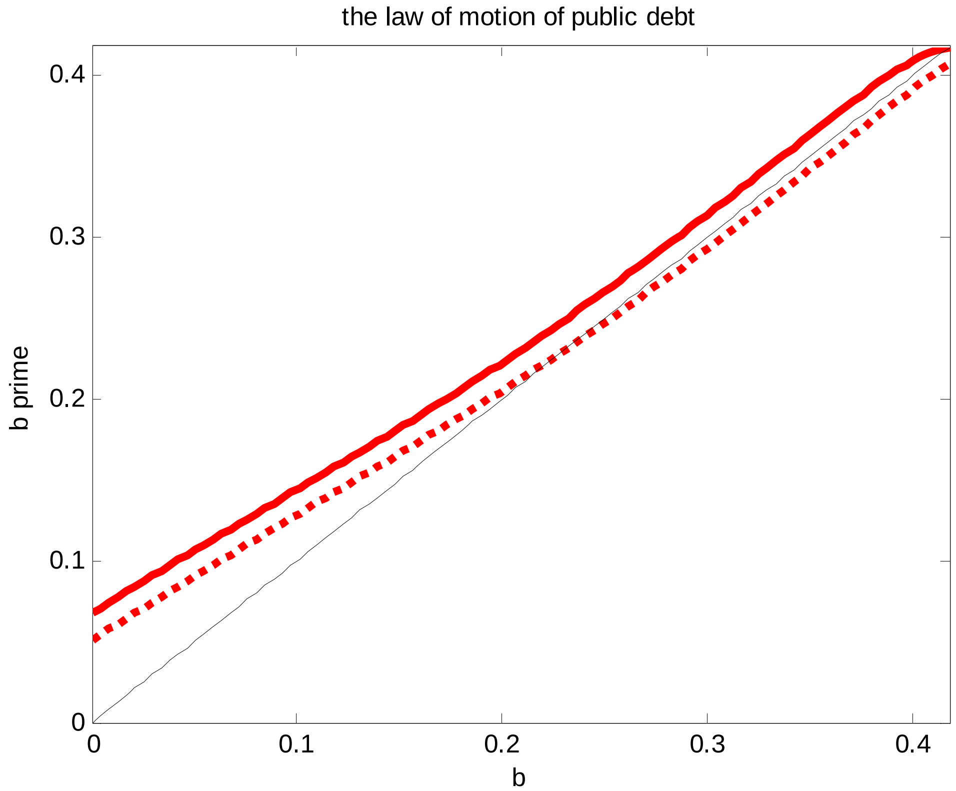
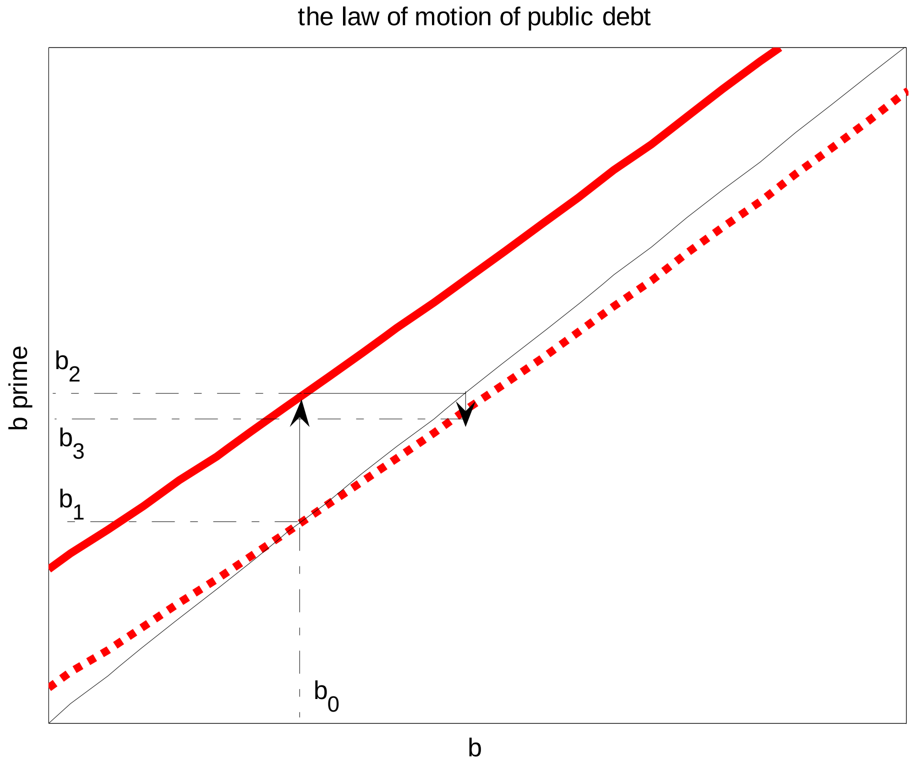


