Growth and fiscal policy: a positive theory[*]

Abstract

We present a political economy theory of growth in which the government affects the growth rate both directly through public investments in infrastructure, and indirectly through the effect of taxation on learning by doing. Policy choices are made by a legislature consisting of representatives elected by geographically-defined districts. The legislature can raise revenues via a discretionary income tax and by issuing public debt. We study the equilibrium relationship between the dynamics of debt and the growth rate of the economy. We use the model to study the impact of an "austerity program" in which a country is forced to reduce the debt/GDP ratio. To quantify these effects, the model is calibrated to the U.S. economy.

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1 Introduction

The rapid deterioration of the fiscal position of the U.S. federal government in the aftermath of the great recession of 2008 has brought the spotlight on the long term effect of public debt on the real economy. Federal debt in the U.S. is currently its highest level since the decade following World War II. Concerns over the growth of public debt has led to the Budget Control Act of 2011. The act triggered automatic across-the board cuts in spending starting January 1, 2013 because a deficit reduction bill of at least 1.2 trillions was not passed by that date. For the U.S. (and for all other countries with high levels of debt[1]) the key questions are: To what extent do high levels of public debt permanently reduce the growth potential of the economy? Are austerity programs effective in reducing debt/GDP and in increasing growth potential and welfare? How should they be designed?

To answer these questions we need a theory in which growth and fiscal policy are jointly determined in equilibrium. The literature on growth, however, has traditionally been more focused on the private sector, emphasizing the role of entrepreneurial innovation and technological advancement. With few notable exceptions, fiscal policy has been ignored or assumed as exogenous. Even in the research that has explicitly considered a role for the government, public policy is assumed to balance the budget in every period and public debt is not studied. Yet, fiscal policy has changed in important ways during last four decades, with potentially significant implications for macroeconomic outcomes (see Figure 1). In the post WWII era, after bottoming at around 25% of GDP during the seventies, the debt level in the U.S. has been steadily increasing over time, surpassing 60% by the end of 2010. During this period, both the tax revenue and the provision of public goods and infrastructure have declined as shares of GDP, with public investment falling rather dramatically.[2]

In this paper we present a political economy theory of endogenous growth in which the government can issue debt to finance expenditures. In our theory the growth rate of the economy depends on public investment and, because of learning-by-doing, on private citizens' labor supply. Fiscal policy affects citizens' incentives in two ways: taxation distorts labor supply and deficits distort the consumption/savings decision through their effect on the interest rate. Policy choices

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[1] In more than a half of the 17 Eurozone countries debt is over 60% of GDP, and in five of them–over 80%.

[2] These findings are robust to alternative accounting definitions of public goods and public investments (see Section 7.6).
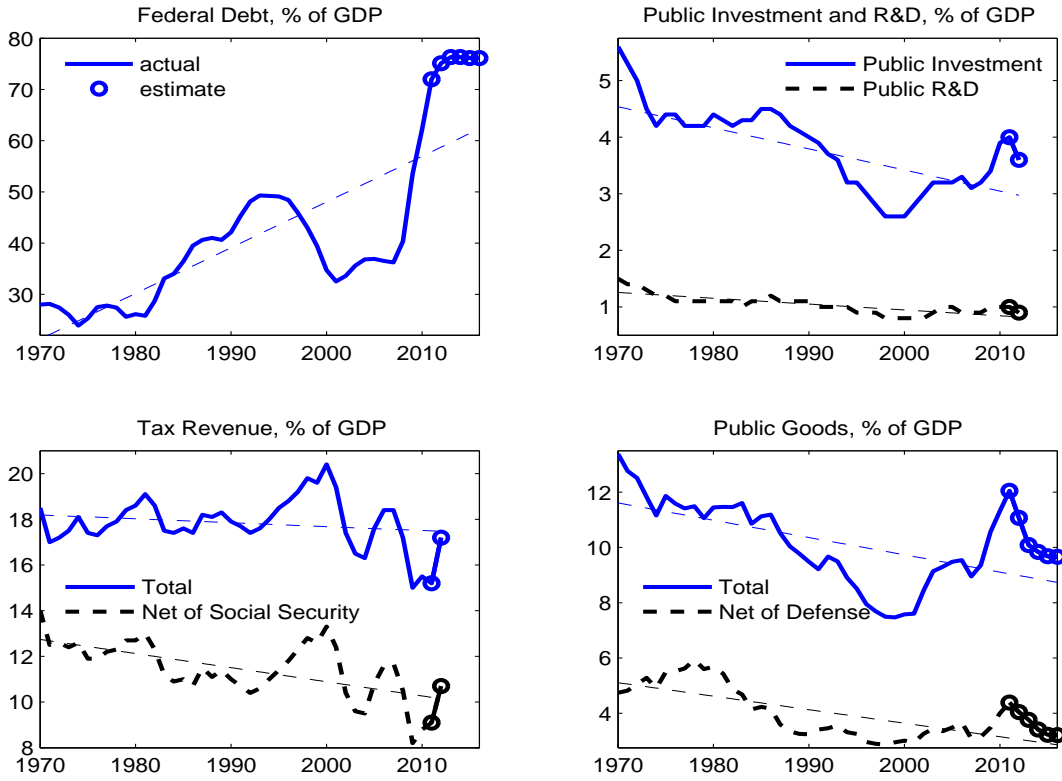
Figure 1: Fiscal trends in the U.S. economy.

are made by a legislature consisting of elected representatives. Political conflict arises because representatives in the legislature have incentives to vote for policies that favor their own constituencies and citizens benefit only partially from local public goods provided to constituencies to which they do not belong. The level of public debt and the level of productivity in the economy are state variables and create a dynamic linkage across policy-making periods. We use the model to provide a positive theory of growth and fiscal policy and to evaluate the normative effects of austerity programs that limit the ability of the government to issue debt. Since our theory is designed as a model for a large closed economy, we calibrate it to the U.S. economy to assess its predictions quantitatively.

Starting from any initial state, the economy in our model converges toward a balanced growth path in which consumption, public investment, public good provision, public debt and productivity grow at the same constant rate. Under standard assumptions, on the balanced growth path the debt-to-GDP ratio is positive and the growth rate of the economy is inefficiently low. The

transition to the balanced growth path is characterized by what we call the *shrinking government effect*: public debt grows faster than GDP, provision of public goods and infrastructure grows slower than GDP, and the tax rate declines. Effectively, as the economy converges to its balanced growth path, a decreasing fraction of GDP is devoted to providing public services. These findings, along with our calibration results, are in line with the U.S. (Figure 1).

The shrinking government effect is a consequence of the political distortion and its effect on the interest rate. Political distortions induce the ruling coalition–the coalition in the legislature that controls fiscal policy–to use debt to shift the burden of taxation to the future. In every period the ruling coalition trades off an extra increase in public goods today for their own districts, with a more than proportional reduction in public goods in the following period for all districts. The former option is always more appealing because the ruling coalition can better target current expenditures to their own districts rather than the future expenditure. Consequently, debt increases, forcing legislators to increase the primary surplus to service its cost. Legislators find it optimal to do this by reducing expenditures rather than increasing taxes: When expenditures are reduced, disposable income and savings increase, and so the interest rate is held down. To the contrary, when taxes are increased, disposable income and savings decline, so the interest rate goes up.

An interesting implication of the shrinking government effect is that, as debt/GDP increases, the growth rate of the economy does not necessarily go down. This occurs because the decline in taxation may induce an increase in labor supply and, hence, in learning-by-doing. This finding may help explain the evidence suggesting a non monotonic relationship between debt and growth.[3]

The fact that there is not necessarily a monotonic relationship between public debt and growth, however, should not be interpreted as a sign that debt has a limited impact on welfare. In our model debt always reduces welfare, even if it does not reduce growth: the reduction in welfare is induced by the reduction in public services.

To study how countries can limit the inefficiencies in growth highlighted above, we study a simple but plausible type of an "austerity program." The government is forced to reduce its deficit (to run a surplus) until the new, lower level of the debt/GDP ratio is reached. Such a program is characterized by two features, a target level for debt and a time horizon: The country is required to bring down debt to a given target level over a given number of years. Three findings emerge from this exercise. First, in our calibration, austerity programs typically increase welfare

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[3] See, for example, Kumar and Woo [2010], Checherita and Rother [2010] and Reinhart and Rogoff [2010].

if they are not excessively ambitious. Second, there is no "one-size-fits-all" austerity program: the optimal plan depends on the fundamentals and on the initial state of the economy. The higher is the accumulated level of debt, the less aggressive the programs should be, both in terms of the debt target and in terms of duration. The third finding is that the growth rate is a poor measure of the success of the program. On the transition path of the optimal austerity program, growth is below the pre-austerity level, but welfare is increasing.

Our paper is related to two strands of literature. First the literature on endogenous growth. Most of this research is normative and focused on evaluating the effects of taxation on the capital accumulation process rather than at explicitly modelling policy making (Rebelo [1990], King and Rebelo [1991], Barro [1991], Stokey and Rebelo [1993], Jaimovich and Rebelo [2012]). Positive theories of growth have been presented in the context of the research studying the political economy of redistribution. The basic idea developed in these papers is that income inequality determines tax policy and therefore growth (Bertola [1993], Perotti [1993], Saint-Paul and Verdier [1993], Alesina and Rodrik [1994], Persson and Tabellini [1994], Krusell and Rios-Rull [1999], Benabou [2000], Saint Paul [2001]). A common trait of these theories (both normative and positive) is that fiscal policy is assumed to balance the budget in every period and so public debt is ruled out by assumption.[4] Our paper contributes to this endogenous growth literature in two ways. First, we allow for a richer policy space with public debt. Second, we propose an explicit dynamic model of political decision making in which rational forward looking policy-makers bargain for the policy outcome. To do this, we focus on a symmetric model in which there is no redistribution of wealth between citizens. Our focus is on the efficiency of policies.

The second strand of literature to which our paper is related is the research on the political economy of public debt (Persson and Svensson [1989], Alesina and Tabellini [1990], Battaglini and Coate [2008] among others). These models are specifically aimed at modelling public debt, but they do not allow for growth and make assumptions that simplify the determination of the equilibrium interest rate. These two issues are intimately connected. The key assumption in this literature is that preferences are quasi-linear: in this case the equilibrium interest rate is constant and independent of the chosen policies.[5] Balanced growth, however, is not consistent

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[4] An exception is Saint-Paul [1992] where the government can issue debt. The main result of this paper is that debt is not welfare improving. The paper is normative and does not present a theory of public debt.

[5] In the context of normative models in which policies are chosen by a benevolent planner, the strategic interaction between fiscal policy and interest rates has been first studied by Stokey and Lucas [1983] and then extended

with these preferences: this is why modelling endogenous growth and the endogeneity of interest rates simultaneously is necessary. As we show in this paper, the endogeneity of interest rates is crucial to understanding the dynamics of fiscal policy in large closed economies. A neoclassical growth model in which the government can expropriate capital in the presence of political economy frictions is presented by Aguiar and Amador [2010, 2012]. Differently from our work, this research focuses on the case of a small open economy for which the interest rate is exogenous: because of this it does not study the interaction between fiscal policy, interest rates and political distortions that is the primary objective of our work. Finally, there is a significant literature studying the political economy of deficit reduction programs both theoretically and empirically.[6] None of the papers cited above has explicitly studied the link between debt, fiscal policy and the endogenous growth process.

The organization of the remainder of the paper is as follows. Section 2 outlines the model. Section 3 characterized the political equilibrium. In Section 4 we study the dynamics of the model using parameters calibrated to the U.S. economy. In Section 5 we use the model to study the effect of an austerity program and we study how the optimal austerity program depends on the environment. Section 6 concludes.

2 Model

The economy A continuum of infinitely-lived citizens live in n identical districts indexed by $i = 1, ..., n$. The size of the population in each district is normalized to be one. There is a single nonstorable consumption good, denoted by c, that is produced using a single factor, labor, denoted by l. There is also a set of n local public goods, denoted by $\gamma = \left\{ \gamma^i \right\}_i$, that can be produced from the consumption good. The variables at time t will be denoted with a subscript t. We will study equilibria in which all agents from the same district j make the same economic choices.

The citizens enjoy the consumption good, benefit the local public goods, and supply labor. For most of the paper we assume that each citizen's preferences in district i are represented by

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to a variety of environments by, among others, Martin [2009] who allows for the presence of money, Rogers [1989], Occhino [2012] and Debortoli and Nunes [2012] who allow for endogenous public spending, and Aiyagari et al [2002] and Shin [2006] who consider stochastic economies.

