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Politically Optimal Fiscal Policy

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Abstract

Why do governments issue large amounts of debt? In what sense and for whom is such a policy optimal? We show that twisting the optimal taxation paradigm produces very reasonable predictions for debt and real interest rates. Adding an extra dimension of uncertainty about the political planning horizon gives rise to a positive and very plausible government debt-to-GDP ratio of about 55 percent in a model that otherwise predicts negative government debt. We quantify the impact of political uncertainty on steady state and business cycle dynamics. We illustrate how populist tax cuts can cause business cycle fluctuations.

JEL Classification Numbers: E62, H21,H39, H63

Keywords: Optimal Fiscal Policy, Incomplete Asset Markets, Political Economy, Government Debt Bias

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I. Introduction

Why do governments typically issue large amounts of debt? In what sense and for whom is such a policy optimal? The most common way to address these questions is to build on the paradigm of the benevolent social planner, whose objective function coincides with that of private agents and who chooses a set of taxation, spending and debt policies to maximize that objective function. But this purely normative approach rules out many strong contenders for an explanation of high levels of government debt. Furthermore, it typically concludes that governments should issue negative debt. However, as we show in this paper, only a slight modification of the benevolent social planner paradigm produces very reasonable predictions for debt and real interest rates while leaving many other key results of the optimal taxation literature intact.

We introduce what we refer to as a Political Planner into an otherwise standard optimal taxation model with incomplete asset markets. This planner commits to the policies announced by his predecessors, and his preferences are based on the welfare of private agents just like the traditional Ramsey Planner.[1] But our model has an additional, political dimension of uncertainty in that the planner has a finite and time-varying planning horizon. He therefore cares more about the welfare of households in the near future, either because he cares about voter approval during his time in office, or more broadly because he cares about his political legacy. Together with continuous debt limits in the form of small quadratic bondholding transaction costs, this model gives rise to a positive deterministic and stochastic steady state for government debt that is not history dependent. This prediction, which is true even for very minimal deviations from the benchmark case of an infinite planning horizon, considerably increases the usefulness of the optimal taxation framework. Our contribution is to quantify the impact of different planning horizons on steady state debt-to-GDP ratios and on business cycle dynamics, both in the long run and over the transition.

Our model overturns a very common finding in the optimal taxation literature, namely that governments should optimally accumulate claims on the private sector rather than issue debt. This counterfactual prediction appears to be very robust to the assumed nature of asset markets and to assumptions about the government's ability to commit to its policies. For representative agent models that assume government commitment, it can be shown to hold irrespective of whether the model includes capital accumulation, and of whether asset markets are complete, as in Chari, Christiano and Kehoe (1994), or incomplete, as in Aiyagari, Marcet, Sargent and Seppälä (2002). The prediction is based on the optimality of maximizing the financing of government spending out of the interest earnings on government assets while reducing distortionary labor taxation as much as possible. Under complete asset markets this is feasible as long as the Ramsey Planner is free to choose the initial tax on debt, thereby enabling him to engineer an instantaneous and nondistortionary wealth transfer.[2] Under incomplete asset markets the same outcome obtains in the long run through government precautionary savings. Martin (2006) overviews the time-consistency literature and concludes that under conventional assumptions long-run government debt is also negative. He shows that it is possible to

[1] See Chari and Kehoe (1999) for a comprehensive review of the optimal taxation literature.

[2] To make complete markets problems more interesting this is therefore typically ruled out through an ad-hoc restriction on the initial tax rate on debt.

reach a substantial positive long-run debt level only by making the strong assumption that consumption and leisure are complements. Under that assumption, in a perfect foresight model with positive initial nominal debt, inflating that debt away becomes too costly. The mechanism relies on the well-known interest rate manipulation suggested by Lucas and Stokey (1983).

There is another strand of literature on government debt bias in an optimal fiscal policy context, based on ex-post heterogeneity of agents, as in Aiyagari (1995), Aiyagari and McGrattan (1998), and Shin (2005). In this class of models households prefer to accumulate government debt as a buffer to insure against individual idiosyncratic shocks, while a Ramsey Planner prefers to accumulate private debt as a buffer against aggregate risk that facilitates tax smoothing. Shin (2005) shows that if idiosyncratic risk is large enough relative to aggregate risk, equilibrium government debt is positive in the long run. This result however depends crucially on the absence of other assets that might permit self-insurance.

Thematically our paper is also related to the political economy literature.[3] Like Alesina and Tabellini (1990) and Persson and Svensson (1989), ours is a positive rather than a normative theory of debt and taxation. In Alesina and Tabellini (1990) debt is the aggregate outcome of a political conflict between different interest groups, modeled as a dynamic game. A related empirical literature (Roubini and Sachs (1989), Persson and Tabellini (2004)) finds that institutions for political conflict resolution are indeed important for fiscal policy outcomes. We find that to explain debt bias it is sufficient to consider the concern of the policymaker with his popularity or legacy. This requires modeling the objective function of the policymaker as different from that of private agents, rather than modeling the objective functions of multiple interest groups. Specifically, we adopt the objective function used by, among others, Grossman and Van Huyck (1988). This allows us to stay methodologically very close to the optimal fiscal policy literature while reversing one of its central results on government debt.

The assumption of different private and social discount factors has been recently exploited to study dynamic inequality and its implications for insurance and taxation[4]. Our assumption about different normative criteria of the Political Planner is conceptually close to Farhi and Werning (2006). When one of the two players cares more about future generations than the other, this small departure from otherwise same positive economic model produces drastically different results for the issue in consideration. In their setting, the society is assumed to discount future slower than the private agents giving rise to non-degenerate long run inequality. We assume that private agents care more about their descendents than the Political Planner. Political uncertainty on the planner's side gives rise to positive and significant long run debt level and to short run debt bias in otherwise standard framework.

The main assumptions of our model are closely related to Aiyagari, Marcet, Sargent and Seppälä (2002). The government finances exogenous spending through distortionary labor income taxation or through the accumulation or decumulation of debt. Asset markets are incomplete in that government debt can only take the form of one-period non-state contingent real bonds. The economy is subject to government spending and productivity

[3] Alesina and Perotti (1995) contains a survey.
[4] See Sllet and Yeltekin (2005) and references therein.

shocks, to which we add shocks to the government's planning horizon. The government acts as a benevolent planner, but its effective discount rate is larger than the market real interest rate. For a sufficiently low initial level of debt the government therefore has an incentive to maximize the welfare of current agents by lowering their taxes. This drives up debt until it reaches a point where further tax cuts would be too costly because of the effect of the debt limit on interest rates, the government budget and therefore on the necessity to raise future distortionary taxation.

The optimal taxation literature typically uses upper and lower ad hoc debt limits in conjunction with no-Ponzi and transversality conditions. We also use ad hoc debt limits, but find it useful to introduce continuous debt limits in the form of small quadratic bondholding transaction costs. These costs are paid to a financial intermediary (broker), and are increasing quadratically in the stock of bonds this intermediary has to administer on behalf of households. As a consequence, higher market interest rates are required to absorb higher government debt. We find that transaction costs which generate empirically plausible predictions for interest rates simultaneously generate realistic predictions for government debt-to-GDP ratios. Furthermore, together with the objective function of a limited horizon policymaker, quadratic transaction costs give rise to a positive and history-independent deterministic and stochastic steady state for government debt. This is a critical advantage for the computational solution of the model, as the discussion in Reiter (2005) makes clear. Namely, our assumption facilitates the use of second-order approximations to characterize the long run behavior of the model. We also go one step beyond examining the long run implications by using a global numerical method, based on Monte Carlo simulations, to solve for the transitional dynamics of the model and show how debt gradually reaches its high long run level staring from zero initial stock.