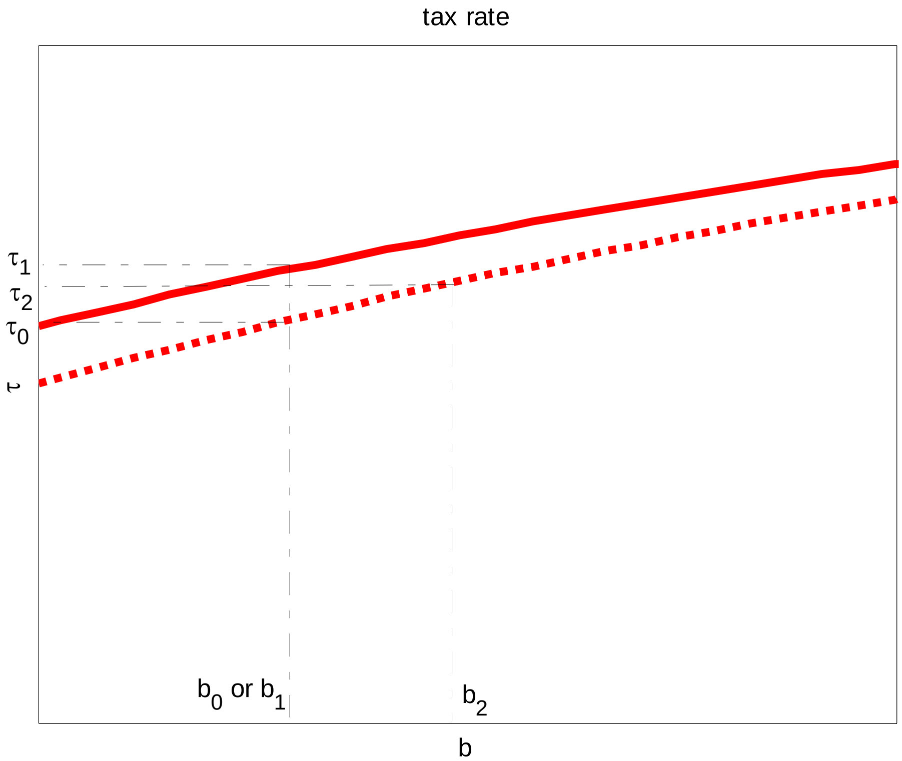
Figure 5-3


the law of motion of public debt
b prime
b
0
0.1
0.2
0.3
0.4
0
0.1
0.2
0.3
0.4

Panel 5-4



Panel 5-5



Panel 5-6

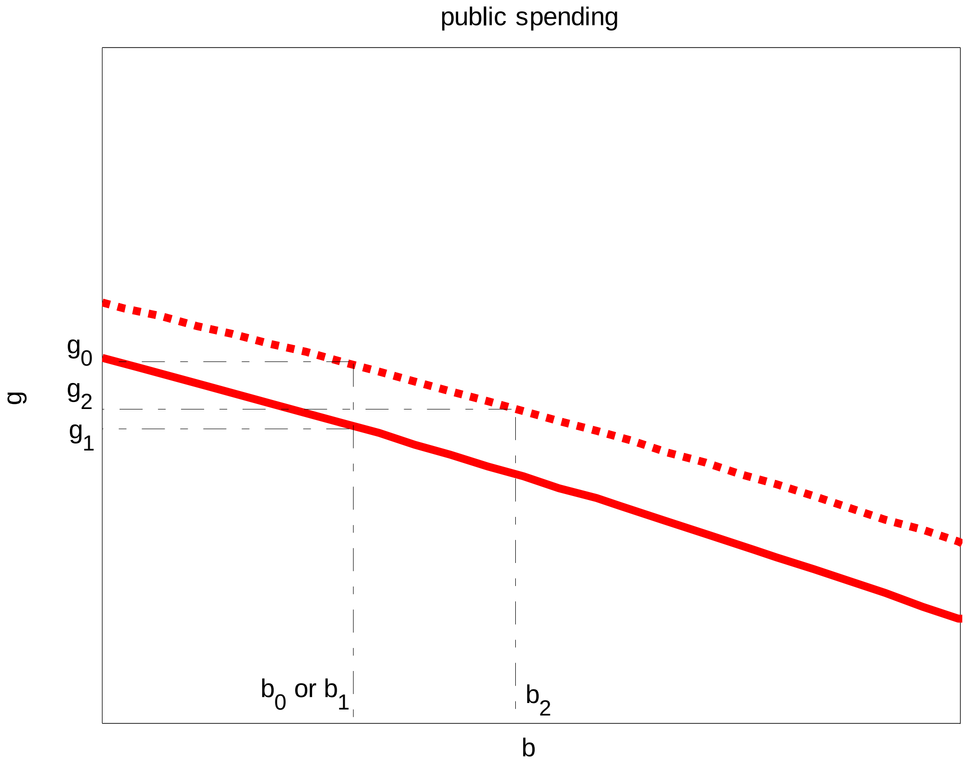


Figure 6: Ramsey policy rules with war after the initial period

(dotted line stands for peace and solid line stands for war)

