

Dynamic Bargaining over Redistribution in Legislatures*

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Abstract. *In modern democracies public policies are negotiated by elected policy-makers. When they agree to replace the current status quo, the approved policy becomes the status quo in the next period. Yet, these two ingredients, bargaining and endogenous status quo, are absent in most macroeconomic models. We revisit the classical capital taxation problem adding legislative bargaining with an endogenous status quo. We analyze a growth model where agents (legislators and consumers) are heterogenous in wealth. We find that legislators may not propose or accept high taxes because doing so may improve, via a change of the status quo, the bargaining power of “poorer” legislators in future negotiations. On average equilibrium capital taxes are between 12% and 55%, depending on the distribution of wealth and other variations on the institutional environment. We also find that a large status quo bias could lead to political growth cycles: decades with low taxes and growing capital are followed by decades with high taxes and decreasing capital (and vice versa).*

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1. Introduction

In modern democracies public choices are usually the result of some sort of negotiation among elected policymakers. The intense negotiation over the US and EU budgets that we have lately witnessed are a clear demonstration of the importance of post-election bargaining. Budget negotiations also point to the key role played by the status quo, the default option in case of disagreement. In the US, for instance, the amount spent on mandatory programs and most taxes are based on formulas already written into law. Unless explicitly changed, the spending and revenue bills approved in the previous budget, the status quo, continue to apply.¹

Motivated by this evidence, we explicitly model post-election legislative bargaining and analyze the strategic role played by the endogenous status quo. In doing so, we depart from most of the current macro political-economics literature which mainly focuses on median-voter equilibria, or with a few exceptions, on legislative bargaining with an exogenous status quo.²

This paper studies sequential bargaining over redistribution in the context of a standard Neoclassical growth model. We assume that legislators are heterogeneous in their initial wealth and that linear taxes on capital income finance lump-sum redistribution. Legislators negotiate changes to the current status quo. The key element of the bargaining process analyzed in this paper is the *endogeneity of the status quo* policy. If there is disagreement in the legislative game, the level of taxation (and redistribution) chosen in the previous legislative session is implemented. Thus, the result of the legislative bargaining in any given period affects, by changing the default option, the bargaining process in all subsequent periods.

Our first contribution is to show, quantitatively, that this additional mechanism has an important disciplinary role reducing policymakers' temptation to set taxes at confiscatory levels. In particular, when we calibrate the model such that the wealth distribution in the

¹Examples of such mandatory programs are social security and medicare. Even in the event of a government shut-down for lack of congressional agreement, taxes remain at the level agreed on in the previous fiscal year. Similarly in the EU, in the absence of an agreement on the new multiannual budget the provisions corresponding to the last year of the previous budget are extended until a compromise is made. See article 312, paragraph 4, of the European Union's Treaty, 2010.

²The legislative bargaining approach, which was pioneered by Baron & Ferejohn (1989), is widely adopted in political economy. However, few papers have used it in the context of a standard macro model. Among the papers using the median voter approach see Meltzer & Richard (1981), Alesina & Rodrik (1994), Persson & Tabellini (1994a), Krusell & Rios-Rull (1999), Azzimonti *et al.* (2006), and Corbae *et al.* (2009). See Section 2 for a review of the related literature.

legislature replicates the net worth distribution in the U.S., we obtain average taxes of around 50%. If instead, we calibrate the model such that the wealth distribution in the legislature coincides with the net worth distribution of the U.S. members of Congress, we obtain average capital taxes of around 25%. We emphasize that in contrast to other solutions analyzed in the literature to mitigate time consistency problems (e.g, implementation lags), our mechanism is endogenous to the model and depends on the political and institutional environment.

Our second contribution is to analyze how institutions affect economics outcomes. By explicitly modeling the bargaining process that leads to policy decisions we generate a rich set of predictions, which differ from those obtained in the median-voter literature, such as political growth cycles and polarization of preferences.

The economy is populated by: (i) consumers; (ii) a competitive firm; (iii) and legislators who periodically vote to determine the current capital tax rate. Tax revenues are used to distribute a common lump-sum transfer to all consumers. Consumers as well as legislators differ with respect to their wealth. Legislators vote in order to maximize the utility of the consumers with their same level of wealth. Since taxes are proportional to capital income, capital taxation is a way of redistributing from consumers with high wealth to consumers with low wealth.