We show that the conventional result of government precautionary saving does obtain in the limit of our model, when the government's discount rate approaches that of the private sector and transaction costs go to zero. But introducing only very small transaction costs eliminates this possibility, implying optimal stochastic steady state government debt very close to zero. More strikingly, even extremely small differences between the public and private discount rates induce substantial levels of steady state government debt. The model is also well suited to analyze the response of the economy to periods of political instability, which have a natural representation as temporary negative shocks to the government discount factor. We show that such shocks give rise to 'populist' tax cuts that can be an independent source of business cycle fluctuations. They lead to short run economic booms that eventually lead to higher debt, higher real interest rates, and therefore higher taxes and an economic contraction. Finally we discuss some aspects of the optimal tax and debt policy that are close to those of the existing literature, most importantly the serial correlation of labor taxes.

The rest of the paper proceeds as follows. Section 2 describes the model and defines the competitive and the political equilibrium. Section 3 presents our main results. Section 4 concludes.

II. The Model

The economy is composed of four types of agents: a representative household, a manufacturing firm, a financial intermediary, and the government. They interact in goods, labor and bond markets. The government acts as a Stackelberg leader who maximizes his objective function over the set of competitive equilibria of the economy. We begin by describing the competitive equilibrium of the decentralized economy and then proceed to the Political Planning problem.

A. Decentralized Economy

1. Households

Households maximize the present discounted value of utility, using a constant discount factor β. Utility at time t is logarithmic in consumption c_t and leisure $(1-\ell_t)$, where 1 is the time endowment and ℓ_t is labor supply:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left\{\log c_t + \kappa \log(1-\ell_t)\right\} \quad . \tag{1}$$

Households' sources of cash flow at time t are after-tax real wages $(1-\tau_t)w_t\ell_t$ (where w_t is the real wage and τ_t is the labor tax rate), lump-sum profit transfers π_t from the financial intermediary, and the redemption value of bonds b_{t-1} purchased at time $t-1$. We assume that government debt has a one-period maturity and pays off one unit of the consumption good at maturity. Markets are therefore incomplete in the spirit of Aiyagari, Marcet, Sargent and Seppälä (2002). The time t price of a bond b_t maturing in period $t+1$ is q_t. Households' uses of cash flow at time t include new bond purchases q_tb_t, consumption c_t and quadratic bondholding transaction costs Φ_t payable to the intermediary in exchange for his administration of the outstanding stock of government debt or assets. The household budget constraint is

$$c_t + q_tb_t + \Phi_t = (1-\tau_t)w_t\ell_t + b_{t-1} + \pi_t \quad . \tag{2}$$

The specification of Φ_t is such that if the household wants to maintain a short or a long position in government bonds, he is obliged to pay a cost that is quadratic in the ratio of debt b_t to per capita output y_t, and proportional to y_t, where y_t is taken as given:

$$\Phi_t = \frac{\phi}{2} y_t \left(\frac{b_t}{y_t}\right)^2 \quad . \tag{3}$$

Households maximize (1) subject to (2) and (3). The first-order condition for the consumption-leisure choice is

$$(1-\tau_t)w_t = \kappa \frac{c_t}{1-\ell_t} \quad , \tag{4}$$

and the consumption-investment choice solves

$$\frac{1}{c_t}(q_t + \phi \frac{b_t}{y_t}) = \beta E_t \frac{1}{c_{t+1}} \quad . \tag{5}$$

2. Firms

Competitive firms produce output employing a simple linear production function in labor that is subject to a random productivity shock z_t:

$$y_t = z_t l_t \quad . \tag{6}$$

Therefore, the wage rate in this economy is stochastic and given by

$$w_t = z_t \quad . \tag{7}$$

The stochastic process for productivity is

$$\log(z_t) = (1-\rho_z)\log(\bar{z}) + \rho_z \log(z_{t-1}) + \varepsilon_t^z \quad . \tag{8}$$

3. Financial Intermediary

The financial intermediary faces zero marginal cost and zero fixed cost of operation. It simply redistributes the transaction cost paid by households back in a lump-sum fashion:

$$\pi_t = \Phi_t \quad . \tag{9}$$

4. Government

In each period, the government has to finance a given stochastic stream of expenditures g_t by levying labor income taxes at the rate τ_t and by issuing government debt b_t^{gov}:

$$g_t + b_{t-1}^{gov} = q_t b_t^{gov} + \tau_t w_t \ell_t \quad . \tag{10}$$

The stochastic process for government spending is given by

$$\log(g_t) = (1-\rho_g)\log(\bar{g}) + \rho_g \log(g_{t-1}) + \varepsilon_t^g \quad . \tag{11}$$

5. Competitive Equilibrium

We define a *government policy* G as a stochastic process $\{\tau_t\}_{t=0}^{\infty}$. Similarly, an *allocation* and a *price system* are lists of stochastic processes $\{y_t, c_t, \ell_t, l_t, b_t, b_t^g\}_{t=0}^{\infty}$ and $\{w_t, q_t\}_{t=0}^{\infty}$. Then we have the following definition.

A ***competitive equilibrium*** *is an allocation, a price system and a government policy such that, given shock processes (8) and (11), and given* b_{-1}*:*

1. *Households maximize (1) subject to (2) and (3).*
2. *Firms minimize cost given their production function (6).*

3. *Condition (9) holds for the intermediary.*
4. *The goods market clears at all times:*

$$c_t + g_t = z_t \ell_t \quad . \tag{12}$$

5. *The labor market clears at all times:*

$$l_t = \ell_t \quad . \tag{13}$$

6. *The bonds market clears at all times:*

$$b_t^{gov} = b_t \quad . \tag{14}$$

We will adopt the notation ℓ_t and b_t for equilibrium quantities of labor and bonds when solving the Political Planner's problem.

B. The Political Planner

The Political Planner maximizes the utility of households in the near future. This means that his objective function is identical to (1) except that the discount factor is smaller than the pure rate of time preference and equals $\gamma_t \beta$, with $\gamma_t < 1$, as in Grossman and Van Huyck (1988). In a quarterly model, the planning horizon of a politician, expressed in years, therefore equals h_t=$1/\left(4(1-\gamma_t)\right)$. We assume that h_t follows an exogenous stochastic process:

$$h_t = (1-\rho_h)\bar{h} + \rho_h h_{t-1} + \varepsilon_t^h \quad . \tag{15}$$

The Political Planner's objective function is

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \Gamma_{0,t} \left\{ \log c_t + \kappa \log(1-\ell_t) \right\} \quad , \tag{16}$$

where $\Gamma_{0,t} = \Pi_{\tau=0}^{t} \gamma_\tau$ and $\gamma_0 = 1$. As in a Ramsey problem, the government maximizes this objective function over the set of competitive equilibria, characterized by the optimality conditions (4), (5), (7) and (9) of the agents' problems and by the government budget constraint (10), the economy's resource constraint (12), and the labor and bonds market clearing conditions (13) and (14). The last four conditions imply the household budget constraint (2). By substituting the competitive equilibrium optimality conditions into the latter we obtain the following implementability constraint:

$$\frac{1-\ell_t-\kappa\ell_t}{1-\ell_t} + (\beta\gamma_t) E_t \frac{1}{\gamma_t} \frac{1}{c_{t+1}} b_t - \frac{1}{c_t}\left(\phi \frac{b_t^2}{z_t \ell_t} + b_{t-1}\right) = 0 \quad . \tag{17}$$

The government plays a Stackelberg game with the agents in the economy: In period 0 it announces a policy G, and subsequently it lets private sector agents choose their allocations as their best response to this policy. We assume that the government has access to a commitment technology and can therefore bind itself to a particular stochastic process for policies once and for all at time 0. This process is contingent on the realizations of technology, government spending and political shocks (8), (11) and (15). In choosing optimal policies the government needs to predict how household and firm allocations and prices will respond to its policies in a competitive equilibrium. This requirement imposes restrictions on the set of allocations that the government can achieve by varying its policies. We define an *allocation rule* as a sequence of functions $A(G) = \{y_t, c_t, \ell_t, b_t \mid G\}_{t=0}^{\infty}$ that maps policies G into competitive equilibrium allocations, and a *pricing rule* as $P(G) = \{w_t, q_t \mid G\}_{t=0}^{\infty}$ that maps policies G into competitive equilibrium prices. Then we have the following definition.