Figure 6-1

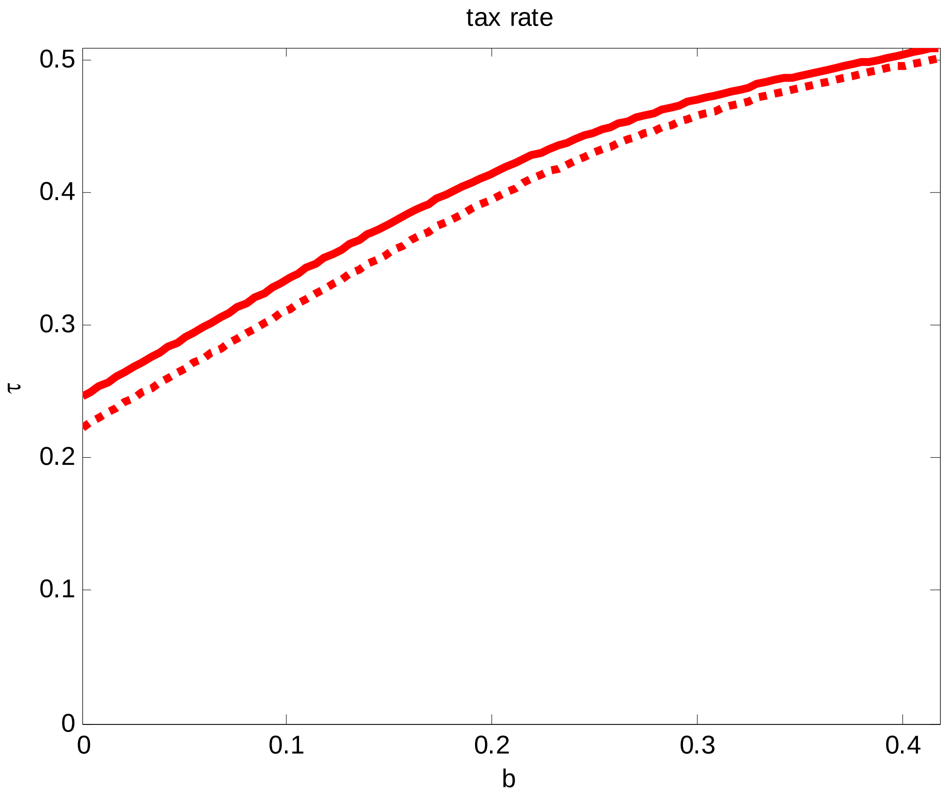


Figure 6-2