[6] Among theoretical contributions we have Alesina and Drazen [1991], Grilli and Drazen [1993], Drazen [2001]). More than on studying the effects of deficit reduction, this literature is focused on studying when deficit reduction program are chosen. The effects of a balanced budget rule has been studied by Azzimonti, Battaglini and Coate [2011]. Among empirical contributions in this literature we have Giavazzi and Pagano [1990], McDermott and Wescott [1996], Alesina and Ardagna [1998], Alesina, Perotti and Tavares [1998], Ardagna [2004].

the following per period utility function:

$$u(c_t, l_t, \gamma_t) = \log \left(c_t (1 - l_t)^\mu \right) + \omega_0 \log \left[\left(\gamma_t^i \right)^\alpha \left(\sum_j \gamma_t^j \right)^{1-\alpha} \right], \tag{1}$$

where $\mu > 0$, $\omega_0 > 0$ and $\alpha \in [0, 1]$. This utility describes a situation in which district i enjoys a direct benefit from public good i, but there may also be an externality from (the sum of) public goods provided to other districts. The parameter α measures the size of this externality: the closer α is to one, the smaller are the externalities and the more γ^i benefits only the citizens in district i. Since (1) is a variation of the standard King, Plosser, Rebelo [1988] utility function augmented for public goods, we will refer to it as KPR.[7] Citizens discount future per period utilities at rate δ.

All local public goods are produced from the consumption good according to a linear technology with marginal rate of transformation equal to one. The consumption good at time t is produced with the linear technology $c_t = z_t l_t$. The variable z_t is interpreted as an economy wide productivity factor, such as human capital. Productivity may increase because of learning-by-doing in the private economy and because of direct public investments, $\mathcal{I}_t$ (such as expenditure on research and development, education, public infrastructure, and other productivity enhancing investments). Specifically, we assume:

$$z_{t+1} = \eta(l_t) \phi \left(\mathcal{I}_t / z_t \right) z_t, \tag{2}$$

where $l_t = \sum_j l_t^j / n$ is the average labor supply, $\eta(l_t) = \eta_0 \cdot (l_t)^{\eta_1}$ and $\phi(\mathcal{I}_t/z_t) = \phi_0 \cdot (\mathcal{I}_t/z_t)^{\phi_1}$ are concave functions with η_i, $\phi_i > 0$ for $i = 0, 1$ and η_1, $\phi_1 < 1$. The function η describes the process of learning-by-doing: the more citizens work, the more they learn from each other and more productive they will be in the future. The function ϕ describes the benefits of public investment: The higher is public investment, the higher is the next period productivity. The scaling by $1/z_t$ is standard to ensure that public investment as a fraction of output does not shrink to zero over time: In a growing economy, the higher is productivity, the more expensive it should be in absolute terms to improve it.[8]

There is a competitive labor market: thus the wage rate at t is equal to z_t. There is also a market in risk-free, one period bonds. Both citizens and the government have access to this

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[7] We will extend the analysis to alternative utility functions in Section 4.2 where we study how wealth effects shape the equilibrium behavior.

[8] Without loss of generality we could have specified the economy wide level of productivity as a product of human capital, h, and public infrastructure, Ψ: $z_{t+1} = h_{t+1} \Psi_{t+1}$, with $h_{t+1} = \eta(l_t) h_t$ and $\Psi_{t+1} = \phi(\mathcal{I}_t/z_t) \Psi_t$.

market. The assets held by an agent in district j in period t will be denoted a_t^j. The gross interest rate is denoted ρ_t: a dollar worth of bonds at time t yields ρ_t at time $t + 1$.

Public Policies The government provides local public goods, public infrastructure and can make direct monetary transfers to the districts. Monetary transfers are uniform across districts and are interpreted as a welfare program symmetrically targeted to all regions. Revenues are raised by levying a proportional tax on labor income and they can be supplemented by borrowing and lending in the bond market. Government policy in any period t is described by $\{\tau_t, \beta_t', \gamma_t^i, ..., \gamma_t^n, \mathcal{I}_t, \mathcal{T}_t\}$, where τ_t is the income tax rate; β_t' is the amount of bonds sold; γ_t^i is the amount of public good provided to district i; $\mathcal{I}_t$ is the level of infrastructure investment; and $\mathcal{T}_t$ is the uniform transfer. When β_t' is negative, the government is buying bonds. In each period, the government must also repay the bonds that it sold in the previous period which are denoted by β_t. The government's initial debt level in period 1 is β_0, agents initial assets are $a_0^j = a_0 = \frac{\beta_0}{n}$.

Government policies must satisfy three feasibility constraints. First, tax revenues and net borrowing must be sufficient to cover public expenditures. To see what this implies, consider a period in which the initial level of government debt is β_t and the interest rate is ρ_t. Total expenditure is $\sum_j \gamma_t^j + \mathcal{I}_t + \mathcal{T}_t + \beta_t$, tax revenue is $\tau_t z_t \sum_j l_t^j$, and revenue from bond sales is β_t'/ρ_t. So the government budget condition is:

$$\beta_t' - \rho_t \left[\beta_t + \sum_j \gamma_t^j + \mathcal{I}_t + \mathcal{T}_t - \tau_t z_t \sum_j l_t^j \right] \geq 0. \tag{3}$$

Second, to keep the policy space compact in the legislator's maximization problem, we assume that local public goods, public investment and transfers as fractions of GDP can not be smaller than some minimal levels: $\mathcal{I}_t/y_t \geq \underline{I}$, $\gamma_t^i/y_t \geq \underline{g}$ and $\mathcal{T}_t/y_t \geq \underline{T}$ for all i, where $\underline{I} \geq 0$, $\underline{g} > 0$ and $\underline{T} \geq 0$. The lower bound $\underline{T}$ is interpreted as commitments on transfers taken in previous legislations that are not directly modelled here (as for example Social Security, Medicare and Medicaid). Third, the feasible debt, relative to GDP, is bounded: $\beta_t/y_t \in [\underline{b}, \overline{b}]$. This constraint rules out Ponzi schemes and reflects the fact that if debt, relative to GDP is too high, then the government will not be able to replay it.

Market equilibrium and political decision making Using the first order necessary conditions for a citizen's problem, labor and consumption choices in district i at time t can be repre-

sented as functions of the policies and net savings $a_t^i - a_{t+1}^i/\rho_t$. In the following we will study a symmetric equilibrium in which $a_t^i = a_t$ as well as $c_t^i = c_t$ and $l_t^i = l_t$ for any district i. Since for any given government policy the interest rate must clear the market for one period bonds, in such an equilibrium we have $a_t - a_{t+1}/\rho_t = \frac{1}{n}(\beta_t - \beta_{t+1}/\rho_t)$. Using (3) and households' optimality conditions with respect to consumption and labor, we can therefore express the citizens' choices as functions of current public policies only. It is useful to express all the variables in terms of GDP. Define $g_t^i = \gamma_t^i/y_t$, $I_t = \mathcal{I}_t/y_t$, $T_t = \mathcal{T}_t/y_t$ and $p_t = \left\{\tau, \left\{g_t^j\right\}_j, I_t, T_t\right\}$. Labor supply can then be written as $l(p_t)$, where:

$$l(p_t) = \frac{1 - \tau_t}{\mu\left[1 - \frac{1}{n}\left(I_t + \sum_j g_t^j\right)\right] + 1 - \tau_t}. \tag{4}$$

Consumption can be written as $c(p_t, z_t) = z_t c(p_t)$, where:

$$c(p_t) = \frac{(1 - \tau_t)\left[1 - \frac{1}{n}\left(I_t + \sum_j g_t^j\right)\right]}{\mu\left[1 - \frac{1}{n}\left(I_t + \sum_j g_t^j\right)\right] + 1 - \tau_t}. \tag{5}$$

These expressions allow us to write citizen i's utility function only as a function of current public policies and the level of productivity:

$$u(p_t, z_t) = (1 + \omega_0)\log z_t + U(p_t) + \omega_0 \log\left[\left(g_t^i\right)^\alpha \left(\sum_j g_t^j\right)^{1-\alpha}\right], \tag{6}$$

where $U(p_t)$ can be interpreted as the indirect per period utility function given p_t from consumption and labor scaled by productivity z_t, as specified in the Appendix.[9] We can also write the resource constraint of the economy as:

$$R(p_t, z_t) = z_t n l(p_t)\left[1 - c(p_t) - \frac{1}{n}\left(I_t + \sum_j g_t^j\right)\right] \geq 0.$$

Let $Z(p) = \eta(l(p))\phi(I \cdot nl(p))$,[10] then we can write $z' = Z(p)z$. The expression for the interest rate now becomes:

$$\rho_t^{-1}(p_t, p_{t+1}) = \delta\frac{U_{c,t+1}(p_{t+1}, z_{t+1})}{U_{c,t}(p_t, z_t)} = \delta\frac{c(p_t)}{Z(p_t)c(p_{t+1})}. \tag{7}$$

From (4)-(5) it is clear that the impact of public investment and transfers affect all districts in the same way. The districts are heterogeneous only with respect to the amount of local public goods $\left\{g_t^j\right\}_j$ they receive. These are the variables over which there is political conflict in the legislature.

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[9] See Appendix 7.2 for details.

[10] Note that from (2) we have $z' = \eta(l)\phi(\mathcal{I}/z)z$, so normalizing $\mathcal{I}$ by y, we have $z' = Z(p)z$ as noted in the text.

Government policy decisions are made by a legislature consisting of representatives from each of the n districts. One citizen from each district is selected to be that district's representative. Since all citizens have the same policy preferences, the identity of the representative is immaterial and hence the selection process can be ignored. The legislature meets at the beginning of each period. To describe how legislative decision-making works, suppose the legislature is meeting at the beginning of a period in which the current level of public debt is b_t. The process has two phases: government formation and bargaining in the government.[11] In the first phase, one of the legislators is randomly selected to form a government, with each representative having an equal chance of being recognized. A government is a cabinet of $\mathcal{G}$ representatives and a policy platform $\{b'_t, \tau_t, G_t, I_t, T_t\}$, where G_t is the aggregate amount of public goods. In the second phase, the cabinet members allocate the local public goods. The initial government formateur proposes a provisional distribution of the local public goods $\left\{g_t^j\right\}_j$. If the first proposal is accepted by $q \leq \mathcal{G}$ cabinet members, then it is implemented and the legislature adjourns until the beginning of the next period. At that time, the legislature meets again with the difference being that the initial level of public debt is b'_t and productivity is given by (2). If, on the other hand, the first proposal is not accepted, another member of the government is chosen to propose an alternative redistribution of $\left\{g_t^j\right\}_j$. The process continues until a proposal is approved by the cabinet. We assume that each proposal round takes a negligible amount of time.[12]

3   The political equilibrium

Before we characterize the political equilibrium in the economy described in the previous section, it is useful to highlight the key determinants of growth in our economy. On a balanced growth path we should expect income, consumption, investment to grow at the same constant rate σ and per capita productivity and the real interest rate to remain constant. In an economy with a non trivial public sector we should also expect public expenditure to grow at the same rate as the

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[11] A similar bargaining process in which first a formateur selects the government and then the cabinet members bargain over the allocation of targetable transfers is presented by Baron and Diermeier [2001]. In Baron and Diermeier [2001] the bargaining phase consists in a take it or leave it offer with a status quo policy in case a qualified majority in the government is not reached.

[12] Our bargaining process gives as special cases many bargaining processes used in the political economy literature. When $\mathcal{G} = 1$ the policy is chosen by a randomly selected dictator who maximizes his own utility as in Alesina and Tabellini [1990]. As we will show, when $\mathcal{G} > 1$ and $q = \mathcal{G}$ the policy is chosen to maximize the aggregate utility of a coalition of size $\mathcal{G}$ as in Battaglini and Coate [2012]. When $\mathcal{G} = q = n$, the policy coincide with the utilitarian optimal policy.

private economy, and tax revenues to be a constant fraction of income:[13]

$$\frac{\Delta \gamma}{\gamma} = \frac{\Delta \mathcal{I}}{\mathcal{I}} = \frac{\Delta \mathcal{T}}{\mathcal{I}} = \sigma, \, \Delta \tau = 0. \tag{8}$$

Using these conditions, it is easy to see that in our economy (4)-(7) imply that the growth rate of all the key variables is determined by the growth rate of productivity: $\sigma = \Delta z/z$. Even before we start studying political decision making, we can see the role of fiscal policy on σ. From (2), in the steady state we have:

$$\sigma = \frac{\Delta z}{z} = Z(p) - 1, \tag{9}$$

where, as defined above, $Z(p) = \eta(l(p))\phi\left(I \cdot nl(p)\right)$. The growth rate is a function of the primitives of the economy and of public policies. This is not in itself a new observation, since it has been long recognized that in endogenous growth models public policies have a long term effect on the growth rate (see Rebelo [1991]). The interesting point is that, in our model, explaining fiscal policy is necessary to obtain an *endogenous* theory of growth.

Condition (9) leaves two open questions. First, what determines the long run fiscal policy, and hence the growth of the economy on the balanced growth path? As it can be seen from (9), this economy may have either positive or negative growth in the steady state, since there is no a priory reason to expect $\sigma > 0$. Second, what are the dynamics of the policy variables? An economy may reach the steady state with an increasing tax rate and decreasing public investment, or with a decreasing tax rate and decreasing investment, or the reverse. Studying the path of the economy towards the balanced growth path is one way to shed light on the long run trends of fiscal policy variables. To answer these questions we need an explicit theory of public policy making. We address these issues in the next two sections. In Section 3.1 we characterize equilibrium behavior. In Section 3.2 we derive the implications for the balanced growth rate and for the transition path converging to it.