*A **political equilibrium** is a government policy G, an allocation rule, and a pricing rule such that, given shock processes (8), (11) and (15), and given b_{-1}:*

1. *The government policy maximizes government utility (16) subject to the government's budget constraint (10) when allocations and prices are given by $A(G)$ and $P(G)$,*
2. *For every government policy $\tilde{G}$, the allocation $A(\tilde{G})$ and the price system $P(\tilde{G})$, together with the government policy $\tilde{G}$, are a competitive equilibrium.*

Based on Marcet and Marimon (1998), we make the above problem recursive by switching to a saddle-point formulation. Letting η_t and λ_t be the multipliers on the resource and implementability constraints, we have

$$\begin{aligned} W_o \quad = \quad & \min_{\{\lambda_t\}_{t=0}^{\infty}} \max_{\{c_t, \ell_t, b_t, \eta_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \Gamma_{0,t} \{\log c_t + \kappa \log(1-\ell_t) + \eta_t (z_t \ell_t - c_t - g_t) \\ & + \lambda_t \left[\frac{1-\ell_t-\kappa\ell_t}{1-\ell_t} - \frac{1}{c_t}\left(\phi \frac{b_t^2}{z_t \ell_t} + b_{t-1} \right) \right] + \lambda_{t-1} \frac{1}{\gamma_t} \frac{1}{c_t} b_{t-1} \right\} \quad , \end{aligned} \tag{18}$$

with initial condition

$$\lambda_{-1} = 0 \quad , \tag{19}$$

and for given shock processes and an initial value b_{-1}. The first-order conditions for the political equilibrium are the resource constraint (12), the implementability constraint (17), and the following conditions with respect to c_t, ℓ_t, and b_t:

$$\eta_t = \frac{1}{c_t} \left[1 + \lambda_t \frac{1}{c_t} \left(\phi \frac{b_t^2}{z_t \ell_t} + b_{t-1} \right) - \lambda_{t-1} \frac{1}{c_t} \frac{1}{\gamma_t} b_{t-1} \right] \quad , \tag{20}$$

$$\eta_t z_t = \frac{\kappa(1-\ell_t+\lambda_t)}{(1-\ell_t)^2} - \lambda_t \frac{1}{c_t} \phi \frac{b_t^2}{z_t \ell_t^2} \quad , \tag{21}$$

$$\lambda_t \frac{1}{c_t} 2\phi \frac{b_t}{z_t \ell_t} = (\beta\gamma_t) E_t \frac{1}{c_{t+1}} \left(\frac{1}{\gamma_t} \lambda_t - \lambda_{t+1}\right) \quad . \tag{22}$$

III. Political Equilibrium - The Results

A. Calibration

We calibrate parameters for the quarterly frequency. The discount factor $\beta = 0.99$ corresponds to an annual interest rate of 4.06%. We assume $\kappa = 3$ for the weight of leisure in utility. This follows Chari, Christiano and Kehoe (1994), who take account of distorting taxes.[5] In our baseline case the politician's average planning horizon is set equal to 15 years, $\bar{h} = 15$. The quadratic bondholding cost is calibrated in the following subsection, based on a steady state relationship between the real interest rate and the debt-to-GDP ratio. The steady state government spending to output ratio is set to 0.18, which is consistent with historic averages for the US. Finally, we follow Schmitt-Grohé and Uribe (2004) in parameterizing the stochastic processes for technology and government spending, with autocorrelations and standard deviations given by $\rho_z = 0.82$, $\rho_g = 0.90$, $\sigma_z = 0.0229$, and $\sigma_g = 0.0302$. For several of our quantitative experiments we assume a deterministic planning horizon. When we consider a stochastic process for the planning horizon we assume that $\rho_h = 0.9$.

B. The Non-Stochastic Steady State

Due to the combined presence of finite government planning horizons and bond transaction costs, the economy described above has a well-defined deterministic steady state, unlike most other models in this class.[6] This has two main advantages. First, it greatly simplifies computational aspects of solving the model. Second, it gives rise to steady state relationships that are very useful for model interpretation and that lend themselves to calibration of one key parameter. These relationships are derived in Appendix A. The key equations are those determining the steady state levels of debt and the real interest rate:

$$b = \frac{\beta y}{2\phi}(1-\gamma) \quad , \tag{23}$$

$$q = \beta - \phi \frac{b}{y} \quad . \tag{24}$$

Equation (23) shows that short government planning horizons, $\gamma < 1$, invariably lead to positive (deterministic) steady state debt, and that shorter planning horizons increase steady state debt. On the other hand, a higher bond transaction cost parameter ϕ pulls steady state debt towards zero. What this relationship does not capture is the precautionary savings motive of the government, as in Aiyagari, Marcet, Sargent and Seppälä (2002) and Shin (2005). As we will see in the following subsection, this motive

[5] This parameter depends on one's benchmark value for the proportion of time spent working in steady state. King and Rebelo (1999), in a business cycle model without distorting taxes, set $\kappa = 3.48$, but values lower than 3 can also be justified on that basis.

[6] As demonstrated in Appendix A, there is a possibility of *two* steady state values for labor and consumption. However, they are far apart and one of them is easy to rule out because it is clearly inferior in terms of welfare. This means that even for large fluctuations around the steady state, the use of a perturbation method that approximates the solution around the superior steady state remains appropriate.

only becomes quantitatively significant if γ is extremely close to one and if in addition ϕ is extremely small - in other words, as we approach the standard case in the literature.

Equation (24) determines the real interest rate $r = (1-q)/q$ in the deterministic steady state. It shows that r exceeds the rate of time preference $(1-\beta)/\beta$ as long as the debt to GDP ratio exceeds zero, which according to (23) is always the case in the deterministic steady state. This relationship yields a convenient way to calibrate the transaction cost parameter ϕ, as it is straightforward to show that[7]

$$\frac{dr}{d\left(\frac{b}{y}\right)} \simeq \phi > 0 \quad . \tag{25}$$

We calibrate these transaction costs as $\phi = 0.015$, implying that a one percentage point increase in the debt to GDP ratio raises government borrowing costs by about 6 basis points per annum. This is at the upper end of the range of empirical estimates for the US provided by Engen and Hubbard (2004) and Laubach (2003).[8,9] Together with our assumption of $\bar{h} = 15$ this implies, by (23), a steady state debt-to-GDP ratio of 55%, very close to the average of this ratio for most developed countries over the last 15 years.[10] Finally, we can combine (24) with (23) to obtain the following:

$$\frac{1}{1+r} = \frac{\beta + \beta\gamma}{2} \quad . \tag{26}$$

The deterministic steady state real interest rate is therefore equal to the simple average of the rates of time preference of the public and private sectors. An environment where politicians have a very short horizon is therefore characterized by high government debt relative to GDP, and by high real interest rates.

C. The Stochastic Steady State

To compute the optimal government policy we analyze the system of equations (12), (17), (20), (21), and (22). We start by performing a second-order approximation of the model around its unique deterministic steady state, using the DYNARE software.[11] The resulting long run characteristics of the model are presented in Table 1 below. As typical for an incomplete markets model, both debt and tax rates are more persistent than the underlying shocks.