Following Romer & Rosenthal (1978), we model the political process as an agenda-setting game. In each period one member of the legislature (the agenda setter) is randomly selected to make a take-it-or-leave-it proposal. Subsequently, the legislature decides whether to accept the new policy or to maintain the status quo. If the proposal is rejected, the capital tax from the previous period (the status quo) is kept in place for one more period. If it is accepted, which happens with a probability equal to the measure of legislators favoring the proposal, the tax is implemented and the current policy becomes the default option in the next legislative session. Note that the status quo becomes a payoff-relevant state since it defines the legislators' reservation utility: forward looking legislators must then internalize the consequences of the current decision on future legislative sessions via its effect on the status quo.

A key feature of our environment is that most politicians have endogenous time-inconsistent preferences over taxes and redistribution. Under commitment, legislators with pre-tax income below the mean would select maximum taxes in the current period (to maximize redistribu-

tion) and lower taxes in the long-run (to minimize distortions on savings decisions). However, once capital has been accumulated, taxing capital is no longer distortive. In the absence of commitment, legislators are thus tempted to raise capital taxes up to the maximum possible level in order to redistribute: the poorer the legislator, the higher the temptation.

We solve for Markov-perfect equilibria of the dynamic game between legislators. Our results show that legislative bargaining with an endogenous status quo strongly reduces policymakers' temptation to raise taxes ex-post. The economic mechanism which disciplines legislators operates through two channels. First, as in Piguillem & Riboni (2013), the role of the status quo as the default option generates endogenous *policy persistence*. Policy changes may be rejected in equilibrium because some legislators may prefer the current status quo policy to most (or some) proposed capital taxes. Legislators internalize that high taxes, by changing the future status quo, will raise the bargaining power of poorer legislators and thus stay in place for more than one period. The existence of this status-quo bias implies that legislators have to balance their present desire for high redistribution with their distaste for long-term savings distortions. Second, in equilibrium policy proposals are monotone increasing in the status quo. The probability of high tax proposals is thus increasing in the status quo. As a result, keeping a low status quo is a way to *strategically manipulate* (namely, improve) equilibrium proposals of future agenda setters.³

It is important to emphasize that such long-run considerations would not arise in models focusing on median-voter equilibria. In those models the past tax is not payoff-relevant. The median voter is able to impose her preferred policy regardless of the policy outcome that was voted in the previous period.

We numerically compute policy proposals and acceptance strategies that are consistent with a sequential equilibrium of the competitive economy. When calibrating the legislators' wealth distribution we have to take a stance on legislators' objectives. On the one hand, if legislators were fully benevolent they should act as representatives of the population that elected them. In this case, the appropriate distribution of wealth would be the distribution of net worth in the whole population. On the other hand, if we believe that legislators are completely self-interested we should calibrate the distribution of wealth to match the

³This second channel is absent in Piguillem & Riboni (2013) where strategies do not depend on the political state variable, the status quo.

distribution of wealth in actual legislatures. We perform both exercises with data for the U.S economy and the U.S. Congress in 2007. Under the first assumption we find that average taxes are around 50% while under the second assumption taxes average 25%.

Legislative bargaining delivers equilibrium capital taxes well below the ones usually obtained by Markov equilibria where, as in this paper, decision makers sequentially choose the *current* capital tax. In order to obtain empirically reasonable tax rates, the literature usually assumes an implementation lag: that is, voting today is over the capital tax for next period. The lesson from this literature is that there needs to be a wedge between policy-makers' preferences and policy implementation in order to generate empirically reasonable levels of taxation and redistribution. From this point of view, we believe that this paper is a step toward understanding the institutional determinants and aggregate implications of this wedge.

After computing the politico-economic equilibrium, we investigate how tax levels and the size of government are affected by changes in the political and institutional environment.

First, we modify the bargaining process by adopting a bicameral system. Intuitively, we find that requiring two concurrent votes to pass legislation aggravates the status-quo bias. Since higher policy persistence increases the cost of going to the next period with a high status quo, we obtain lower tax proposals. In addition, in order to maximize the probability of acceptance legislators propose more gradual policy changes. Under our two alternative calibrations we find that average taxes decrease to 34% when legislators represent the population, and to 12% when they are self-interested.