3.1 Equilibrium behavior

To characterize behavior when policies are chosen by a legislature, we look for a symmetric Markov perfect equilibrium (SME) in which players' strategies depend only on the level of public debt per unit of human capital, i.e. $b_t = \beta_t/z_t$. As we formally show below there is no loss of generality in

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[13] Obviously these conditions need not be satisfied on the path of convergence. The predictions of the model for the convergence path will be discussed in Section 3.2. in greater detail.

adopting b_t as a state variable.[14]   A symmetric Markov equilibrium can be formally defined by a collection of policy functions $p(b) = \{\tau(b), I(b), T(b), b'(b), g(b), g^c(b)\}$.   Here $\tau(b)$, $I(b)$ and $T(b)$ are the tax rate and the share of GDP spent on public investment and transfers proposed in state b.   The function $b'(b)$ is the new level of debt normalized by the future level of human capital, i.e. β'/z' where $z' = Z(p(b))z$.[15]   The remaining two functions describe how local public goods are distributed in the economy.   In a SME the proposer randomly selects $\mathcal{G} - 1$ legislators to form a governmental cabinet, choosing them from the remaining $n - 1$ legislators with equal probability. The proposer provides sufficient local public goods to q cabinet members to guarantee their vote, and as little as possible to the others (in the cabinet or outside).   The functions $g(b)$ and $g^c(b)$ are the shares of GDP of the public good proposed for, respectively, the proposer's district and the other districts in the minimal winning coalition.   All the other representatives excluded from the minimal winning coalition receive the minimal share of GDP possible, $\underline{g}$.

As standard in the theory of legislative voting, we focus on weakly stage undominated strategies, which implies that legislators vote for a proposal if they prefer it (weakly) to continuing on to the next proposal round.   We focus, without loss of generality, on equilibria in which, at each round, proposals are immediately accepted by at least q legislators so that, on the equilibrium path, no meeting lasts more than one proposal round.   We say that an equilibrium is smooth if the policy functions are continuously differentiable in b.   In the reminder of the paper we focus the analysis on smooth equilibria.   This property is satisfied by construction in all equilibria computed in Section 4.

To characterize the equilibrium strategies consider the problem faced by the proposer.   The proposer chooses the policies to maximize the utility of his own district under two sets of constraints.   First, the budget constraint and the feasibility constraints that we have described in the previous section.   Second, an incentive compatibility constraint that guarantees that the proposal is voted by a qualified majority.   To be approved, the policies must be such that:

$$U(p) + \omega_0 \log\left[(g^c)^\alpha \left(\sum_j g^j\right)^{1-\alpha}\right] + \delta v(b', z') = v_{\mathcal{G}}(b, z), \tag{10}$$

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[14] Strategies can not depend on the current level of debt/GDP since GDP is itself a function of current policies. The debt/GDP ratio at time t is $\beta_t/z_t n l(p_t)$.   While β_t/z_t is a state inherited from the past, p_t is a control vector chosen at t.

[15] The future level of debt in absolute terms can therefore be expressed in terms of the current policies as $Z(p(b))z \cdot b'(b)$.   The future debt in terms of future GDP depends on future policies so it is indeterminate at the time $b'(b)$ is chosen.   In expectation it is $b'(b)/(n l(b'(b))$ where $l(b'(b))$ is future labor supply in state $b'(b)$.

where $z' = Z(p)z$ is the expected productivity level after policy p is implemented and $v_{\mathcal{G}}(b,z)$ is the outside option of a cabinet member. The left hand side of this constraint is the expected utility of accepting the proposal for a member of the minimal winning coalition who receives a level $g^c(b)$ of local public good. The outside option of a cabinet member, $v_{\mathcal{G}}(b,z)$, is the expected utility of voting no and therefore moving to the stage of the bargaining game in which a new government member is randomly selected.[16] The next result shows that (10) imposes a precise relationship between $g(b)$ and $g^c(b)$:

Lemma 1. *In equilibrium, the incentive compatibility constraint (10) is satisfied if and only if* $g^c(b) = g(b)^{Q(\mathcal{G},q)} \cdot \underline{g}^{(1-Q(\mathcal{G},q))}$, *where* $Q(\mathcal{G},q) = \frac{1}{\mathcal{G}-q+1} \in (0,1]$.

Lemma 1 shows that the bargaining process forces the proposer to provide a level of pork to the members of the minimal winning coalition equal to a geometric average of the level he assigns to his own district and the level he assigns to the districts outside the coalition, $\underline{g}$. Total expenditure in public goods, moreover is a function of g only: $G(g) = g + (q-1)g^{Q(\mathcal{G},q)} \cdot \underline{g}^{(1-Q(\mathcal{G},q))} + (n-q)\underline{g}$. It should be noted that the weight on $g(b)$ is increasing function of q: the larger is q, the more the proposer is forced to internalize the welfare of the other government members. Indeed, when the voting rule is unanimous and so $q = \mathcal{G}$, we have $g^c = g$.[17]

As seen in Section 2, the citizens' per period indirect utility function is separable in z and p (see (6)). The value function has a similar representation. As shown in the appendix, we can express the value function as $v(b,z) = \mathcal{A}\log z + \mathcal{V}(b)$ where $\mathcal{V}(b)$ is defined recursively as:

$$\mathcal{V}(b) = \mathcal{U}(p(b)) + \alpha\frac{\mathcal{G}}{n}Q(\mathcal{G},q)\omega_0\log g(b) + \delta\mathcal{V}(b'(b)), \tag{11}$$

where $\mathcal{A}$ is a constant and $\mathcal{U}(p)$ is specified in closed form in the Appendix.[18] Using Lemma 1,

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[16] Of course, the incentive constraint needs to be satisfied as a weak inequality, requiring the left hand side to be not smaller than the right hand side. In equilibrium, however, the proposer minimizes the cost of obtaining a minimal winning coalition, so (10) is always satisfied as a equality.

[17] When the government deliberates by unanimous rule (i.e. $q = \mathcal{G}$), all the government members are treated in the same way and the policy is chosen to maximize the aggregate utility of government members.

[18] The function $\mathcal{U}(p)$ can be interpreted as the indirect utility function given policy $p(b)$ from consumption and labor, augmented by the externality from the total provision of public goods and the (permanent) effect of current policy $p(b)$ on future productivity. We represent the indirect utility function as in (11) to highlight the difference with the objective function of the proposer in (12), as discussed below. See Section 7.2 for the closed form representation of $\mathcal{U}(p)$.

moreover, the proposer's problem can be written as:

$$
\max_{b',\tau,g,I,T} \left\{ \begin{array}{c} \mathcal{U}(p) + \alpha\omega_0 \log g + \delta\mathcal{V}(b') \\[2mm] s.t. \ Z(b)b'/\rho(b,p) - [b + G(g) + I + T - \tau nl(p)] = 0 \\[2mm] b' \leq \bar{b}, \ g \geq \underline{g}, \ I \geq \underline{I}, \ T \geq \underline{T}, \tau \in [0,1] \end{array} \right\} \tag{12}
$$

The representation in (11)-(12) highlights the role of the political process on how policies are chosen in equilibrium. When $\alpha = 0$ policies have a uniform effect on the citizens' welfare. In this case there is no political conflict and the proposer chooses policies to maximize the welfare of the representative citizen. When $\alpha > 0$, districts value local public goods differently. In this case the proposer overestimates the welfare effect of g. The magnitude of the overestimation depends on $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$. When $q = \mathcal{G} = n$, we have $Q(\mathcal{G},q) = 1$ and full alignment of interest across districts is re-established. When $\mathcal{G} < n$ and/or $q < \mathcal{G}$ then $\frac{\mathcal{G}}{n}Q(\mathcal{G},q) < 1$ and we have political conflict.

Using (11)-(12) we have the following characterization of a political equilibrium:

Proposition 1. *Under KPR utility functions:*

- *If $p = \{\tau, I, T, b', g, g^c\}$ solves (12) given $\mathcal{V}$, and $\mathcal{V}$ satisfies (11) given p, then p is an equilibrium policy function and $v = \mathcal{A}\log z + \mathcal{V}$ is the associated equilibrium value function.*

- *If $p = \{\tau, I, T, b', g, g^c\}$ is a political equilibrium with value function v, then p is a function only of b and there are a function $\mathcal{V}$ of b only and a constant $\mathcal{A}$ such that the value function can be represented as $v = \mathcal{A}\log z + \mathcal{V}$. Moreover, p solves (12) given $\mathcal{V}$, and $\mathcal{V}$ satisfies (11) given p.*

The first bullet of Proposition 1 shows that to characterize an equilibrium we can simply study (11) and (12), where the state variable is b. Once we have solved for the fixed-point implied by these two conditions, the value function can be immediately found with the formula $v = A\log z + \mathcal{V}$. The second bullet shows that there is no loss of generality in considering the representation (11) and (12), since all equilibria can be expressed in this way.

3.2 Balanced growth and transition dynamics

To study the dynamic properties of a political equilibrium, it is useful to introduce a key concept in public finance - the marginal cost of public funds (MCPF). The marginal cost of public funds is

the compensating variation for a marginal increase in tax revenues.[19]   It is, therefore, a measure

of the distortion introduced by the government into the economy.   To see the importance of this

concept, consider the marginal cost of public funds associated with the policies $\{\tau_t^*, b_t^{*\prime}, I_t^*, T_t^*, g_t^*\}$

that would be chosen by a benevolent planner who can commit to the optimal policy plan.   Under

standard assumptions, the planner aims at smoothing the cost of taxation over time as much as

possible.   This implies that polices are chosen so that the marginal cost of public funds is equalized

over time: $MCPF_t^* = MCPF_{t+1}^*$ for any $t > 0$.[20]   A constant marginal cost of public funds

implies that fiscal policy and the growth level of the economy are all constant for any $t > 0$.   Is

this result still valid in a political equilibrium?   If not, what are the implications for the dynamics

of the economy?

To answer these questions, let us define $\rho(b', b)$ as the interest rate in state b when the new

level of debt is b' (and the other policies are at the equilibrium level).   The elasticity of the interest

rate with respect to b' evaluated at the equilibrium level $b' = b'(b)$ in state b is:

$$\varepsilon_\rho(b) = \frac{\partial \rho(b', b)}{\partial b'} \frac{b'}{\rho(b', b)}. \tag{13}$$

This elasticity has a clear empirical interpretation since it measures the relationship between two

observable variables, debt and the interest rate.   Let us also define $\varepsilon_g(b)$ as the elasticity of g with

respect to debt, $\varepsilon_g(b) = \frac{\partial g(b)}{\partial b} \frac{b}{g(b)}$.   We have the following characterization of the Euler equation

in a political equilibrium:

Proposition 2.   *In equilibrium:*

$$[1 - \varepsilon_\rho(b_t)] \cdot MCPF(b_t) = \left[1 - \alpha \omega_0 \left(\frac{\mathcal{G}}{n} Q(\mathcal{G}, q) - 1\right) \Phi(b_{t+1}) \varepsilon_g(b_{t+1})\right] \cdot MCPF(b_{t+1}),$$

$$\tag{14}$$

where $\Phi(b)$ is a nonnegative function of debt.

This representation of the Euler equation has a straightforward interpretation that clarifies the

forces shaping the dynamics of fiscal policy.   The left hand side is the marginal benefit of debt:

by increasing debt by a unit, tax revenues can be reduced by a unit at t, inducing a net welfare

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[19] In intuitive terms, the $MCPF$ is the marginal monetary compensation necessary to compensate an agent for a marginal increase in tax revenues.

[20] A formal analysis if the planner's problem is available from the authors upon request.   See also Ljungqvist and Sargent [2004] for the analysis of a similar problem in a model with no endogenous growth.

gain equal to $MCPF(b_t)$. This term is corrected by $(1 - \varepsilon_\rho(b_t))$ to account for the fact that the government is not a price taker in the bond market. When, for example $\varepsilon_\rho(b_t) > 0$, an increase in debt implies an increase in the interest rate: the corresponding reduction in resources limits the benefit of an increase in b. The right hand side can be interpreted as the marginal cost of debt. An increase in debt generates two effects: it reduces future resources (with a welfare effect measured by the first term, $MCPF(b_{t+1})$), and changes the policy mix by affecting policies (this second effect is represented by the term $\left[1 - \alpha\omega_0 \left(\frac{\mathcal{G}}{n}Q(\mathcal{G},q) - 1\right)\Phi\left(b_{t+1}\right)\varepsilon_g(b_{t+1})\right]$). When policies are chosen by a utilitarian planner, the second effect is irrelevant: policies are always optimal, so by the envelope theorem, a marginal change from the optimal level has no welfare effect. Since in the model described above policies are inefficient, however, the change in the policy mix induced by b has a first order impact that can not be ignored. The first term of the right hand side of (14), therefore, incorporates the political distortion. Not surprisingly, the size of the political distortion depends on α and $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$: the larger is α, the more severe is political conflict because citizens internalize little of the benefit of local public goods provided to districts to which they do not belong; the smaller is $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$, the less the ruling coalition is forced to internalize the welfare of the remaining districts. When $\alpha = 0$ and/or $\frac{\mathcal{G}}{n}Q(\mathcal{G},q) = 1$, it is as if policies were chosen by a utilitarian decision maker, so the political distortion is zero.[21]

On a balanced growth path debt grows at the same rate as income, so b_t remains constant at b^*. We say that balanced growth path is *stable* if there is a neighborhood of b^* such that the debt ratio b converges to b^* for any initial state in the neighborhood. In general it is hard to establish analytically the properties of the equilibrium policies and of a stable stead state. In the next sections we will use propositions 1 and 2 to study a calibrated version of the model numerically. However, in the reminder of this section we can use (14) to show that, in the model described above, political distortions are necessary to explain two stylized empirical facts about developed countries and to characterize the key properties of the convergence path.