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[7] Let the gross real interest rate be denoted by $\tilde{r}$ and the gross rate of time preference by $\tilde{\beta}$. Then the equation can be rewritten as $\tilde{r} = \tilde{\beta}/\left(1 - \tilde{\beta}\phi\frac{b}{\ell}\right)$. The real interest rate is approximately given by $r = log(\tilde{r})$. For small values of ϕ the derivative $dr/d\left(\frac{b}{\ell}\right)$ of this expression is approximately equal to ϕ.

[8] Somewhat higher estimates are reported by Gale and Orszag (2003) for the US, and by Chinn and Frankel (2003) for the Euro area.

[9] The main merit of the quadratic adjustment cost formulation in (3) is clearly its analytical tractability. This allows us to remain consistent with the cited empirical evidence while focusing our main attention on the implications of short government planning horizons. In more elaborate models such as overlapping generations models based on Blanchard (1985) and Yaari (1965), a relationship such as (25) emerges endogenously.

[10] Statistics computed for 24 developed countries excluding Belgium, Italy, and Japan. Source: OECD Factbook 2006: Economic, Environmental and Social Statistics.

[11] Available at http://pythie.cepremap.cnrs.fr/mailman/listinfo/dynare.

Table 1: Long Run Characteristics of the Model

	Mean	**Std.**	**Autocorr.**	**Corr(z,·)**	**Corr(g,·)**
Output	0.2480	0.0099	0.8537	0.9832	0.0707
Consumption	0.2033	0.0102	0.8638	0.9581	-0.2348
Hours	0.2478	0.0018	0.7734	-0.0911	0.3860
Debt	0.1295	0.0237	0.9960	-0.3509	0.4405
Labor Tax Rate	0.1901	0.0137	0.9805	-0.4584	0.6405
Interest Rate	0.0179	0.0085	0.8882	-0.9364	0.0611
Debt-to-Output	0.5249	0.1072	0.9874	-0.5144	0.3778

As emphasized by Reiter (2005), local approximation techniques have two problems when applied to the solution of models of optimal fiscal policy. First, initial conditions on Lagrange multipliers such as (19) mean that the economy will in general be far away from steady state in period 0, so that a local approximation around that steady state cannot be expected to give a reasonable approximation to the general problem, starting in period 0. Second, the level of government debt in steady state depends in general on the initial condition and the full transition path to the steady state. These models therefore typically have a continuum of steady states, indexed by the level of government debt.

Our model does not suffer from the second problem. It is therefore also easy to check whether the initial condition (19) puts the economy so far away from the deterministic steady state that a local approximation technique must be considered inaccurate. In that case we have two options. First, we can use a global method to characterize the complete transitional dynamics starting in period 0. Or second, we can ignore initial conditions, because in our model the stochastic steady state does not depend on them, and further analyze the properties of the second order approximation. This is the 'optimal policy from a timeless perspective' as in Woodford (1999). The following two subsections deal with each of these in turn.

D. Transition to the Stochastic Steady State

Here we ask how a government that is planning at time 0 would transition to the steady state given $\lambda_{-1} = 0$ and an initial level of debt $b_{-1} = 0$. We compute the transition to the stochastic steady state using a global method and show the results, for a particular history of shocks, in Figure 1. We also compute the transition to the deterministic steady state (which is very close to the stochastic steady state) using a Newton method and show the results in Figure 2.

Our global approach combines the DYNARE-based local solution method used for the long run with a global method used for the transition path, the Parameterized Expectations Algorithm (PEA) by Marcet[12]. We first use the simulated stochastic series generated by DYNARE to compute a parameterization of expectations for the long run of the model. Then we use that parameterization as the starting point to search for a parameterization for the transition period. To do so we run one thousand short (50

[12]See Marcet and Lorenzoni (1999).

periods) Monte Carlo simulations inside the PEA and iteratively update the expectations parameterization. Appendix B contains the details of the solution method.

Figures 1 and 2 show a scenario where a government that cares comparatively little about burdening future generations with high levels of debt has inherited no debt at all. It therefore immediately engineers a consumption and output boom through low labor income taxes. As a consequence, the primary fiscal deficit increases and debt builds up. This in turn implies that real interest rates show an upward trend throughout the entire transition. High debt and real interest rates over time force the government to turn its primary deficit into a primary surplus by raising the labor tax rate. This eventually depresses output and consumption.

Figure 1: Transition to the Stochastic Steady State for a Given History of Shocks

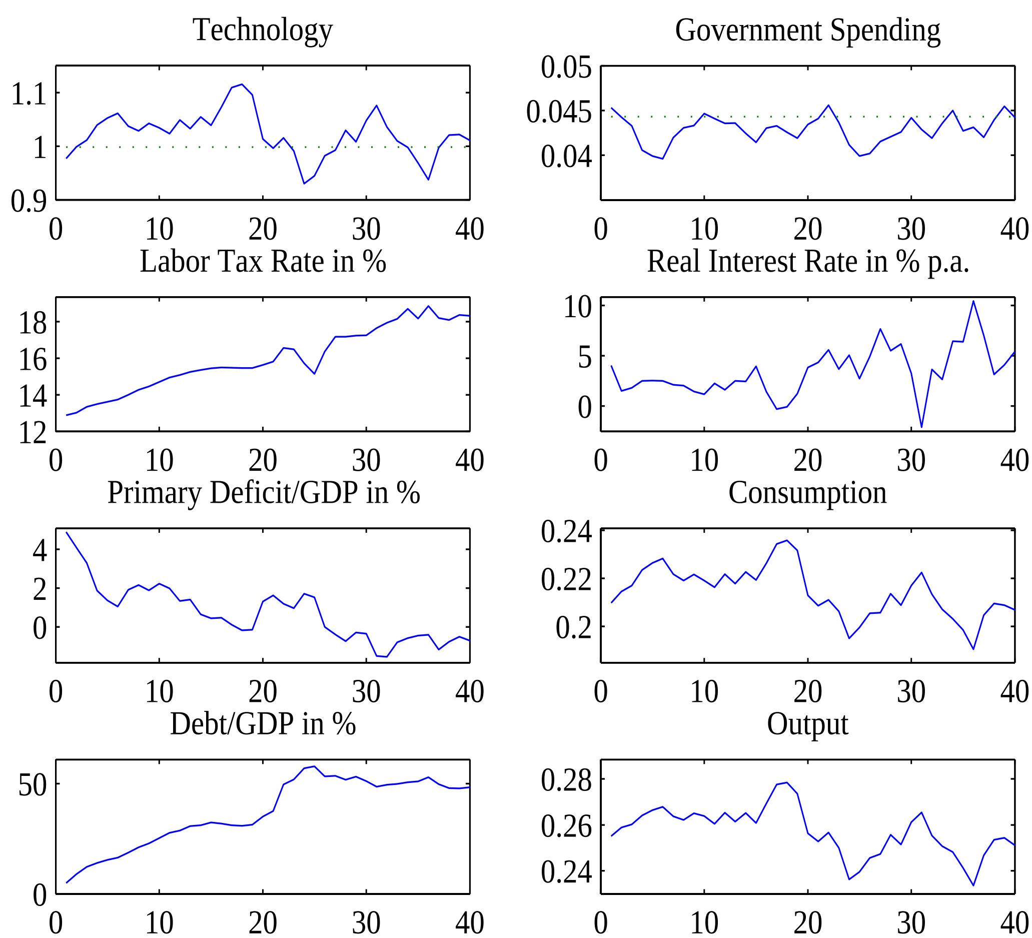
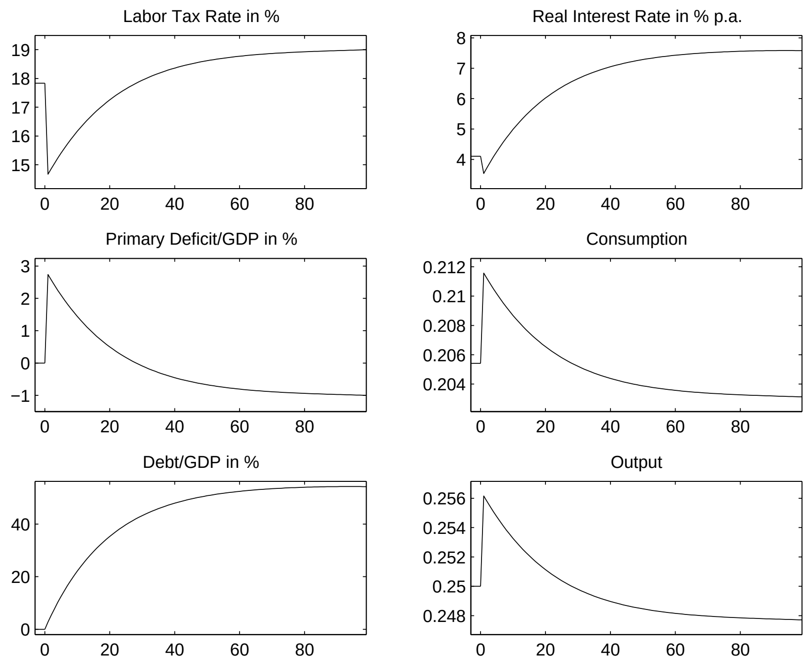