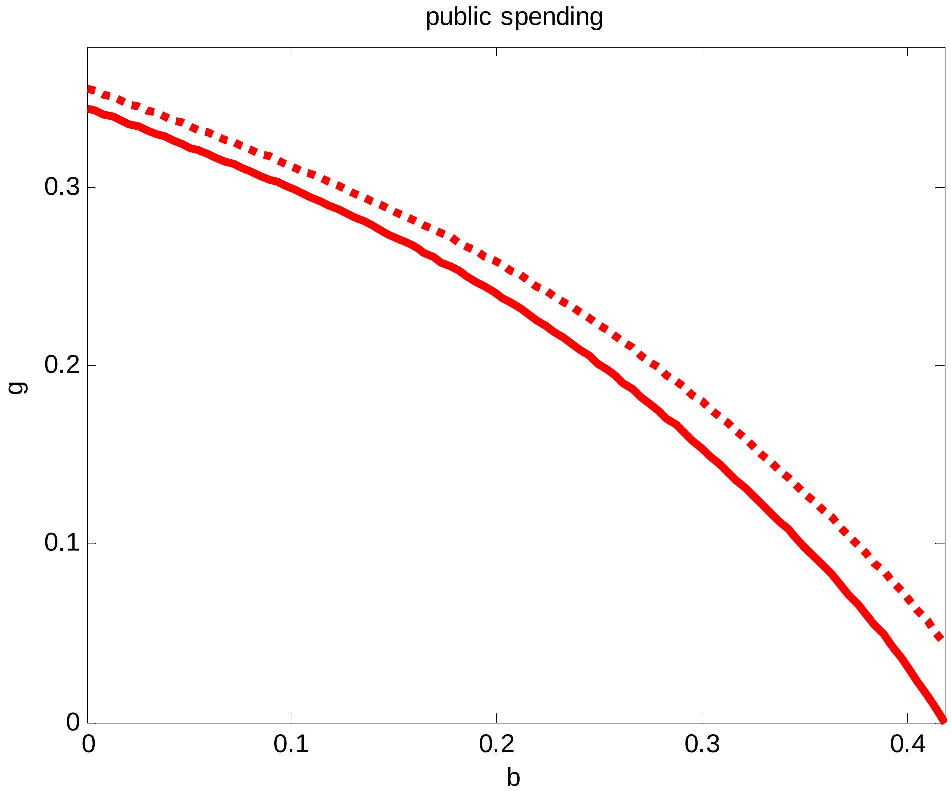
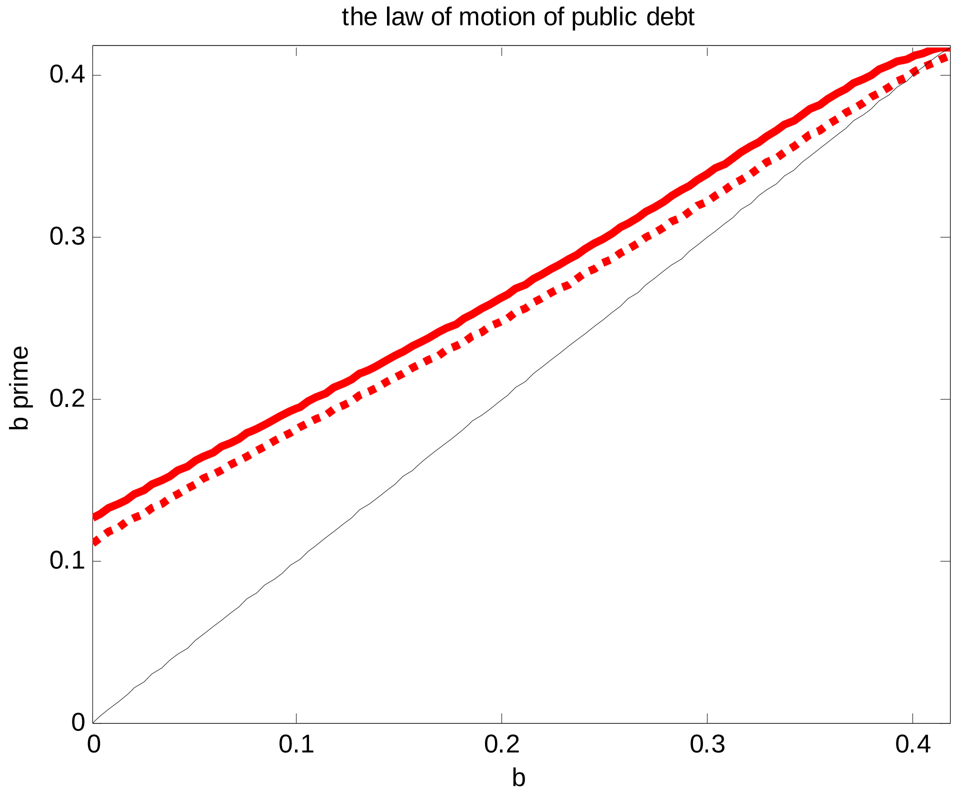