We show that the endogeneity of the status quo induces politically driven growth cycles. When the stock of capital is high, the inefficiency cost of high taxes is small because even without further capital accumulation, output would stay high. Moreover, the gains from redistribution are larger since the pie is bigger. The opposite is true when the stock of capital is low. Thus, periods with low capital tend to be associated with low taxes. Since taxes are persistent, observing low taxes encourages consumers to save. However, as capital accumulates legislators become increasingly tempted to set higher taxes. Eventually, a tax hike will pass, which leads to low investment and negative capital accumulation, and the cycle begins again.

Median voter models predict that when the median-to-mean ratio increases, the size of

government decreases.⁴ Our model differs in that, 1) recognition and acceptance probabilities depend on the entire legislature's wealth distribution, not just the median-to-mean ratio; and 2) changes in the distribution have direct as well as indirect effects on economic policies.

Consider a distributional shift that augments inequality by increasing the mass of rich legislators. On the one hand, since rich legislators gain less from redistribution, this shift implies that low taxes are proposed and accepted more often. This is the direct effect which tends to decrease taxes and redistribution. On the other hand, since more legislators favor low taxes, the marginal benefit of keeping taxes low in order to constrain future legislators diminishes. Legislators with relatively low wealth have an incentive to free ride on others' responsibility: consequently, they favor higher taxes than the ones they would have supported in a poorer legislature. This is the indirect effect which attenuates the effect on taxes implied by the direct channel. As a result of both effects, our model generates a weaker, as empirically observed, relation between inequality and government size than the one predicted by median-voter models.

It is often suggested that voters, in order to mitigate time-consistency problems, should elect conservative legislators who are less tempted to raise taxes *ex-post*.⁵ The above discussion suggests that electing rich legislators could have unintended consequences: it raises the demand for redistribution of relatively poorer legislators and thus leads to polarization of policy preferences within the legislature.

2. Literature Review

There are two main approaches to study capital taxation: the traditional normative approach taken by the literature on optimal capital taxation and the positive approach, used in, for example, the recent macro-dynamic-political economy literature. The two approaches lead to different implications. The normative approach prescribes that, in a wide range of environments, the tax on capital should be zero in the long-run.⁶ Conversely, the positive literature has shown that, without assuming either ad-hoc constraints or history-dependent strategies, the tax on capital is very close to 100%. For instance, in Klein *et al.* (2008) and Azzimonti

⁴This empirical prediction is not well supported by the data. See Perotti (1996) and Iversen & Soskice (2006)

⁵See Rogoff (1985) and Persson and Tabellini (1994b).

⁶This is the classical result under commitment of Chamley (1986) and Judd (1985). Positive capital taxes are obtained in Aiyagari (1995), Conesa *et al.* (2009), and Piketty & Saez (2012).

et al. (2006) the equilibrium capital taxes without commitment are extremely high (81% and 100%, respectively). To avoid this outcome, the typical constraint assumed in the literature is that policymakers can choose the tax for the next period, not the current one.⁷

The positive literature using computational methods was pioneered by the work of Krusell *et al.* (1997), who propose a notion of politico-economic equilibrium where political outcomes chosen by a forward looking median voter must be consistent with a sequential equilibrium of the competitive economy. Krusell & Rios-Rull (1999) consider a calibrated version of the Solow model. In contrast to this paper, they assume that the median voter theorem holds and agents vote on the tax in the next period. Their findings show that the size of transfers predicted by the model is close to that in the US data. More recently, Corbae *et al.* (2009) consider a setting in which individuals have uninsurable idiosyncratic labor efficiency shocks and conclude that in the US, the median model would predict an excessively large increase of redistribution following the increase in wage inequality in the 80s and 90s. Bachmann & Bai (2011) study the comovement of government purchases with macroeconomic fluctuations under two politico-economic equilibria: probabilistic voting and wealth-weighted majority voting. Bassetto (2008) is one of the few papers that incorporates a bargaining process into a standard macro model. He considers an economy where two overlapping generations Nash-bargain over tax rates, transfers, and government spending. Aguiar & Amador (2011) consider a growth model where incumbent governments prefer consumption to occur when they are in power and, thus, have an incentive to expropriate capital. They focus on self-enforcing equilibria supported by threat of switching to the autarky.⁸

Alesina & Tabellini (1990), Persson & Svensson (1989), Amador (2003), Azzimonti (2011) and Azzimonti & Talbert (2013), show that governments affect the policy carried out by future governments by manipulating their successors' constraints via some state variable (e.g., debt or investment). In our setting, besides capital, the dynamic linkage across periods is created by the status quo. Another key difference from these papers is that they assume that the winning party is a policy dictator (no checks and balances) and, consequently, there is no need

⁷ See for instance Persson & Tabellini (1994a), Bénabou (1996), Krusell & Rios-Rull (1999), Klein & Rios-Rull (2003), and Corbae *et al.* (2009). One exception is Martin (2010), who allows for endogenous capacity utilization. Alternatively, low capital taxes may be sustained thanks to reputation mechanisms (see Chari & Kehoe, 1990, and Phelan & Stacchetti, 2001).