Figure 2: Perfect Foresight Transition to the Deterministic Steady State



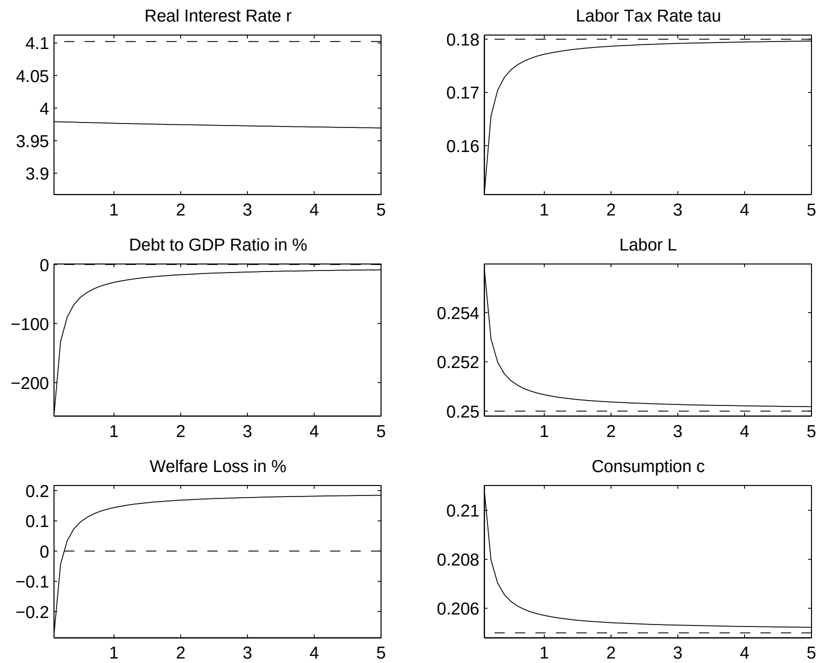
E. Optimal Policy from a Timeless Perspective

1. Precautionary Government Saving

Our first experiment involves replicating the government precautionary savings motive and negative debt bias found by the literature. The standard optimal taxation model is based on the case of $\gamma = 1$ and $\phi = 0$. We therefore assume that γ is very close to one and then compute the stochastic steady state of government debt (and other variables) as ϕ approaches zero from above. We choose a planning horizon of one million years, $\bar{h}$=10^6, implying $\gamma = 0.9999997$. The results are presented in Figure 3. In this and all subsequent figures the broken line represents the non-stochastic steady state while the solid line represents the stochastic steady state computed using the second order approximation of the model. Because negative debt bias only arises for extremely small ϕ, we restrict ourselves to the range $\phi \in [0.00001, 0.0005]$. We show $\phi * 10^4$ along the horizontal axis.

We observe that debt is indeed negative for this case, but as long as ϕ is not too small debt remains very close to zero. As ϕ approaches zero we observe a negative debt-to-GDP ratio that can be significant, as predicted by the optimal taxation literature. The stochastic steady state of the labor tax rate is reduced since the interest revenue on the government's assets provides a superior (non-distortionary) source of financing government spending.

Figure 3: Steady State Effects for the Case of No Transaction Costs and Long Policy Horizon



The reduced tax distortions lead to higher output, consumption and welfare. The latter is shown in the bottom left panel, and represents the Lucas (1987) compensating variation in consumption. This is the percentage reduction in deterministic steady state consumption that would make agents indifferent between the deterministic and stochastic steady states. If ϕ becomes sufficiently small we observe an improvement in welfare relative to the deterministic steady state. This is because the reduction in tax distortions outweighs the fact that volatility per se is costly to households. By comparing the standard deviations of fiscal variables it can furthermore be shown that, as ϕ approaches zero, changes in debt rather than changes in labor taxation become the main fiscal shock absorber.

Notice however the extreme assumptions that were required to generate these results. The values of ϕ at the left of the range shown imply that a one percentage point increase in the debt-to-GDP ratio is associated with a 0.004 basis points increase in the real interest rate, far less than suggested by even the most conservative empirical evidence. More importantly, the policymaker is assumed to be much more patient than what seems plausible. The results of Figure 3 can in fact be reversed by reducing the policymaker's planning horizon to 200 years - still infinite for all practical purposes. In that case, short political planning horizons dominate the precautionary savings motive, debt is always positive, and furthermore debt increases as ϕ is reduced.

2. The Effect of Planning Horizons

We now consider in more detail the effects of politicians' planning horizons on equilibrium debt and taxation. Figure 4 shows the impulse responses for a permanent reduction in the policymaker's planning horizon $\bar{h}$ in equation (15), from its baseline value of 15 years to 10 years.[13] This change, which can be interpreted as a turn to greater populism, induces the government to lower taxes in the short run, because it now has much less concern for the longer term. This creates a short run boom in output and consumption, which is however soon reversed as debt builds up by more than 17 percentage points of GDP, requiring higher interest rates, and therefore higher labor taxes to service the larger and more expensive debt. In the long run interest rates rise by over 1%, and the economy contracts by around 0.5%.[14] Note the similarity between this transition and that shown in Figures 1 and 2. This similarity is not surprising, because in both cases a government has inherited a debt stock that is low given its current planning horizon.

A more systematic exploration of the role of planning horizons is shown in Figure 5. As in Figure 3, the plots show the stochastic steady states of the model's key variables, but this time holding transaction costs at the baseline calibration of $\phi = 0.015$ and varying $\bar{h}$ between one year and twenty years along the horizontal axis. The first striking result is that the differences between the deterministic and stochastic steady states are small, which supports our reliance on a local approximation method. Second, for shorter planning horizons we observe the outcome suggested by Figure 4, in that they are associated with attempts to generate short-term booms at the expense of greater long-run distortions. In the long run they therefore lead to much higher debt and real interest rates. Government budget balance consequently requires a higher labor tax rate, whose distortionary effect lowers output and consumption. As shown in the bottom left panel, this also entails significant welfare losses, this time measured relative to the deterministic steady state with $\bar{h} = 20$. As the planning horizon approaches one year, the welfare loss can be shown to approach one percent. It can also be shown that all components of the government budget become much more volatile as the planning horizon decreases, which is part of the reason for the higher welfare loss shown in Figure 5.