We say that a balanced growth path is *regular* if it stable and two conditions are met: (1) debt is positive on the path, i.e. $b^* > 0$; and (2) the interest rate elasticity is positive at the steady state: i.e., $\varepsilon_\rho(b^*) > 0$ (or $\partial\rho(b',b)/\partial b' > 0$ at b^*). From a theoretical point of view neither of these two properties need to necessarily hold in equilibrium. There is however evidence that these two

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[21] We obtain an interesting interpretation of (14) by dividing both sides by $1 - \varepsilon_\rho(b_t)$. The government acts as a standard monopolist: debt is chosen to equalize the marginal benefit to the marginal cost of debt weighted by a standard markup factor that depends on the elasticity of the demand: $1/\left(1 - \varepsilon_\rho(b_t)\right)$.
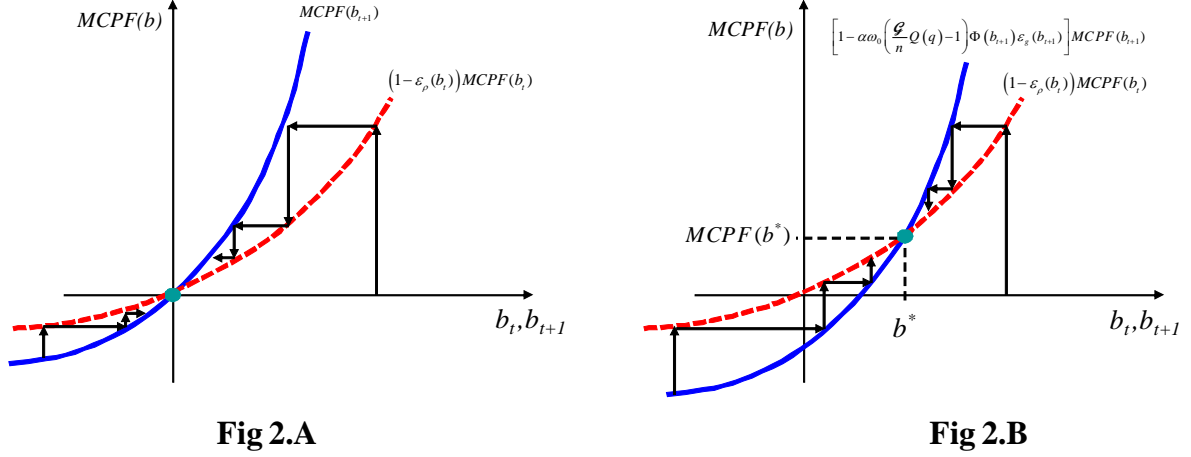
$$\textbf{Fig 2.A} \qquad\qquad\qquad \textbf{Fig 2.B}$$

Figure 2: The Euler equation for $\mathcal{G} = q = n$ and $q < n$.

properties are satisfied in most economies.[22]   Indeed, they are always satisfied in the calibrations we present in the next section. We say that there is *political conflict* in the economy if $\alpha > 0$ and $q < n$. We have:

Proposition 3. *A stable steady state is regular only if there is political conflict.*

The intuition behind Proposition 3 is illustrated by Figure 2.   Consider first Figure 2.A where we represent an equilibrium in an environment with no political conflict (so $\frac{\mathcal{G}}{n}Q(G,q) = 1$ and/or $\alpha = 0$).   The red dotted line represents the left hand side of the previous equation, $(1 - \varepsilon_\rho(b))MCPF(b)$; the blue solid line represents the right hand side, $MCPF(b')$.[23]   We have a stable steady state when the blue solid line intersects the red dotted line from below. At the steady state, $MCPF(b_{t+1}) = MCPF(b_t)$, so the only way to satisfy the equilibrium condition is to have $\varepsilon_\rho(b^*) = 0$: as it is apparent from (13), in a regular economy this is possible only if $b^* = 0$ when there is no political distortion (i.e. $\alpha = 0$ and/or $\frac{\mathcal{G}}{n}Q(\mathcal{G},q) = 1$). The only way to have $b^* > 0$ on the balanced path is to shift $MCPF(b')$ "downward," so that the intersection moves to the right. As illustrated in Figure 2.B this is possible only if $\alpha\omega_0\left(1 - \frac{\mathcal{G}}{n}Q(\mathcal{G},q)\right)\Phi(b_{t+1})\varepsilon_g(b_{t+1}) > 0$, i.e., only if there is a political distortion: $\frac{\mathcal{G}}{n}Q(\mathcal{G},q) < 1$ and $\alpha > 0$.

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[22] The requirement of a positive level of debt at the steady state seems natural. For evidence on the interest rate see, for example, Ardagna, Caselli and Lane [2007] and Laubach [2009].

[23] In the Figure, $MCPF(b)$ intersects the origin, but it is not necessary to have $MCPF(0) = 0$. The actual level of $MCPF(0)$ is irrelevant for the analysis.

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It is interesting to note that the positive *interior* level of debt in the model is the result of two contrasting forces: on the one hand, political economy distortions push debt up; on the other hand, the attempt to manipulate the interest rate pushes debt down. We would not have positive debt at the steady state without the first effect; we would not have an interior level of debt without the second effect: politicians would always have an incentive to shift the financing of expenditure to the future and accumulate more debt. At the steady state the two incentive exactly counterbalance each other.

The next result characterizes the dynamics of the public sector on the convergence path to a regular steady state.

Proposition 4. *Starting from any b_0 in a left neighborhood of a regular steady state, both infrastructure and the expected level of local public goods grow at a slower rate than GDP.*

An interesting implication of Proposition 4 is that despite the fact that in this economy the policy-maker has excessive incentives to spend in local public goods, the expected supply of public goods declines over time, and so the public sector becomes smaller and smaller as a fraction of GDP. This phenomenon is a consequence of the political distortion in the presence of endogenous interest rates. As debt increases, the proposer finds it optimal to increase the primary surplus by reducing expenditures rather than by increasing taxes: reducing expenditures rather than raising taxes forces up disposable income and savings, and so it holds interest rates down. To the contrary, an increase in taxes forces down disposable income and savings, and, hence, puts upward pressure on the interest rate. Proposition 4 shows that the legislators always find it optimal to shrink the provision of public services (both in terms of public goods and infrastructure). However, the proposition does not establish that they find it optimal to decrease taxation. This finding will be established in the next section when we solve numerically a version of the model calibrated after the U.S. economy.

What is the implication of this converging path for productivity? When there is no learning-by-doing, this question can be easily answered.

Proposition 5. *If $\eta_1 = 0$, then starting from any b_0 in a left neighborhood of a regular steady state, the growth rate in productivity $\Delta z_t / z_t$ gradually declines on the convergence path.*

Figure 3 illustrates the last part of Proposition 4 and Proposition 5. As b converges to b^* infrastructure declines: in this case the growth rate of productivity $\phi(I)$ shifts towards the 45
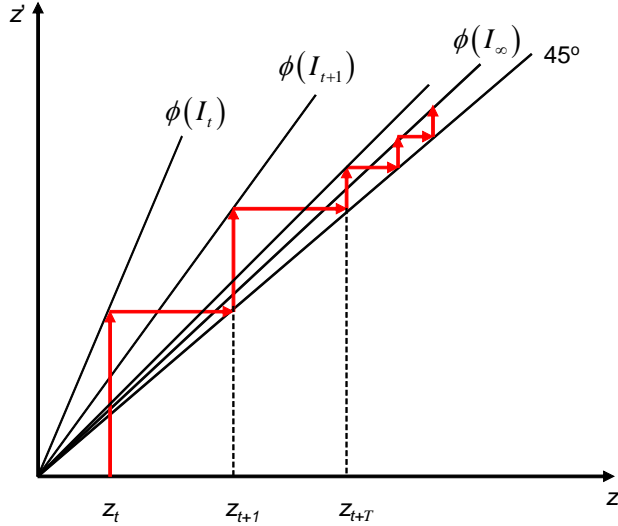
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Figure 3: Growth Dynamics

degree line and z grows at a decreasing pace (or potentially may even decline if $\phi(I)$ is lower than one).

Proposition 5 does not necessarily hold in the presence of learning-by-doing. The reason is that the tax rate may decline on the transition path. If this decline implies an increase in labor supply, then we have two forces pushing in opposite directions. A decline in the tax rate, however, does not generally imply that labor supply increases. The reason for this is that, as debt increases, agents hold more financial wealth. The wealth increase implies higher marginal utility for leisure: this may more than counterbalance the effect of the decrease in taxation. In the next section we show that with KPR preferences labor supply typically declines on the transition path, so productivity is decreasing also with learning-by-doing.

4 A calibrated solution of the model

4.1 Positive analysis

In this section we study the model presented above by numerical methods, calibrating it to the U.S. economy. The key parameters describing preferences and technology are chosen to minimize the differences between the steady state values of the key aggregate variable predicted by the

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model and the corresponding average values in the U.S. economy in the 2001-2010 period. These variables include public spending, public investment and debt, as fractions of GDP. Implicit is the assumption that fiscal variables have been, on average, at their balanced growth levels during this time period. The details on the calibration are presented in the appendix. We will discuss alternative scenarios in Section 4.2 and 5. With few exceptions that we discuss below, all of the qualitative results presented here are robust to specific details of the calibration.

Figure 4 shows that the model has no difficulty in achieving the calibration targets (note that the tax revenue/GDP ratio is not explicitly targeted in the calibration). Figure 5 describes the dynamics of the model showing the transition to the balanced growth path and compares it to the data.[24] A number of interesting features of the equilibrium dynamics emerge.

First, consistently with the theoretical analysis of the previous sections, in the model debt grows faster than GDP during transition toward the balanced growth path. Although the empirical time series are naturally more volatile, the low frequency behavior of fiscal variables appears consistent with the U.S. evidence.

Second, both tax revenues and expenditure in public goods and in infrastructure grow slower than GDP on the transition path. The numerical solution therefore reinforces the analytic results presented in the previous section by showing that not only do expenditures over GDP decline, but the tax revenues over GDP decline as well. This is the same shrinking government effect discussed in Proposition 4. As debt increases, the government has to increase the primary surplus by either increasing taxes or reducing expenditures. Reductions in expenditures, however, tend to be more effective as they increase citizens' savings and, hence, reduce the equilibrium interest rate. By reducing expenditure the government relaxes the budget constraint in two ways: directly by reducing expenditures; and indirectly, by reducing the equilibrium interest rate. The effect of an increase in taxation is different. Higher taxes reduce disposable income and therefore, ceteris paribus, reduce savings and increase the equilibrium interest rate. As the stock of debt increases, the interest rate effect becomes increasingly significant, making tax increases even less attractive.

The third feature regards labor supply and provides some insight about the mechanics of the model. The right panel of Figure 6 shows that despite the reduction in taxation, labor supply declines over time. This phenomenon is due to the fact that as debt increases, households hold

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[24] In our comparison of the model with the data we focus on the period from 1971 to 2010. We do not consider earlier data because we would like to abstract from the consequences of WWII and the Korean War, which had significant fiscal impacts not related to the specific issues we are studying in this paper.

	Federal Debt GDP	Public Goods GDP	Public Investment GDP	Tax Revenue GDP
Data	40.4	9.4	0.9	10.3
Model	40.5	9.3	0.9	11.1

Figure 4: Calibration.

increasing levels of wealth to finance it: the wealth effect increases the marginal utility of leisure, and reduces labor supply. Movements in labor supply, however, are not particularly strong: overall, it declines by less than one percent over the 40 year period.

The final feature of the equilibrium shown by Figure 6 regards the growth rate: both productivity and income growth rates decline as they reach their steady state levels. This finding also extends the results of the previous section by showing that productivity and output growth decline as the economy approaches the balanced growth path even in the presence of learning-by-doing (at least in the calibrated solution). The decline in growth is due to two factors: the decrease in the investment in infrastructure by the government and the decrease in labor supply due to the wealth effect. Since the tax rate declines over time, if we did not have the wealth effect to keep labor supply down, we would have two contrasting effect: the decline in investment and the increase in labor supply due to the decline in τ.