Figure 6-3

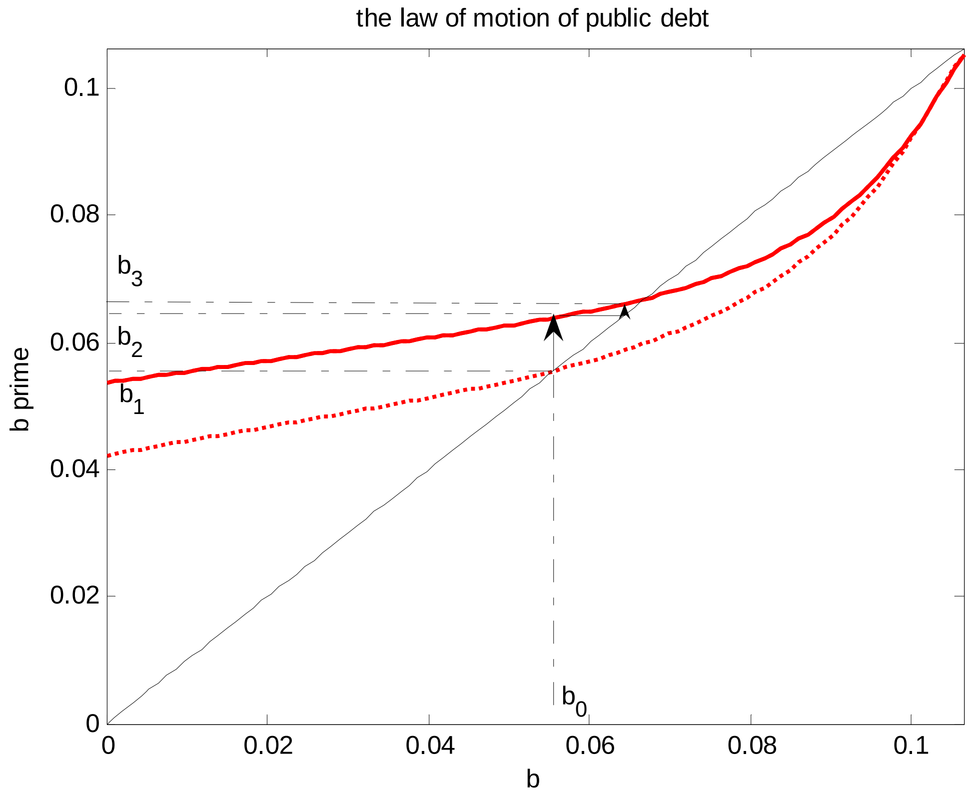


the law of motion of public debt
b prime
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
b