We see in Figure 5 that the debt-to-GDP ratio in the stochastic steady state varies within a plausible range for the parameterization and range of planning horizons we have considered. To better understand the range of values that this variable can take we turn to Figure 6, which explores its joint dependence on the planning horizon and on bondholding transaction costs. We observe that low debt-to-GDP ratios can be a result of either high policymaker patience, which makes it preferable to avoid a debt build-up, or of high bondholding transaction costs, which makes such a build-up costly.[15] Our baseline calibration of $\bar{h} = 15$ and $\phi = 0.015$ yields a debt-to-GDP ratio of exactly 55%.

[13] All plots in Figure 4 show deviations from the original steady state, either in % or in percentage points.

[14] It would be interesting to extend the model to one with capital, where such increases in the real interest rate would have more sizeable effects on output.

[15] The latter may be the main reason why debt-to-GDP ratios in developing countries are often comparatively low, see Reinhart, Rogoff and Savastano (2003).

Figure 4: Permanent Reduction in the Planning Horizon from 15 to 10 Years

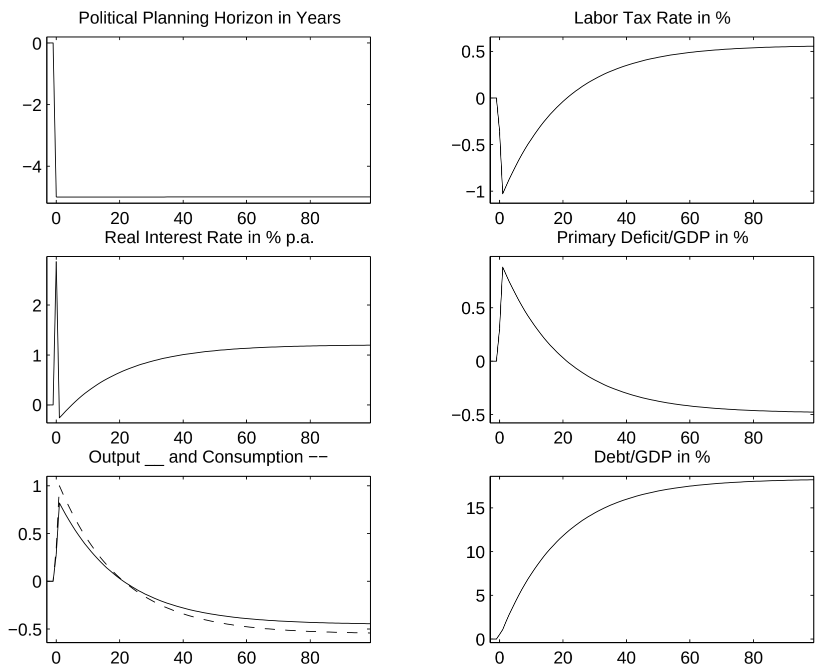


Figure 5: Steady State Effects of Varying the Planning Horizon

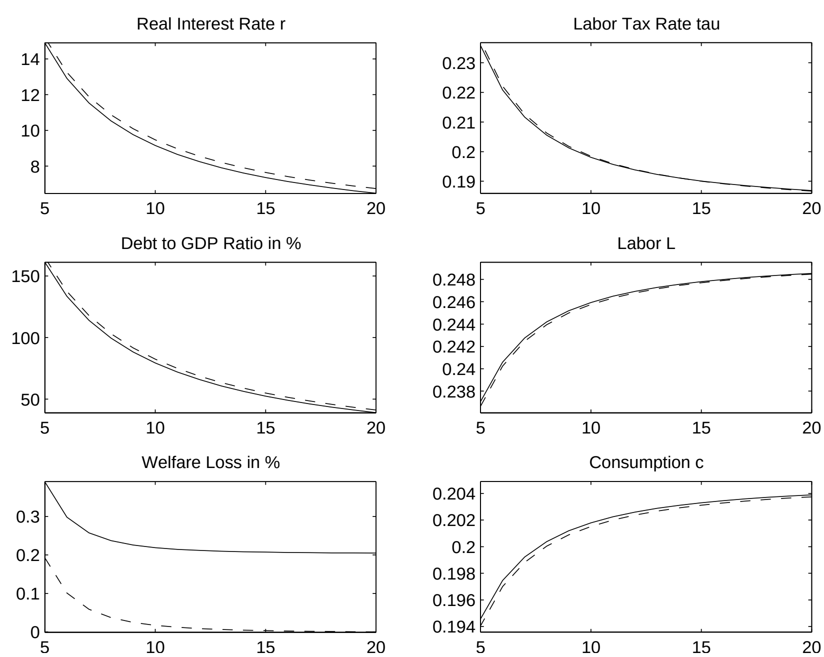
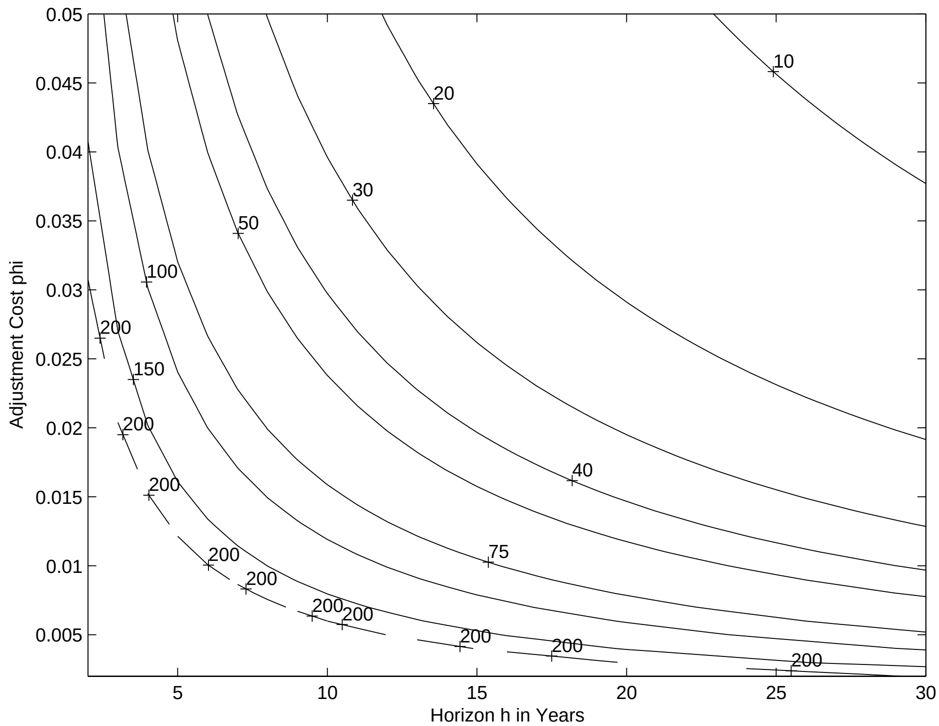


Figure 6: Stochastic Steady State Debt-to-GDP Ratios as a Function of the Planning Horizon and Adjustment Costs