We can see the role played by political distortions by comparing the evolution of the fiscal variables in equilibrium to the evolution we would have in the same economy with no political distortions ($\alpha = 0$ or $q = n$). With no political distortions the steady state converges to a zero debt/GDP ratio; on the transition path, moreover, we observe that taxes, public goods and infrastructure all increase over time: all of these predictions are in sharp contrast with the U.S. experience in the last 40 years. This discrepancy with the data does not depend on the calibration: as we know from Proposition 3, with no political distortions a zero debt/GDP ratio is the only regular steady state.

It is worth emphasizing that the model is calibrated using only average values of fiscal variables over 2001-2010 period and standard RBC parameter values. Given such parsimonious parameterization, the model's ability to fit low frequency dynamics of the U.S. fiscal policy is, perhaps,
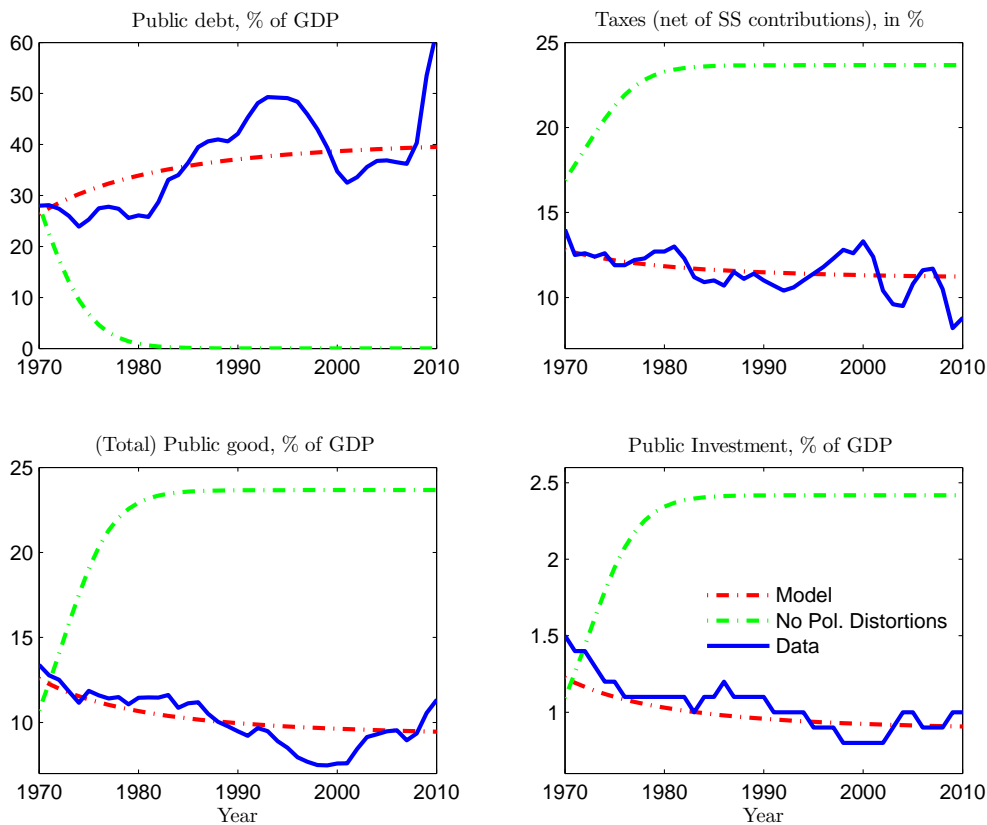
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Figure 5: Fiscal Policy Dynamics: data, political equilibrium, and equilibrium with no political distortions.

quite remarkable. We should also stress that modest response of the growth rates to the rise in debt along the transition path is a consequence of our conservative calibration strategy. Namely, in the calibration the growth elasticity with respect to public investment is positively related to the specific definition of public investment used as target value.[25] For the latter we use a narrow definition, "Research and Development" component of federal outlays. Using a broader measure, such as "Total Investment Outlays for Major Public Physical Capital, Research and Development, and Education and Training" component of federal outlays would amplify the effect of political economy distortions on the growth rates of productivity and output.

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[25] As we detail in Appendix, the calibrated value of the parameter ϕ_1 is tiny: 0.00181.
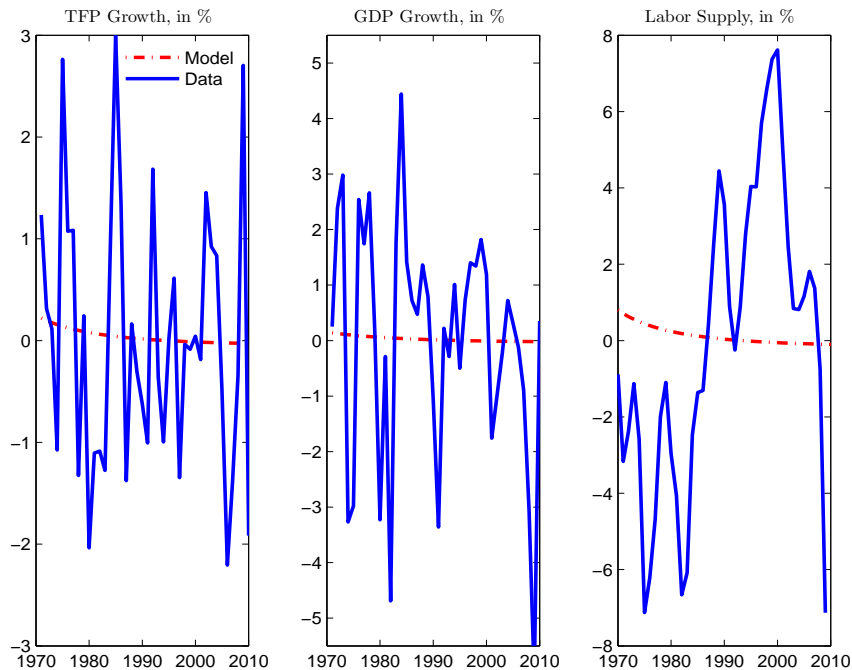
Figure 6: Growth and Labor Supply Dynamics

4.2 Comparative statics

In this section we study how the equilibrium changes as we change the fundamentals of the economy. We focus on two key variables. First, we consider changes in the political conflict in the economy, as measured by α. As α increases, the conflict between districts increases because citizens become less sensitive to public goods provided to constituencies to which they do not belong. Second, we study the role of wealth effects in shaping equilibrium dynamics of the economy. To this end, we study a version of the model in which citizens decisions over labor supply are independent of their consumption/saving decision.

4.2.1 Political conflict

Figure 7 illustrates the effect of changes in α from its baseline value of 0.53 to 0 (where there are no benefits from pure local public goods) on the balanced growth path values of the variables of interest. The lower is α the lower is political conflict, since preferences are more aligned.

Three findings are worth noting. First, a lower level of political conflict induces a lower steady state level of debt. The level of debt relative to GDP indeed converges to zero as α converges to
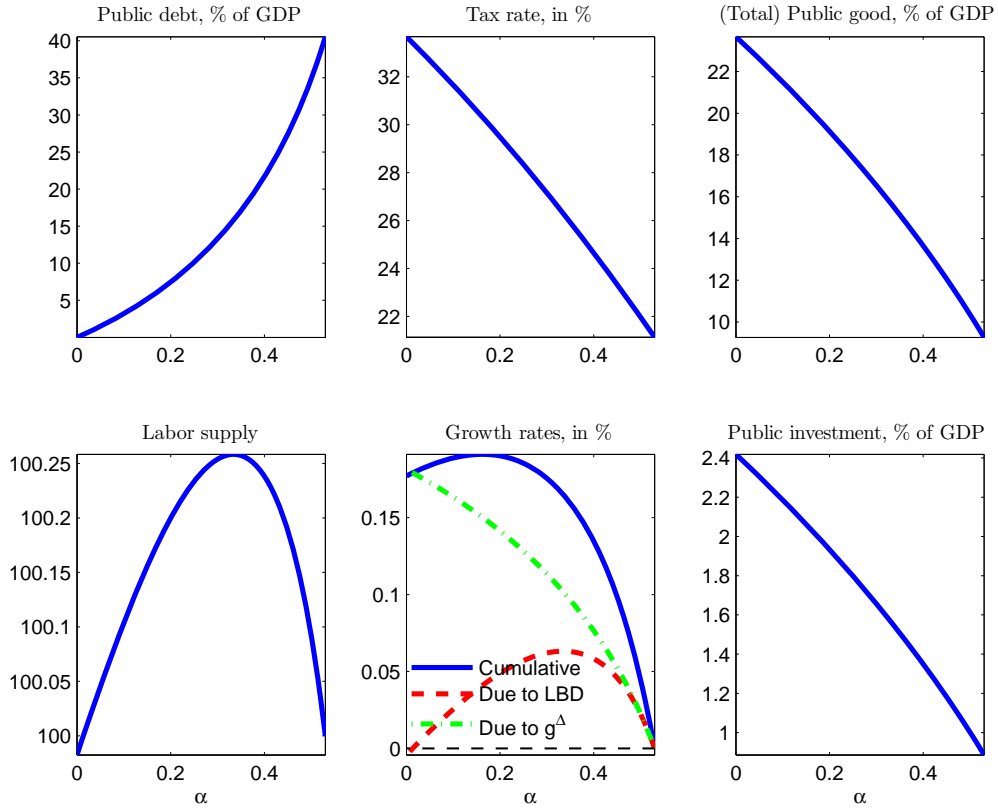
Figure 7: Public Good Externality, Fiscal Policy and Economic Outcomes.

0, as discussed in Section 3.

Second, a decrease in political conflict induces a higher level of investment in public infrastructure and local public goods. As α decreases the proposer internalizes more of the benefit of all local public goods and he/she internalizes less of the benefit of the local public good provide to his/her own district. This reduces the political bias: indeed, when $\alpha = 0$ the proposer chooses policies in the same way as a utilitarian decision maker.

The third effect is perhaps more surprising: a decrease in political conflict induces an increase in the tax rate and it has a non-monotonic effect on labor supply and growth. As α decreases, the tax rate increases to finance higher provision of public good without increasing debt (for the reasons discussed in Section 3.2). As α decreases, steady state labor supply initially increases. This phenomenon is due to the wealth effect: the decrease in α induces a decline in public debt and, hence, in privately held wealth, so it induces a decline in the marginal utility of leisure as

well. For lower levels of α, however, the higher tax rate tends to counterbalance the wealth effect, and labor supply decreases in response to a decline in α. Nonetheless, the effects of taxation and wealth roughly offset each other–the differences in labor supply across different α's do not exceed 0.25 percent.

The non monotonicity in labor supply explains why the growth rate is non monotonic in α. It is important to stress that welfare is monotonically increasing in α: hence, the growth rate is not necessarily a good measure of welfare in this model. As political distortions are reduced, the public goods share of output increases: public goods increase welfare, but they do not increase growth. The result is that with higher α we may have more "consumption" in the form of public goods, but a lower growth rate. In these situations, the economy grows at a slower rate, but it has a superior balance (as measured by welfare) between the private and the public sector.

Since debt is monotonically decreasing in α, the non monotonicity of the growth rate with respect to α may explain why there is evidence suggesting a non monotonic relation between debt and growth.[26] Figure 7 suggests that we should expect the relationship between growth and debt to be negative for countries with a high α, and positive for countries with low α.

4.2.2 Wealth effects

As we have described above, wealth effects play an important role in the dynamics of the economy. Even with a declining tax rate, labor supply declines over time because of the accumulation of private wealth necessary to finance the stock of public debt. To study the role played by wealth, we compute the equilibrium with an alternative utility function in which wealth effects are absent. The comparison between economies with and without wealth effect will help to better understand the role of the wealth effect on growth and the policy-making process.

To this end we assume that the citizens' preferences are described by a version of Greenwood, Hercowitz and Huffman (GHH, 1988) utility function. As is well known, GHH preferences need to be adjusted to be consistent with balanced growth path. We do this in spirit of Jaimovich and Rebelo (2008). In particular, we assume that the utility function from consumption and labor is

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[26] For evidence on the relationship between debt and growth see, for example, Kumar and Wo [2010], Checcherita and Rother [2010] and Reinhart and Rogoff [2010].

given by

$$U(c_t, l_t) = \log\left(c_t - x_t \frac{l_t^{1+\psi}}{1+\psi}\right).$$

(15)

In this definition the variable x_t depends on aggregate (or average) consumption and labor in period t: the higher aggregate consumption is, the higher is labor disutility; the higher is aggregate labor supply, the lower is labor disutility. More precisely:

$$x_t = \frac{\bar{x} \cdot (\bar{c}_t + \bar{g}_t)}{\bar{l}_t},$$

where $\bar{x}$ is a constant and the upper bar on the other variables indicates their respective average values (which are taken as exogenous by the individual citizens). Figure 8 illustrates the dynamics of an economy calibrated in the same way as in the baseline model. The behavior of fiscal variables is very similar to that described in the previous section with exception of taxes. Here the tax rate decline is less pronounced. As before, the growth rates decline over time (see Figure 9). Since with GHH utilities we do not have wealth effects, labor supply is now driven by the reduction in taxes, and so it is increasing over time.[27]

5 Growth and austerity programs

As the analysis of the previous section has highlighted, the political equilibrium is inefficient: it leads to an excessive accumulation of debt relative to GDP and may result in a lower than efficient growth rate. Can we improve welfare by forcing the government to run a larger primary surplus? And if yes, how does the economy react to such an imposition? Answering these question may help better understand the likely effects on welfare of austerity measures of the type passed by the U.S. congress with the Budget Control Act of 2011.[28] In this section we use the political economy model described above to study the effects of these types of programs and the way they should be designed. First, we consider a simple type of austerity program: starting from the balanced growth path, a country is required to run a surplus to permanently reduce the debt to GDP ratio to a target level B in T years.[29] Second, we then relax the assumption that

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[27] Note that depending on the parameterization, it is possible to have positive growth on the transition path: e.g., shutting down public investment in this example will imply that growth depends only on learning-by-doing, and hence increases as the debt rises.