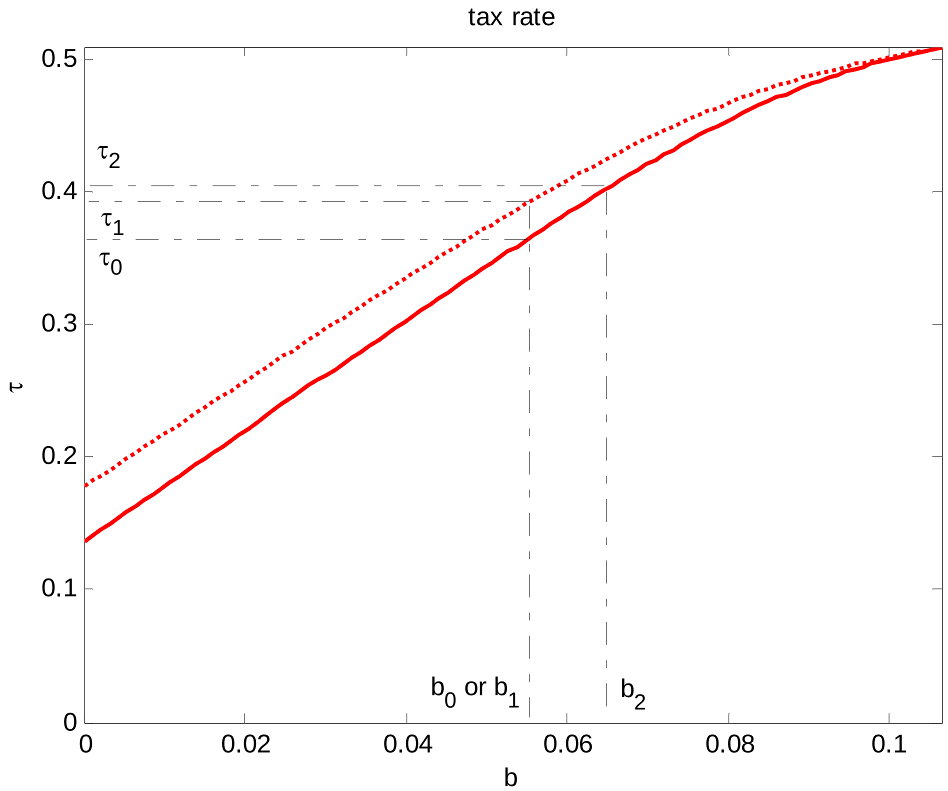
Figure 7: Political Regime Shifts

(dotted lines for the left-wing regime, and solid lines for the right-wing)

Panel 7-1

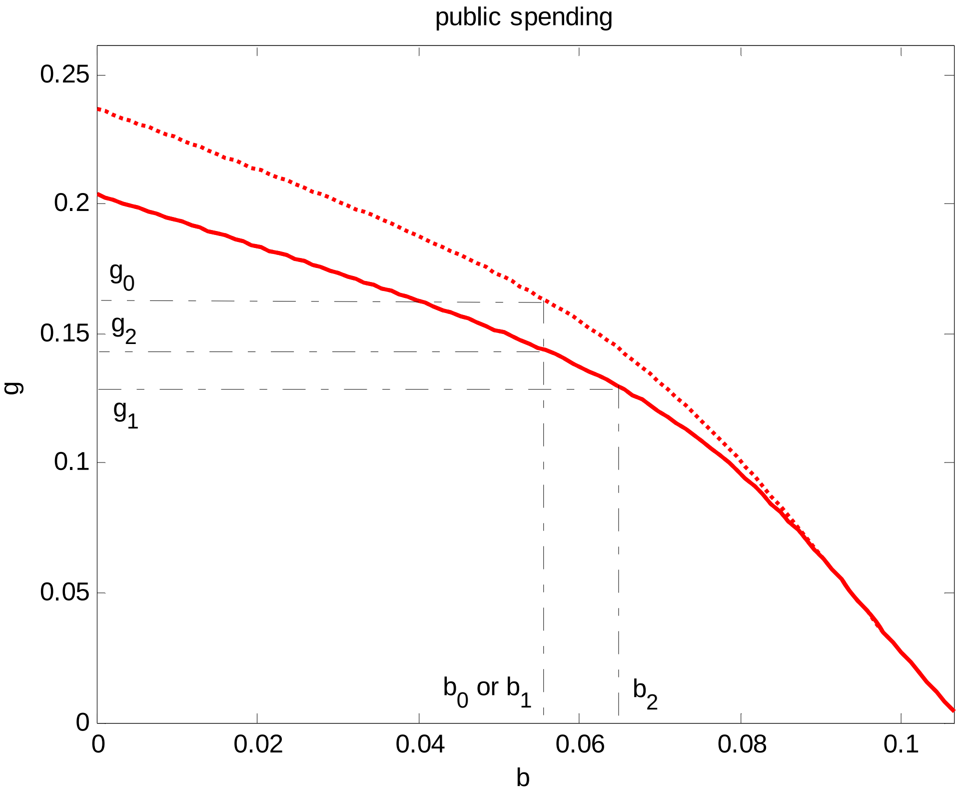


Panel 7-2



tax rate
0.5
0.4
0.3
0.2
0.1
0
τ
τ_2
τ_1
τ_0
b_0 or b_1
b_2
0
0.02
0.04
0.06
0.08
0.1
b