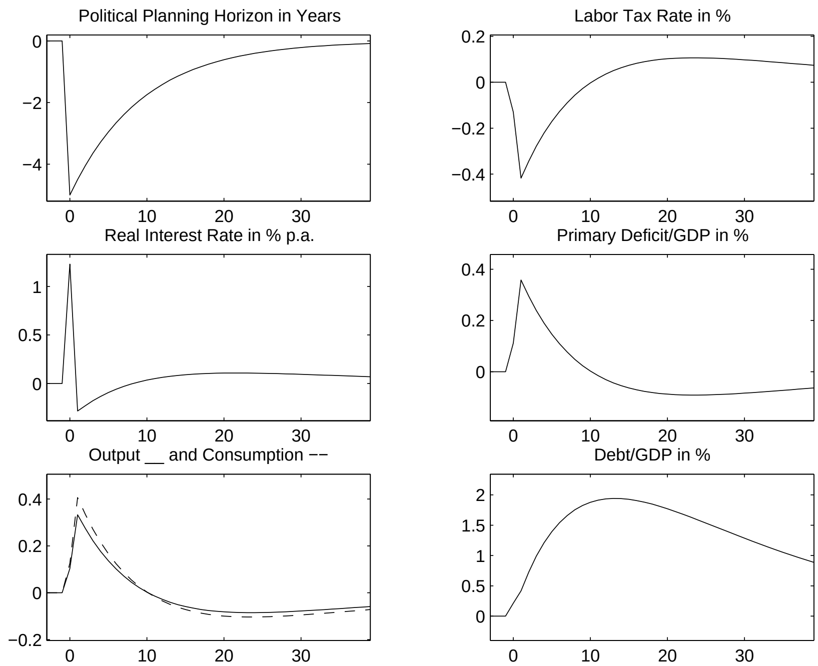


F. Political Instability

In Figure 7 we consider the effects of political instability, defined as a temporary reduction in the policymaker's planning horizon from 15 years to 10 years in equation (15), with $\rho^h = 0.9$. We analyze the nature of business cycles induced by such shocks.

This surge in 'populism' on the part of the policymaker induces a temporary reduction in the labor tax rate by 0.4% that supports a temporary consumption boom. This is accompanied by an increase in the primary deficit of initially 0.4% of GDP, and a build-up of debt that leads to a roughly 2 percentage point increase in the debt-to-GDP ratio after 3 years. As political stability returns, the policymaker begins to raise labor taxes in line with his changing preferences. In fact taxes need to rise above their original steady state value for several years to pay down the additional debt accumulated during the transition. The associated distortions contract output and consumption. From the point of view of household welfare, political instability is clearly detrimental.

Figure 7: Temporary Shock to the Planning Horizon



G. The Cyclical Properties of Optimal Fiscal Policy

We finally turn to an examination of the cyclical properties of fiscal variables. The first panel of Figure 8 shows the impulse response for a government spending shock, and the remaining panels show the endogenous response of different fiscal variables. There is an immediate sharp increase in the labor tax rate, but as a proportion of GDP labor tax revenue rises by significantly less than the increase in spending. As a result the government must issue additional debt such that its debt stock eventually rises by nearly 1.5 percentage points of GDP. This debt build-up also leads to an increase in the real interest rate, which puts additional pressure on the government budget. The government must consequently keep its labor tax rate high for a prolonged period to service interest and pay down the additional debt accumulated during the transition. In other words, the tax rate is much more persistent than the underlying spending shock. This result is well known from Aiyagari, Marcet, Sargent and Seppälä (2002), who show that taxes under incomplete markets follow a near random walk, supporting a claim originally made by Barro (1979). Figure 9 confirms that the serial correlation of taxes is indeed very high, and as importantly that it is nearly independent of the serial correlation of the underlying shocks to technology or government spending. We find its value to be at or above 0.97 for any serial correlation of the underlying shocks, and approaching a unit root as the underlying shocks approach a unit root.

Models of optimal taxation under complete markets typically find that state-contingent taxes on debt are the optimal shock absorber for fiscal shocks, accounting for a far higher share of the budgetary adjustment than labor taxes. For example, Chari and Kehoe (1999) find that labor taxes only account for around one quarter of the adjustment. Under incomplete markets this result is reversed dramatically, labor taxes now account for over 125% of the fiscal adjustment for government spending shocks such as that displayed in Figure 8.[16] This is because the return on debt is now not available as a shock absorber except to a small extent in the first period. In fact because interest rates rise as debt builds up, labor taxes have to more than compensate for the increase in spending.

Figure 8: Budgetary Implications of a Government Spending Shock

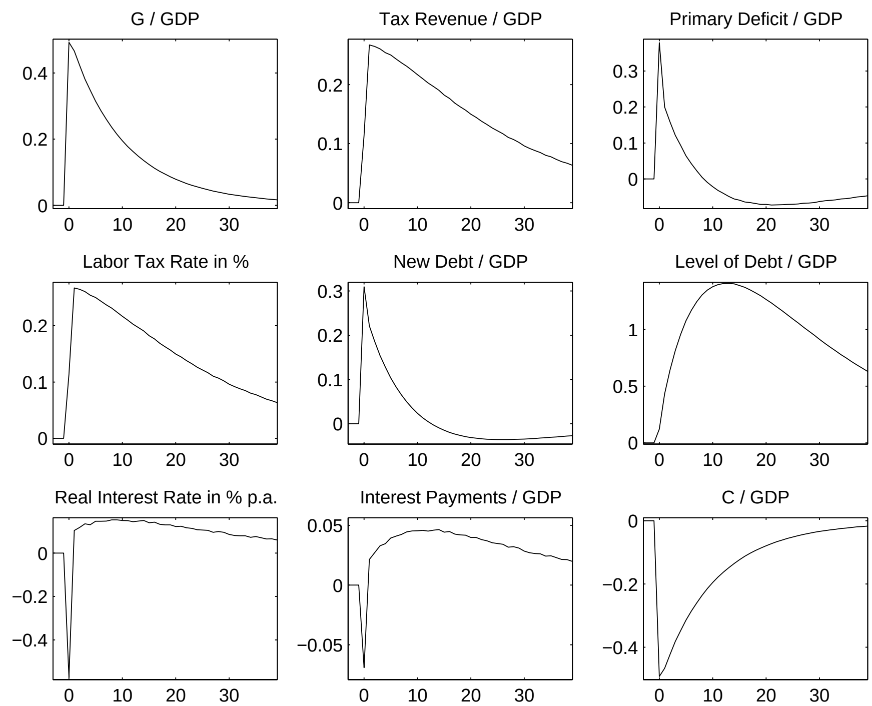
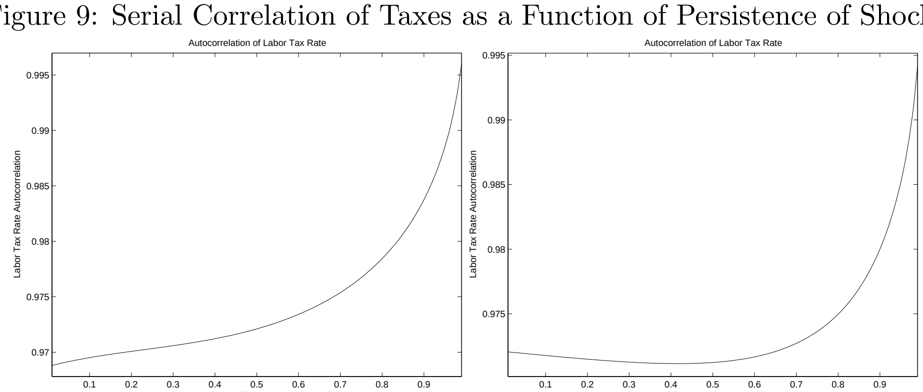


Figure 9: Serial Correlation of Taxes as a Function of Persistence of Shocks



[16] To obtain this ratio we compute the present discounted values of the increases in government spending and in labor income taxation at the steady state real interest rate. The remainder is accounted for by the difference between the present discounted values of primary surpluses evaluated at the steady state and at the actual real interest rates. This remainder is negative, because real interest rates rise during the transition.