[28] The Budget Control Act of 2011 establishes over 900 billions in budget cuts in 10 years and triggers automatic across-the board cuts in spending if a deficit reduction bill of at least 1.2 trillions is not passed by January 2013.

[29] In particular we assume that the legislators are forced to reduce b by a constant amount in every period until the new target of debt/GDP is reached.
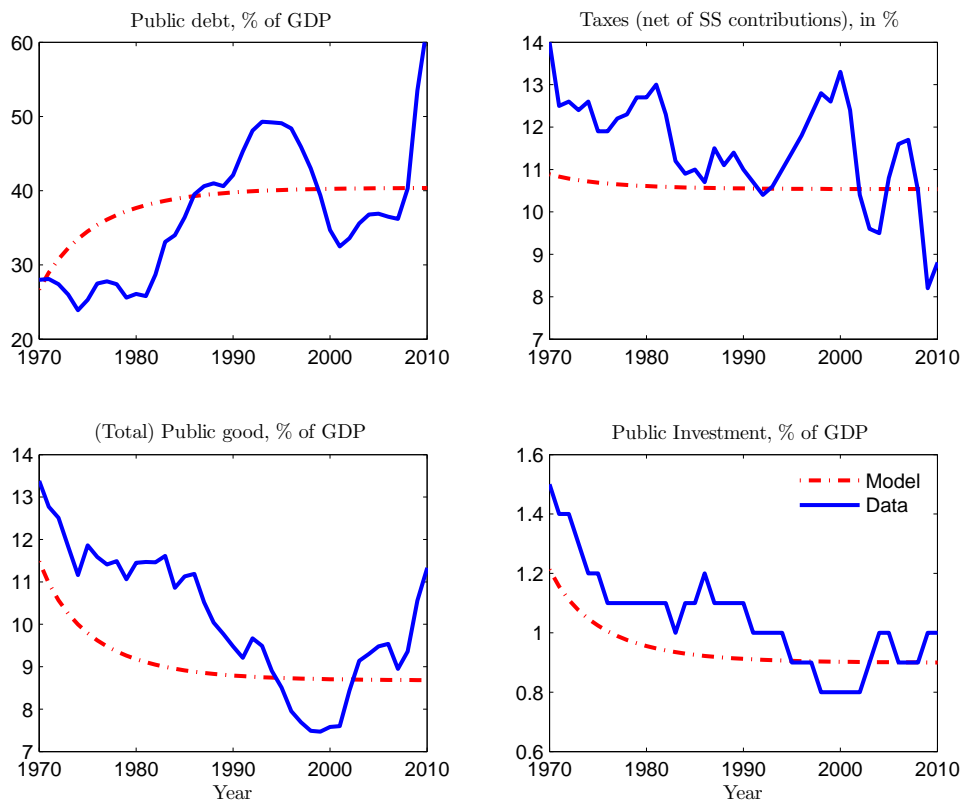
Figure 8: GHH: Fiscal Policy Dynamics

the austerity program can last forever: We consider the case in which austerity can only be imposed for a limited amount of time, after which legislators are free to choose fiscal policy with no constraints.

The effects of an austerity plan with commitment. Figure 10 illustrates the evolution of the equilibrium studied in the previous section when, starting from the steady state, the economy is forced to reduce the level of debt relative to GDP by 50% of its current level in 7 years. We consider this plan because, as we will show below, it is the optimal austerity plan for the specific economy assumed in the calibration (the design of the optimal plan is discussed in greater detail in the next subsection).[30]

Perhaps not surprisingly, after the introduction of the program the tax rate and government

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[30] In the next subsection we consider alternative calibrations of the economy. All the qualitative feature of the dynamics of the economy after an austerity program discussed here are robust to the specific calibration.
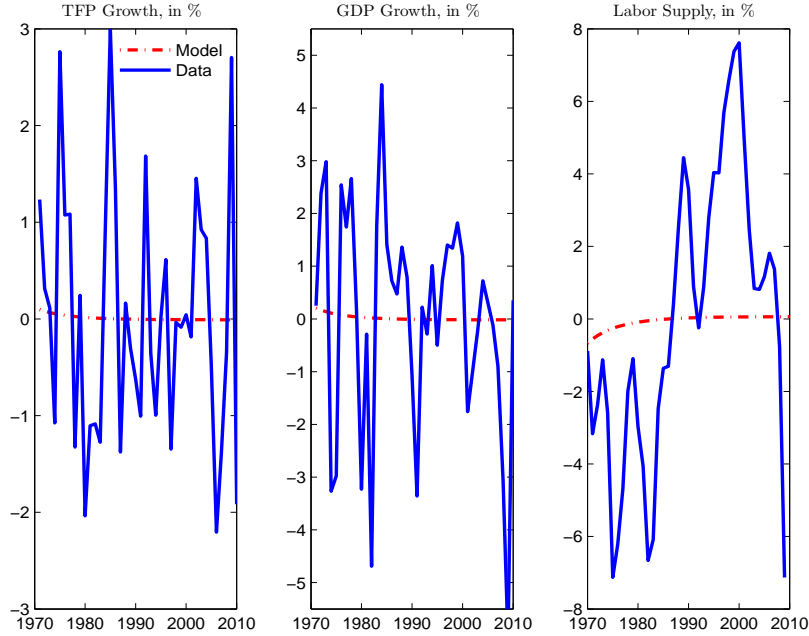
Figure 9: GHH: Growth and Labor Supply Dynamics

expenditure in public goods and infrastructure respectively spike up and down. There is however a key difference in their reaction: the tax rate keeps increasing for the entire period of the program and it settles at a permanently higher steady state; by contrast, public good provision dips below the pre-program period steady state level for two years, it then recovers and keeps increasing until the higher steady state is reached. In the seven years of the program, the tax rate increases by 4 percentage points and total public expenditure as a share of GDP increases by 5 percentage points.[31] During the austerity program, the growth rate of GDP remains below the pre-program level by about 0.5%. Because of the fall in the growth in GDP, the debt/GDP ratio initially increases, but then it gradually falls until it reaches the new steady state.

The transition process exhibits a number of interesting features. First, as the economy converges toward a new balanced path, the growth rate is below its pre-program level. The growth rate, however, is a poor measure of welfare and a poor way to measure the success of the program. The last panel of Figure 10 illustrates the dynamics of the per period expected indirect utility (i.e. the expected value of (6)) scaled by productivity. Citizens' utility initially falls and remains

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[31] The latter rises more than the former because the government has to pay less interest on debt after the change.
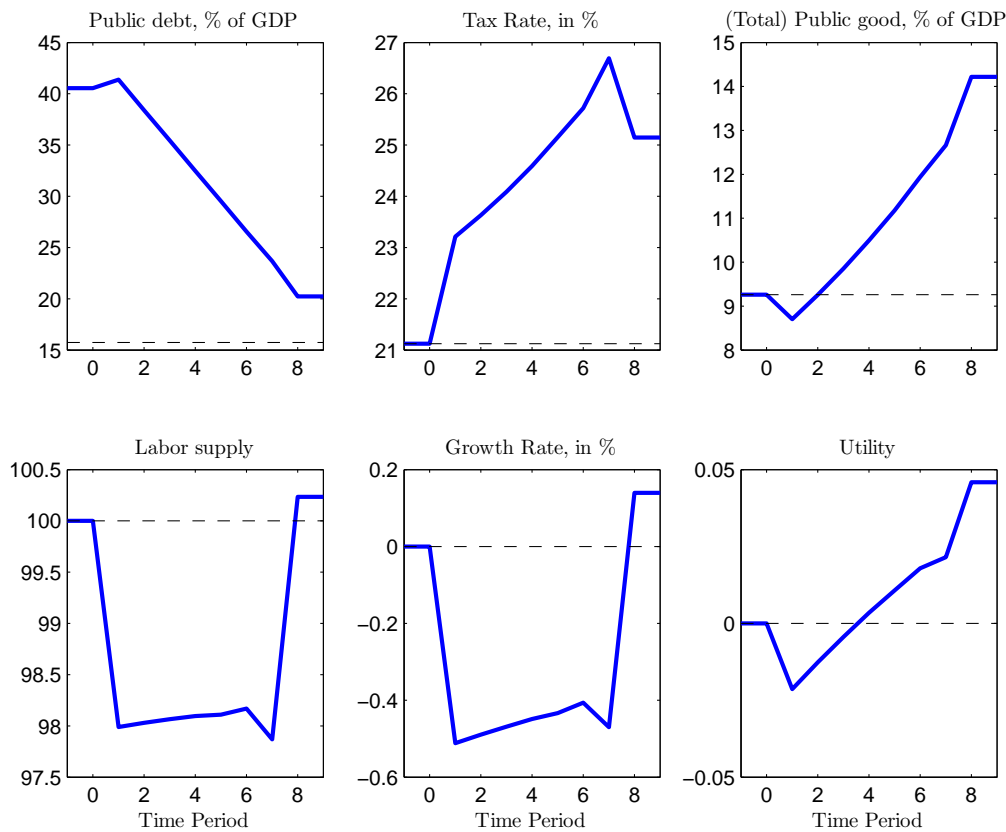
27

Figure 10: Evolution of the economy during the austerity program.

below the pre-austerity level for the first 4 years. After three years, however, the per period indirect utility starts increasing, and it continues to increase until the end of the program.

The second interesting feature of the transition is that although the program imposes to run a fiscal surplus, the size of the public sector over GDP increases over time. This process is the reverse of the *shrinking government effect* that we have highlighted in the previous sections. As we have explained, the endogeneity of the interest rate makes reduction in expenditures a more effective way to increase the budget surplus than increases in taxation when debt is high a reduction in expenditure lowers the interest rate. As debt is forced to decline, therefore, this bias in the policy mix is reduced.

The optimal austerity plan. We now discuss how to chose the optimal austerity plan, and how it changes with the environment. Figure 11 compares the welfare effects of alternative austerity

Target	Duration											
Level	1	2	3	4	5	6	7	8	9	10	15	20
35	0.52	0.81	0.84	0.85	0.85	0.84	0.83	0.82	0.80	0.79	0.72	0.66
30	0.45	1.35	1.46	1.5	1.51	1.5	1.49	1.47	1.45	1.43	1.32	1.21
25	-0.50	1.56	1.81	1.92	1.95	1.96	1.96	1.94	1.92	1.9	1.77	1.64
20	-3.24	1.39	1.84	2.04	2.12	2.16	2.18	2.18	2.17	2.15	2.04	1.91
15	–	0.70	1.46	1.78	1.94	2.03	2.08	2.1	2.12	2.12	2.08	1.99
10	–	-0.69	0.51	1.01	1.27	1.43	1.53	1.61	1.66	1.7	1.79	1.79
5	–	-3.1	-1.28	-0.53	-0.12	0.14	0.33	0.48	0.60	0.70	1.02	1.2
0	–	-7.12	-4.4	-3.32	-2.69	-2.26	-1.94	-1.67	-1.45	-1.25	-0.53	-0.04

Figure 11: Long term austerity programs. An entry in the table is empty when the corresponding reduction in debt is unfeasible.

programs for the baseline calibration. The rows of the table list alternative target reductions in the debt relative to output. The columns of the table list alternative horizons of the program. The entry x_{ij} in column i and entry j is the equivalence variation associated to the austerity program expressed as a percentage of consumption in each period.[32]   Two interesting observations can be drawn from this table. First, except for the cases in which the program is extremely ambitious (both in terms of debt reduction and/or in terms of time horizon), austerity is welfare improving. Second, the effect of a program is neither monotonic in its size nor in its time horizon. If, for example, we fix the time horizon at $T = 7$ periods, austerity implies a gain of 0.83% in per period consumption for target level of 35% of GDP; as we reduce the target to 20% of GDP, the benefit increases to 2.18%; but for targets below 20%, the benefit declines, reaching a negative value of -1.94% for a complete reduction of debt to zero. Similarly, if we fix B at 20%, achieving the goal in one period is equivalent to a *permanent* reduction in consumption of -3.24%; achieving it in 7 periods induces a permanent increase in consumption by 2.18 percent; achieving it in 20 years

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[32] In particular, let c_t, l_t, γ_t and $\widehat{c}_t$, $\widehat{l}_t$, $\widehat{\gamma}_t$ be the path of consumption, labor and public goods provided before and after austerity program ij implemented at t_0. The variable x_{ij} is is chosen so that $\sum_{t=t_0}^{\infty} \delta^t \left[u(c_t(1 + x_{ij}), l_t, \gamma_t) \right]$ is equal to $\sum_{t=t_0}^{\infty} \delta^t u(\widehat{c}_t, \widehat{l}_t, \widehat{\gamma}_t)$.

induces an increase by 1.91%.