Panel 7-3

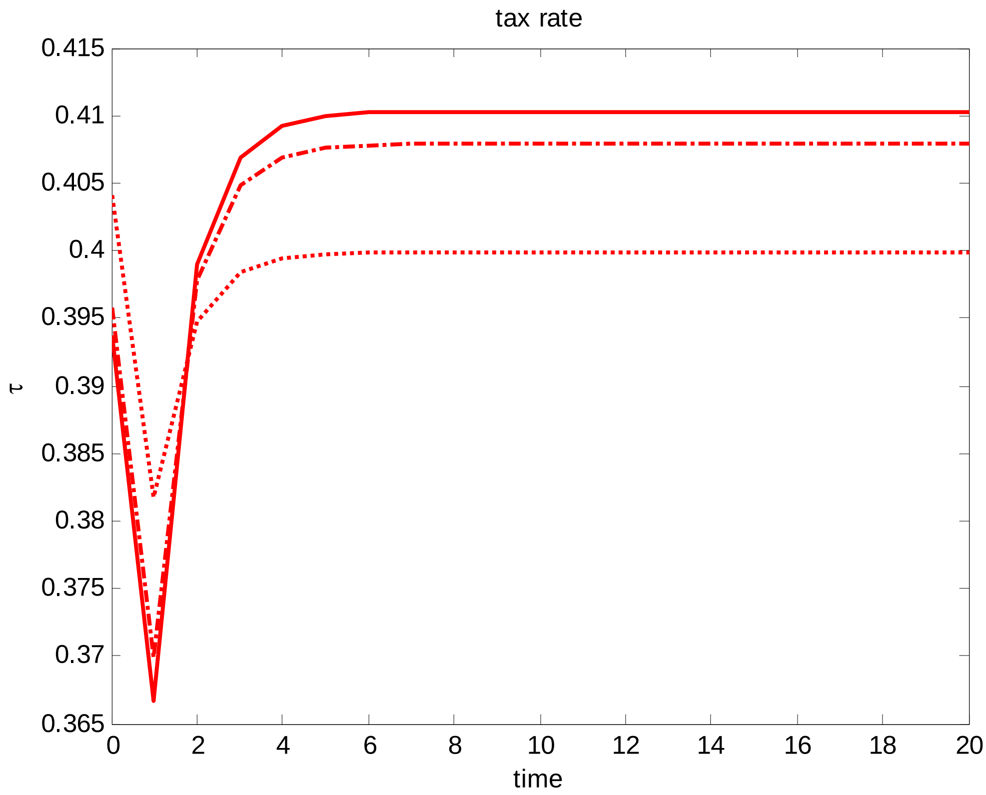


public spending
g
b
0.25
0.2
0.15
0.1
0.05
0
0.02
0.04
0.06
0.08
0.1
g_0
g_2
g_1
b_0 or b_1
b_2

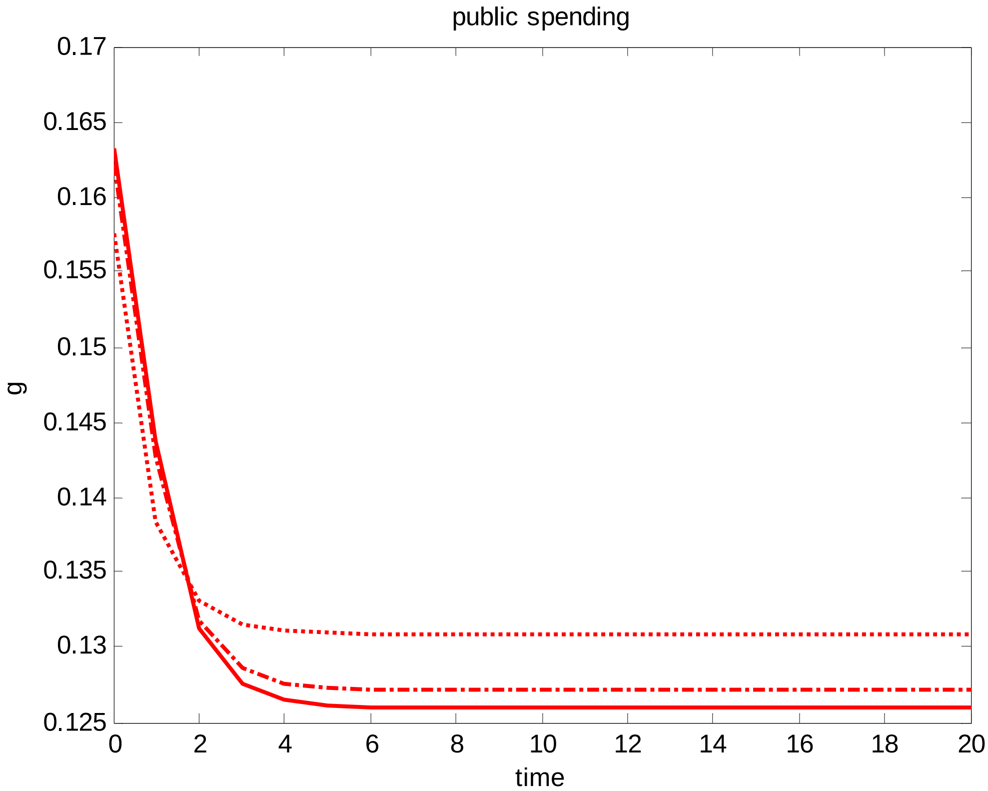
Figure 8: Time-Series for Political Regime Switches