IV. Conclusion

The question we set out to answer in this paper is why governments typically issue large amounts of debt. We showed that the main body of economic theory that is available to address this question, the theory of optimal taxation under the paradigm of the benevolent social planner, generally does not give a very satisfactory answer. Indeed it typically finds that a welfare maximizing government should have a negative stock of debt. In our view it seems unnecessary to insist on explaining observed debt levels only through theories that posit a social planner whose objectives coincide fully with those of private agents. Instead we start from the premise that policymakers have their own motivations, which coincide partly but not wholly with the objective function of private agents. If this can be agreed, what is needed is a positive theory of government behavior that takes these differences in objectives into account.

We have suggested one possible way of formulating such a theory. A considerable advantage is that we are able to continue working with the well developed analytical framework of the optimal taxation literature. Our theory relies on only two departures from that literature, a finite and time-varying government planning horizon and continuous debt limits. After calibrating both of these in a plausible way, our theory generates reasonable predictions for the sign and size of the government debt-to-GDP ratio. It also generates intuitive predictions for political business cycles in response to fluctuations in the planning horizon of policymakers.

We would hope that our approach will be judged useful not only for its theoretical contribution but also in applied policymaking, because purely normative models are not likely to provide a complete understanding of the determinants of many actual fiscal policy outcomes. As such we have found the literature on optimal taxation to be of very little use for the study of practical fiscal policy problems, which is in stark contrast to the usefulness of the literature on optimal monetary policy in the study of monetary policy problems. Our future research agenda is aimed at remedying this, and the present paper is a first step in this direction.

Appendices

Appendix 1. The Non-Stochastic Steady State.

We drop time subscripts to denote steady state values of variables. The non-stochastic steady state of the economy is given by the system of five equations (12), (17), (20), (21) and (22) determining the variables c, ℓ, b, η and λ. Equations (20), (21) and (22) become

$$\eta = \frac{1}{c}\left(1+\lambda\frac{1-\ell-\kappa\ell}{1-\ell}\right)+\lambda b\frac{1}{c^2}(\beta-\frac{1}{\gamma}) \quad , \tag{A1}$$

$$\eta = \frac{\kappa(1-\ell+\lambda)}{(1-\ell)^2}-\lambda\frac{1}{c}\phi\left(\frac{b}{\ell}\right)^2 \quad , \tag{A2}$$

$$2\phi\frac{b}{\ell}=\beta(1-\gamma) \quad , \tag{A3}$$

where we have combined (20) with (17). Consider the case of $\lambda = 0$. In that case we would have $\eta = 1/c$ and $\eta = \kappa/(1-\ell)$. Then by the consumer's first-order condition (4) it would have to be true that $\tau = 0$ for all periods. Such a case would only be possible in the first-best, which is only achievable if the government can accumulate a sufficient amount of assets to buffer fiscal spending shocks without incurring any additional cost for doing so. This is however ruled out in our model by condition (A3), which makes the steady state debt stock positive. We can therefore rule out $\lambda = 0$. The remaining steady state conditions are

$$c+g=\ell \quad , \tag{A4}$$

$$1-\frac{\kappa\ell}{1-\ell}=\frac{1}{c}\left((1-\beta)b+\phi\frac{b^2}{\ell}\right) \quad . \tag{A5}$$

In a first step, the steady state values b, c and l can be solved from (A3), (A4) and (A5). In a second step, the remaining equations (A1) and (A2) then determine λ and η. The first step results in the following quadratic equation for ℓ:

$$[\kappa+1-\varphi]\,\ell^2-[1+(\kappa+1)g-\varphi]\,\ell+g=0 \quad . \tag{A6}$$

where

$$\varphi=\frac{\beta(1-\gamma)}{2\phi}\left(1-\frac{\beta(1+\gamma)}{2}\right) \quad . \tag{A7}$$

There are therefore two possible solutions for steady state labor, and by (**??**) also for steady state consumption. The roots of equation (**??**) are given by

$$\ell_{1,2}=\frac{1+(\kappa+1)g-\varphi\pm\sqrt{(1+(\kappa+1)g-\varphi)^2-4g(\kappa+1-\varphi)}}{2(\kappa+1-\varphi)} \quad . \tag{A8}$$

While both roots are positive for our parameterization, the smaller root gives rise to a level of consumption very close to zero ($c = 0.005$) and a much lower welfare than the larger root (-7.7 versus -2.4).

Appendix 2. Solving the Model Using a Global Method.

To apply the Parameterized Expectations Algorithm (PEA), we first reduce the number of equations and variables. The resulting First-Order Conditions for $(c_t, l_t, b_t, \lambda_t)_{t=0}^{\infty}$ are given below:

$$c_t = z_t l_t - g_t \ , \tag{B1}$$

$$\lambda_t \left\{ \frac{1}{c_t^2} \left(\phi \frac{b_t^2}{z_t l_t} + b_{t-1} \right) - \frac{\kappa}{z_t(1-l_t)^2} + \frac{1}{c_t} \phi \frac{b_t^2}{z_t^2 l_t^2} \right\} = \frac{\kappa}{z_t(1-l_t)} - \frac{1}{c_t} + \lambda_{t-1} \frac{1}{c_t^2} \frac{1}{\gamma_t} b_{t-1} \ , \tag{B2}$$

$$\lambda_t \frac{1}{c_t} \phi \frac{b_t}{z_t l_t} = \frac{\beta \gamma_t}{2} E_t \frac{1}{c_{t+1}} \left(\frac{1}{\gamma_t} \lambda_t - \lambda_{t+1} \right) \ , \tag{B3}$$

$$1 - \frac{\kappa l_t}{1-l_t} + \beta E_t \frac{1}{c_{t+1}} b_t = \frac{1}{c_t} \left(\phi \frac{b_t^2}{z_t l_t} + b_{t-1} \right) \ . \tag{B4}$$

To solve this system of equations we approximate the expectational terms rather than policy functions. It is well known that expectations, or integrals, are usually smoother functions than the underlying policy functions. We define $E_t(1/c_{t+1}) \equiv \Psi_{c,t} > 0$ and $E_t\left((1/c_{t+1})\lambda_{t+1}\right) \equiv \Psi_{\lambda,t}$. These are approximated using iterated nonlinear regressions of $\Psi_{c,t}$ and $\Psi_{\lambda,t}$ on polynomials of first order in the model's state variables $S_t = [1 \ z_t \ g_t \ b_{t-1} \ \lambda_{t-1}]$:

$$\Psi_{c,t} = \exp(S_t \cdot \beta_1) + \varepsilon_t^c \ , \tag{B5}$$

$$\Psi_{\lambda,t} = S_t \cdot \beta_2 + \varepsilon_t^{\lambda} \ . \tag{B6}$$

Here $\Psi_{c,t}$, $\Psi_{\lambda,t}$ and S_t are simulated series, ε_t^c and ε_t^{λ} are error terms and β_1 and β_2 are the estimated coefficients of the PEA. To find the starting values for β_1 and β_2 that are needed to run the first simulation of the transition period, we first simulate (B1)-(B4) to obtain one long (10,000 periods) stochastic series that describes the long run behavior of the model, using the coefficients for the policy functions from DYNARE. We then compute the regressions (B5) and (B6) using that long run simulation. The solutions, denoted by β_1^{LR} and β_2^{LR}, are used as starting values for the PEA. In the PEA we run short Monte Carlo simulations (1000 series of 50 periods each) of (B1)-(B4) for the transition and use the resulting series in (B5) and (B6) to iteratively update our estimates for β_1 and β_2 until they converge. We experiment with several possible durations of transition and choose T such that the series are, on average, in the neighborhood of their long run means. Alternatively, we could have used the PEA to obtain the long run coefficients but we would have needed to apply the homotopy approach - a much more time consuming exercise.

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