The fact that an austerity program forcing fast debt repayment improves welfare may appear surprising at first sight. Although the debt level is inefficiently high at the equilibrium steady state, it may appear that the best way to pay it back is just to evenly spread its cost over time by servicing its cost and keeping the principal constant. To see where the problem with this reasoning is, we should note that although at the steady state the legislators keep policies constant, the policy mix is inefficient. First, political distortions induce a biased distribution of expenditures toward local public goods for the districts of the ruling coalition; second, the lack of commitment induces legislators to use fiscal policy to keep the interest rate inefficiently low. Forcing legislators do run a primary surplus is not directly beneficial because it reduces public debt; it is beneficial because it induces them to change the policy mix. This could be seen by comparing the equilibrium steady state b^* with the steady state that would be reached by a benevolent planner with commitment (the first best) and with the steady state reached after the austerity plan, in both cases starting from $b_0 = b^*$.[33] The benevolent planner would increase the tax rate from the equilibrium steady state level from 21.1% to 35.3%, g from 9.3% to 23.3%, and I from 0.9% to 2.4%. Imposing the austerity plan at b^* does not induce such a large long term change in the policy mix, but it brings it closer to this optimal levels, inducing the intermediate levels τ=25.2%, g=14.2% and I=1.4%.

How does the design of the optimal austerity program depend on the steady state level of debt before the plan is implemented? In the baseline calibration presented above the parameters are chosen so that the steady state level of debt/GDP is 40.5%. Figure 12 illustrates alternative calibrations with higher values α, the measure of the externality and therefore of the political conflict in the economy (and keeping all the remaining parameters constant). For each level of α, the corresponding row illustrates the key variables of the new political equilibrium: the first column shows the steady state level of the debt-to-GDP ratio with no austerity plan; the following two columns describe the associated optimal austerity program in terms of its time horizon and final debt/GDP target (calculated assuming the economy starts at the steady state level of debt). Figure 12 illustrates that there is no "one-size-fits-all" optimal austerity program. As α increases, and therefore the steady state level of debt/GDP increases as well, the time horizon of the optimal program becomes longer and the target level less demanding, ranging from a debt to GDP level

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[33] The computation of the steady state when policies are chosen by a benevolent planner with commitment is omitted to save space. The details are available from the authors.

Value	Implied SS of	Optimal Austerity Measure	
of α	debt/GDP ratio	Years	Target Level
.53	40.5	7	20.1
.55	47.0	9	20.3
.57	55.7	9	22.8
.59	63.1	10	23.7
.61	70.1	10	24.5
.62	78.9	11	25.7

Figure 12: Optimal austerity for different α's.

of 20.1 for the benchmark economy (with $\alpha = .53$) to a target of 25.7 for an economy in which α is .62. Note that even though the target level increases with α, the effective amount of debt reduction also increases in α. In other words, as α increases, even though the target level of debt increases, the optimal austerity program requires larger debt reductions.

No commitment. The assumption that the austerity plan can induce a permanent reduction in debt is very strong: it is perhaps more realistic to assume that austerity can be imposed only for limited period of time, after which legislators are free to choose policies with no constraints. Figure 13 illustrates the effect of reducing debt to 20% of GDP (from a steady state of 40.5%) in 5 years; at the end of the 5th year the program is terminated and so legislators return to the political equilibrium.[34] As it can be seen from the figure, the program induces only a temporary effect on policies, that then return to the original steady state when the program is terminated. Figure 14 illustrates the welfare effects of alternative austerity programs of this type. It is interesting to note that even with a limited commitment of 2-5 years, an austerity program that is not too ambitious can improve welfare. This is due to the fact that after the end of the program, the equilibrium converges to the (inefficient) steady state only gradually, so policies remain closer to the first best for a period that is much longer than the length of the program. The benefit of a temporary austerity programs, however, are uniformly much smaller than the benefits achieved

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[34] Obviously, we assume that the length of the program is rationally anticipated by the legislators, who therefore take into account the temporary nature of the program in choosing the policies.
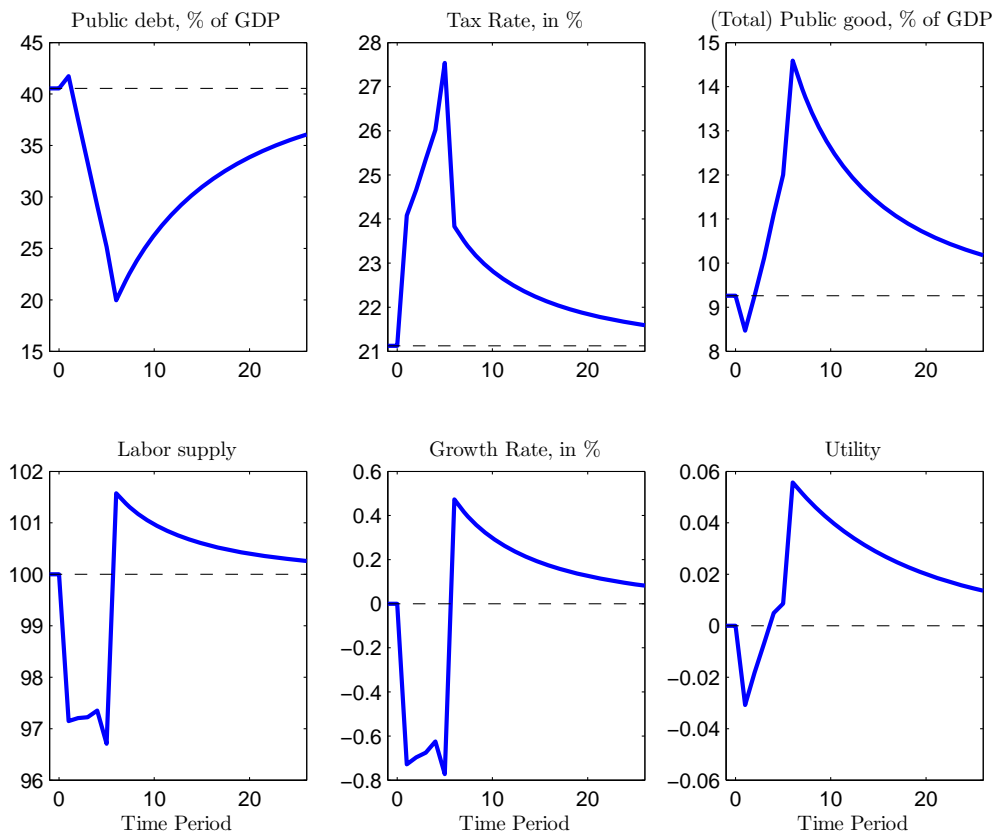
Figure 13: Evolution of the economy during the austerity program.

with programs with commitment presented in Figure 11, and are never higher than 1% of per period consumption.

6   Conclusion

This paper develops a political economy theory of growth and fiscal policy. In the theory, the growth rate of the economy depends on public investment and, through learning-by-doing, on labor supply. Fiscal policy affects citizens' incentives in two ways: taxation distorts labor supply and deficits distort consumption/savings decision through their effect on the interest rate. Policy choices are made by a legislature consisting of elected representatives. Political conflict arises because representatives in the legislature have incentives to vote for policies that favor their own constituencies and citizens benefit only partially from local public goods provided to constituencies

Target	Duration				
Level	1	2	3	4	5
35	-0.04	0.29	0.34	0.37	0.39
30	-0.58	0.39	0.54	0.63	0.68
25	-1.89	0.29	0.59	0.76	0.85
20	-4.88	-0.02	0.50	0.76	0.91
15	–	-0.56	0.26	0.64	0.85
10	–	-1.38	-0.15	0.38	0.68
5	–	-2.55	-0.76	-0.03	0.35
0	–	-4.18	-1.60	-0.64	-0.14

Figure 14: Short term austerity programs. An entry in the table is empty when the corresponding reduction in debt is unfeasible.

to which they do not belong.

The model predicts that the economy converges to a balanced growth path in which consumption, public investment, public good provision, public debt and productivity grow at the same constant rate. The transition to the balanced growth path is characterized by what we call the *shrinking government effect*: public debt grows faster than GDP, provisions of public goods and infrastructure grow slower than GDP and the tax rate declines. These findings are consistent with the U.S. experience over the past few decades, both from a qualitative point of view and, in our calibrated solution, from a quantitative point of view.

We use the model as a laboratory to study the impact of a simple "austerity program" in which a country is required to bring down the debt/GDP ratio. We show that austerity programs may be used to limit political distortions and increase welfare. The analysis however shows that there is no "one-size-fits-all" optimal austerity program: the higher is the accumulated level of debt, the less aggressive the optimal program should be (in terms of both the debt target to reach and timing). The analysis also shows that the growth rate and the short term dynamics of debt/GDP are poor measures of welfare and a poor way to measure the success of the program. On the transition path of the optimal austerity program, growth is below the pre-austerity level,

but welfare is increasing.

There are many different directions in which the ideas presented here might usefully be developed. To focus on public policies, we have made a number of simplifying assumptions both on the description of the economy and on the political process: there is no private capital, no shocks, we are restricting attention to a symmetric economy with no redistribution, and with a relatively simple political decision making process. Extending the model to relax these assumption would certainly provide a richer framework for analysis and improve the model's predictive ability. We are confident that these assumptions can be relaxed in future research.

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7 Appendix

In this appendix we first detail the statements and propositions presented in Sections 2 and 3. We then discuss our data sources and the calibration presented in Sections 4 and 5. As a preliminary result, we start showing that the citizens' indirect utility functions can be represented as in *(6)*.

Lemma A1. *The per period indirect utility function is given by (6) where*

$$U(p_t) = \log \left(n^{\omega_0} \mu^\mu (1 - \tau_t)^{1+\omega_0} \left[1 - \frac{1}{n} \left(I_t + \sum_j g_t^j \right) \right]^{1+\mu} \left[\frac{1}{\mu \left[1 - \frac{1}{n} \left(I_t + \sum_j g_t^j \right) \right] + 1 - \tau_t} \right]^{1+\mu+\omega_0} \right)$$

(16)

Proof. The second term of (1) can be written as $u(c_t, l_t, g_t) = \log \left(c_t (1 - l_t)^\mu (nz_t l_t)^{\omega_0} \right) + \omega_0 \log \left[(g_t^i)^\alpha \left(\sum_j g_t^j \right)^{1-\alpha} \right]$. Substituting (4) and (5) we have the result. ∎

We next provide the proof of Lemma 1.

7.1 Proof of Lemma 1

A citizen, whose district is in the government, has the following expected continuation value:

$$v_{\mathcal{G}}(b, z) = U(p) + w_0 E \log \left[(g^i)^\alpha \left(\sum_j g^j \right)^{1-\alpha} \right] + \delta v(b', z').$$

Hence, the incentive compatibility constraint holds equality iff $E \log g^i = \log g^c$. Since

$$E \log g^i = \frac{1}{\mathcal{G}} \left(\log g + (q - 1) \log g^c + (\mathcal{G} - q) \log \underline{g} \right).$$

it must be the case that $g^c = g^{\frac{1}{\mathcal{G}-q+1}} \underline{g}^{1 - \frac{1}{\mathcal{G}-q+1}}$, as stated. ∎

7.2 Proof of Proposition 1

Write $v_t = \sum_{\tau=t}^\infty \delta^{\tau-t} u(p_\tau, z_\tau)$ as:

$$v_t = \sum_{\tau=t}^\infty \delta^{\tau-t} \left\{ (1 + \omega_0) \log z_\tau + U(p_\tau) + \omega_0 E \log \left[(g_\tau^i)^\alpha \left(\sum_j g_\tau^j \right)^{1-\alpha} \right] \right\}$$

Since $\log(z_{t+1}) = \log(z_t) + \phi_1 \log (I_t) + \eta_1 \log l_t + \log \phi_0 \eta_0 n^{\phi_1}$, we have:

$$\log(z_{t+T}) = \log z_t + \sum_{\tau=t}^{t+T-1} \left[\phi_1 \log (I_\tau) + (\eta_1 + \phi_1) \log l_\tau + \log \phi_0 \eta_0 n^{\phi_1} \right]$$

Using this formula and (4)-(7), we can express v_t as

$$v_t = \frac{1+\omega_0}{1-\delta} \log z_t +$$

$$+ \sum_{\tau=t}^{\infty} \delta^{\tau-t} \left\{ \begin{array}{c} U(p_\tau) + \frac{(1+\omega_0)\delta}{1-\delta} \left[\phi_1 \log (I_\tau) + (\eta_1 + \phi_1) \log l_\tau + \log \phi_0 \eta_0 n^{\phi_1} \right] \\ + \omega_0 E \log \left[\left(g_\tau^i\right)^\alpha \left(\sum_j g_\tau^j\right)^{1-\alpha} \right] \end{array} \right\},$$

which, in turn, using the expression for $E \log g^i$ can be written as

$$v_t = \mathcal{A} \log z_t + \sum_{j=t}^{\infty} \delta^{j-t} \left[\mathcal{U}(p_t) + \omega_0 \alpha \frac{\mathcal{G}}{n} Q(\mathcal{G}, q) \log g_t \right],$$

where $\mathcal{A} = \frac{1+\omega_0}{1-\delta}$ and

$$\begin{aligned} \mathcal{U}(p_t) =\ & A_0 + U(p_t) + \frac{(1+\omega_0)\delta}{1-\delta} \left[\phi_1 \log (I_t) + (\eta_1 + \phi_1) \log l_t \right] \\ & + \omega_0 (1-\alpha) \log \left(g_t + (q-1) g_t^{Q(\mathcal{G},q)} \underline{g}^{(1-Q(\mathcal{G},q))} + (n-q)\underline{g} \right), \end{aligned} \tag{17}$$

with $A_0 = \frac{(1+\omega_0)\delta}{1-\delta} \log \left(\phi_0 \eta_0 n^{\phi_1} \right) + \alpha \omega_0 \left(\frac{\mathcal{G}}{n} \frac{\mathcal{G}-q}{\mathcal{G}-q+1} + \frac{n-\mathcal{G}}{n} \right) \log \underline{g}$.