(solid lines for p=1, dashed lines for p=0.9 and dotted lines for p=0.5)

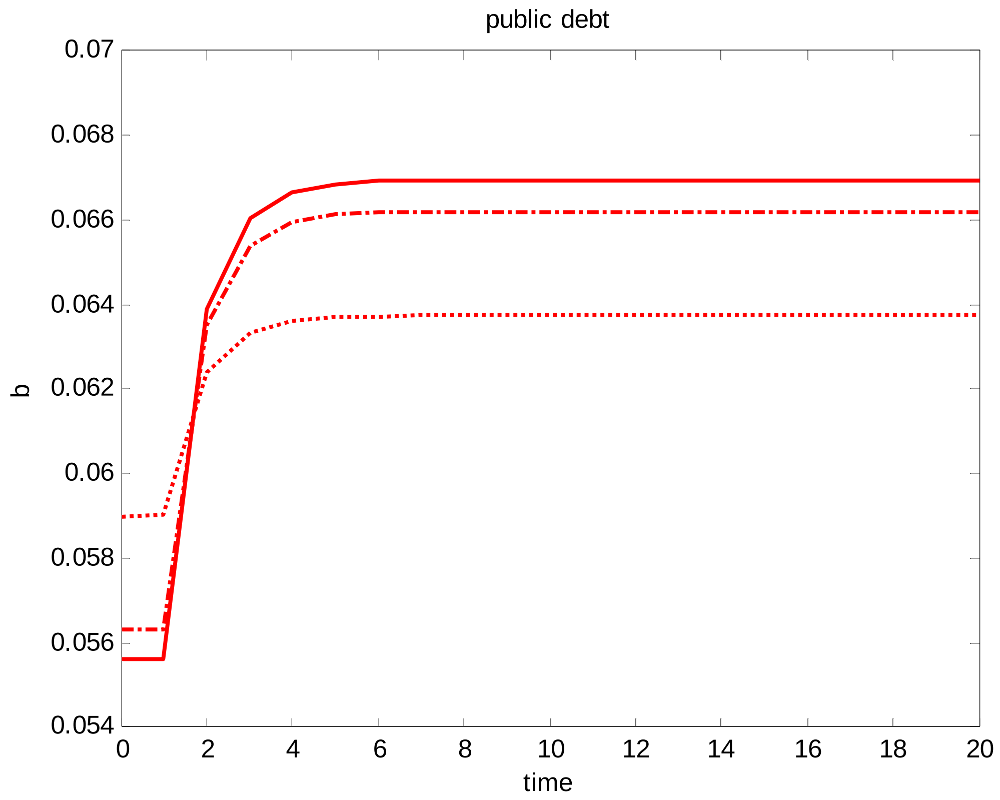
Panel 8-1



Panel 8-2


public spending
g
0.17
0.165
0.16
0.155
0.15
0.145
0.14
0.135
0.13
0.125
0
2
4
6
8
10
12
14
16
18
20
time

Panel 8-3


public debt
0.07
0.068
0.066
0.064
0.062
0.06
0.058
0.056
0.054
b
0
2
4
6
8
10
12
14
16
18
20
time