If we define $\mathcal{V}_t = \sum_{\tau=t}^{\infty} \delta^{\tau-t} \left[\mathcal{U}(p_\tau) + \alpha \omega_0 \frac{\mathcal{G}}{n} Q(\mathcal{G}, q) \log g_\tau \right]$ or, in a recursive form,

$$\mathcal{V}_t = \mathcal{U}(p_t) + \omega_0 \alpha \frac{\mathcal{G}}{n} Q(\mathcal{G}, q) \log g_t + \delta \mathcal{V}_{t+1} \tag{18}$$

condition (17) can be written as $v_t = \mathcal{A} \log z_t + \mathcal{V}_t$. The expected value of a citizen who knows to be a government formateur v_t^p can be represented in the same. The only difference is that the proposer receives $\log g_t$ for sure instead than $E \log \left[\left(g_t^i\right)^\alpha \left(\sum_j g_t^j\right)^{1-\alpha} \right]$. As it can be easily proven, we have:

$$v_t^p = \mathcal{A} \log(z_t) + \mathcal{U}(p_t) + \alpha \omega_0 \log g_t + \delta \mathcal{V}_{t+1}. \tag{19}$$

where $\mathcal{V}_{t+1}$ is defined by (18).

The proof of the proposition now follows immediately. Since $\mathcal{A} \log z$ is a constant, if $p(b)$ solves (12) given $\mathcal{V}(b)$, then it must be an optimal reaction function given the true value function $\mathcal{A} \log(z) + \mathcal{U}(p) + \alpha \omega_0 \log g + \delta \mathcal{V}(b')$; moreover if $\mathcal{V}(b)$ satisfies (11) given $p(b)$, then $v(b, z) = \mathcal{A} \log z + \mathcal{V}(b)$ is the expected value in the game. On the contrary, if $p(b)$ is an equilibrium, then we must have $v(b) = \mathcal{A} \log z + \mathcal{V}(b)$ and the proposer must maximize (12). ∎

7.3 Proof of Proposition 2

It is first convenient to define the marginal cost of public funds (described informally in Section 3). Let $B(b,p) = \rho(b,p) [b + G(g) + I + T - \tau n l(p)]$. From the proposer's budget constraint

in (12), we have $\beta' = zB(b,p)$. In order to reduce nominal debt β' by one marginal unit the required increase in taxes must be $d\tau = -[zB_\tau(b,p)]^{-1}$. The net marginal reduction in utility by an increase in taxes is given by $\mathcal{V}_\tau(b,p)$, where $\mathcal{V}$ is the indirect utility function defined in (11).[35] The reduction in utility in absolute value is therefore $\frac{\mathcal{V}_\tau(b,p)}{zB_\tau(b,p)}$. Moreover the marginal utility of consumption is $\frac{1}{zc(p(b))}$. The marginal cost of public funds, then is: $\frac{c(p)\mathcal{V}_\tau(b,p)}{B_\tau(b,p)}$. Note that the Lagrangian multiplier λ from (12) can be written as: $\lambda(b) = \frac{\mathcal{V}_\tau(b,p)}{B_\tau(b,p)}$. We conclude that the marginal cost of public funds when policies are p and the Lagrangian multiplier is λ is

$$MCPF(b) = \lambda(b)c(p).$$

We now prove (14). Consider the first order condition with respect to b' of (12):

$$\frac{\lambda(b)Z(p)}{\rho(b,p)}\left[1 - \frac{b'}{\rho(b,p)}\frac{\partial\rho(b,p)}{\partial b'}\right] = -\delta \cdot \mathcal{V}'(b'),$$

We have

$$\frac{\lambda(b)Z(p)}{\rho(b,p)}\left(1 - \varepsilon_\rho(b)\right) = -\delta \cdot \mathcal{V}'(b'), \tag{20}$$

where $\varepsilon_\rho(b)$ is the elasticity of the interest rate as defined in (13). Let $\mathcal{V}_p(b)$ be the objective function of (12). Adding and subtracting $\alpha\omega_0 \log(g(b))$, we can write: $\mathcal{V}(b) = \mathcal{V}_p(b) + \alpha\omega_0\left(\frac{\mathcal{G}}{n}Q(\mathcal{G},q) - 1\right)\log g(b)$. From the envelope theorem applied to (12), at any point of differentiability we have $\mathcal{V}'_p(b) = -\lambda(b)$, so we can write:

$$\mathcal{V}'(b) = -\lambda(b) + \alpha\omega_0\left(\frac{\mathcal{G}}{n}Q(\mathcal{G},q) - 1\right)\frac{\partial g(b)/\partial b}{g(b)}. \tag{21}$$

Using (20) and we have:

$$\left(1 - \varepsilon_\rho(b)\right)\frac{\lambda Z(p)}{\delta\rho(p)} = \lambda(b') - \alpha\omega_0\left(\frac{\mathcal{G}}{n}Q(\mathcal{G},q) - 1\right)\frac{\partial g(b')/\partial b'}{g(b')}. \tag{22}$$

Observe now that (7) can be written as: $\delta\rho(b,p) = c(p(b'))Z(p)/c(p)$. We can therefore write:

$$\left(1 - \varepsilon_\rho(b)\right)c(p)\cdot\lambda(b) = c(p(b'))\cdot\lambda(b')\left[1 - \frac{1}{\lambda(b')}\alpha\omega_0\left(\frac{\mathcal{G}}{n}Q(\mathcal{G},q) - 1\right)\frac{\partial g(b')/\partial b'}{g(b')}\right] \tag{23}$$

Define: $\Phi(b') = 1/(b'\cdot\lambda(b'))$, and let $\varepsilon_g(b') = \frac{\partial g(b')}{\partial b'}\frac{b'}{g(b')}$ be the elasticity of $g(b')$ with respect to b'. Using the fact that $MCPF(b) = \lambda(b)c(p)$, we obtain (14). ∎

7.4 Proof of Proposition 3

If $\mathcal{G} = q = n$ and/or $\alpha = 0$, we have $\alpha\left(1 - \frac{\mathcal{G}}{n}Q(\mathcal{G},q)\right) = 0$. In this case, at the steady state b^* we must have: $\frac{\partial\rho(b',b^*)}{\partial b'}\frac{b^*}{\rho(b^*,b^*)} = 0$, where the derivative is evaluated at b^*. Since $MCPF(b^*) > 0$ and $\frac{\partial\rho(b',b)}{\partial b'} > 0$ at $b = b^*$, a steady state is possible only if $b^* = 0$. ∎

7.5 Proof of Proposition 4

In a regular steady state b^* we have:

$$\varepsilon_\rho(b^*) = -\alpha\omega_0\left(1 - \frac{\mathcal{G}}{n}Q(\mathcal{G},q)\right)\Phi(b^*)\,\varepsilon_g(b^*). \tag{24}$$

where $\varepsilon_\rho(b^*) > 0$ and $\Phi(b^*) > 0$. We conclude that $\varepsilon_g(b^*) < 0$ and so $g(b)$ is decreasing in b in a neighborhood of the steady state in any smooth equilibrium. Since the steady state is stable, starting from b_0 in a left neighborhood, $b_{t+1} > b_t$, and so $\gamma_{t+1}/\gamma_t < y_{t+1}/y_t$ for any $t > 0$. By Lemma 1, we must have and $\gamma_{t+1}^c/\gamma_t^c < y_{t+1}/y_t$, where $\gamma_t^c = g_t^c y_t$ is the dollar value of public goods allocated to the districts in the minimal winning coalition. From the first order conditions of (12) it is also easy to show that I_t is monotone in g_t, so we have $\mathcal{I}_{t+1}/\mathcal{I}_t < y_{t+1}/y_t$ as well. ∎

7.6 Data and Calibration

Data In this section we provide information on the sources of the data used to construct Figures 1, 4, 5 on the U.S. economy. We also briefly discuss the statistical significance of the trends illustrated in the Figures.

Data on output and the tax revenue-to-GDP ratio is obtained from BEA's National Income and Product Accounts (NIPA, Tables 7.1 and 14.2, respectively).[36]   Tax revenues are measured net of Social Security contributions. Data on productivity is obtained from John Fernald's series on utilization adjusted TFP based on Basu, Fernald and Kimball [2006].[37]   Labor supply data is from Neville and Ramey [2009]. Data on debt is taken from the U.S. Office of Management and Budget, (Table 7.1).[38]   For public goods we use the U.S. Office of Management and Budget

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[36] Available at *http://www.bea.gov/iTable/index_nipa.cfm*

[37] Available at *http://www.frbsf.org/economics/economists/staff.php?jfernald.*

[38] Available at *http://www.whitehouse.gov/omb/budget/Historicals).*

(Table 3.1).[39]   Our definition of public investment comes from Federal Outlays, NIPA, Table 9.1. We have looked at two measures: "Research and Development," and "Total Investment Outlays for Major Public Physical Capital, Research and Development, and Education and Training." In our baseline calibration we conservatively use the former.

Over the period of 1971-2010 we observe that Federal debt (as a fraction of GDP) shows positive statistically significant time trend. Public goods (as a fraction of GDP) show negative statistically significant time trend. This fact is robust to the inclusion/exclusion of Health and to inclusion/exclusion of National Defence in the definition of public goods. Public investment (as a fraction of GDP), defined either way, shows negative statistically significant time trend. This fact is robust to the inclusion/exclusion of the defence share. Tax revenues (as a fraction of GDP), show negative statistically significant time trend.

Calibration   The key parameters describing the fundamentals σ, ψ and μ are chosen following the RBC literature. We choose log-utility function for consumption with $\sigma = 1$ as in Jaimovich and Rebelo [2008] and McGrattan and Prescott [2010].   We set $\mu = 1.37$, which yields labor elasticity of about 1.5 at the steady state of the model and is in a mid-range of the parameters used in the literature. We set δ to 0.954, so that we match the real interest rate of 6% (Jaimovich and Rebelo, [2008]).   The literature provides no guidance on the (long-run) elasticity of growth via LBD. We set it to $\eta = 0.245$. That is, we assume that the long run elasticity of the LBD with respect to labor is three quarters of its short run elasticity, as estimated by Chang et al. [2002]. The transfer parameter is set to its empirical counterpart, 10% of GDP. The parameters describing the political process are n, $\mathcal{G}$, q, and $\underline{g}$.   We set the number of districts to 100, the government size, $\mathcal{G}$, to 100, the majority required to pass the legislation to 51, and $\underline{g}$ to .01: 1% of output of a single district.   The exact number of districts, the government size, and the size of the minimal winning coalition are not particularly relevant in absolute terms, what matters is the ratio $\frac{\mathcal{G}}{n}Q(\mathcal{G}, q)$. In the standard calibration it is therefore set to 51%. The ratio $\underline{g}$ is also not particularly important for the results: we have done extensive sensitivity analysis obtaining very

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[39] We use the following classification of Federal Outlays, as reported by the Office of Management and Budget: Public Goods: (i) National Deference; (ii) Education, Training, Employment and Social Services; (iii) Health, (iv) Energy; (v) National Resources and Environment; (vi) Transportation; (vii) Community and Regional Development; (viii) International Affairs; (ix) General Science, Space and Technology, (x) Agriculture; (xi) Administration of Justice; (xii) General Government; (xiii) Veterans Benefits and Services. Transfers: (i) Medicare; (ii) Income Security; (iii) Social Security; (iv) Commerse and Housing Credit. Other: Net Interest.

similar results.[40]   The remaining parameters are chosen to fit the key moments.   In particular, we choose α, ω_0 and ϕ_1 to match the debt-to-GDP ratio, the share of total public good and investment in GDP. This yields values of 0.53, 0.49 and 0.00181, respectively.

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[40] E.g., increasing or decreasing it by a factor of two leaves the quantitative results of the paper virtually unchanged.