⁸Other contributions to the recent dynamic political economy literature include the electoral accountability models by Acemoglu *et al.* (2008) and Yared (2010).

of negotiating. Their main result is that alternating power leads to strategic manipulation and generates inefficiency (such as, excessive debt or low investment). Notice that in contrast to this literature, political turnover is overall beneficial in our model. On the one hand, it increases policy variability. But on the other hand, the risk of losing power gives current policymakers the incentive to strategically maintain a low status quo.⁹

Recently, Battaglini & Coate (2007, 2008) and Battaglini *et al.* (2010) have adopted the legislative bargaining approach. They analyze a legislature of representatives making decisions about pork barrel spending, public good, and debt. Besides considering different subject matters, their setting differs from ours along two other dimensions.¹⁰ First, they abstract from capital and they assume that the default option in case of disagreement is exogenous. In their model the dynamic linkage across periods is given by the level of public debt. Second, we study a different source of disagreement between current and future governments. In Battaglini & Coate (2007, 2008) current governments disagree with their successors on how to allocate pork. In our model disagreement between current and future governments arises for two different reasons. First, given that the supply of future capital is elastic, today's government would like future governments to choose lower capital taxes. Second, current and future governments disagree because they represent constituencies with different wealth. Riboni (2010) builds a dynamic agenda setting model in a stylized Barro-Gordon economy in order to study monetary policymaking. As in this paper, the endogenous status quo plays a key disciplinary role. He finds conditions under which monetary policy committees perform better than single central bankers. Persson *et al.* (1997, 2000) analyze alternative legislative-bargaining games in order to study the size and composition of government spending under presidential and parliamentary regimes.¹¹

Finally, this paper is related to the growing literature on legislative bargaining with an endogenous status quo. This literature generally finds that when legislators have concave utilities having an endogenous status quo improves welfare by reducing policy variability. This result was first obtained by Baron (1996), who finds that policy converges to the alternative preferred by the median legislator. By means of numerical simulation, Baron & Herron

⁹The beneficial effect of political turnover has been pointed out in Acemoglu *et al.* (2011).

¹⁰Their goal is to analyze how policies respond to shocks in public spending needs and to characterize how public debt evolves over time. Azzimonti *et al.* (2011) analyze the impact of a balanced-budget rule.

¹¹The empirical relation between budgetary institutions and policy outcomes is analyzed, among others, by Alt & Lowry (1994), Persson & Tabellini (2003), and Besley & Case (2003).

(2003) obtain a similar result in a two-dimensional setting. Duggan & Kalandrakis (2011) also argue that when players are sufficiently patient, the endogeneity of the status quo induces core convergence.¹² Bowen & Zahran (2012) study a divide a dollar game with endogenous default and shows that legislators have an incentive to reach a compromise.¹³ Bowen *et al.* (2012) study public good provision and argue that when the status quo public good allocation is endogenous, current governments are able to insure themselves against power switches. As opposed to all papers in this literature we consider time inconsistent preferences. We emphasize that in this paper the endogenous status quo is beneficial for a completely different reason: because it serves a disciplinary role. In Piguillem & Riboni (2013) we consider a model without capital accumulation and linear utilities and argue that a similar disciplinary role arises. The contribution of Piguillem & Riboni (2013) is to analyze, in the context of a tractable model, the strategic interactions among current and future decisions by legislators who have an exogenous present-bias for current spending.

3. The Model

3.1. Overview

The model economy includes three types of decision makers: consumers who consume and invest, a firm that rents inputs and produces the only good in the economy, and legislators who decide the tax on capital in every period. It is important to keep in mind the general timing of events (see Figure 1). At the beginning of each period t , firms make their production decision, and then legislators meet and bargain over the current tax τ_t . Finally, knowing the political outcome, consumers make their consumption and saving decisions.

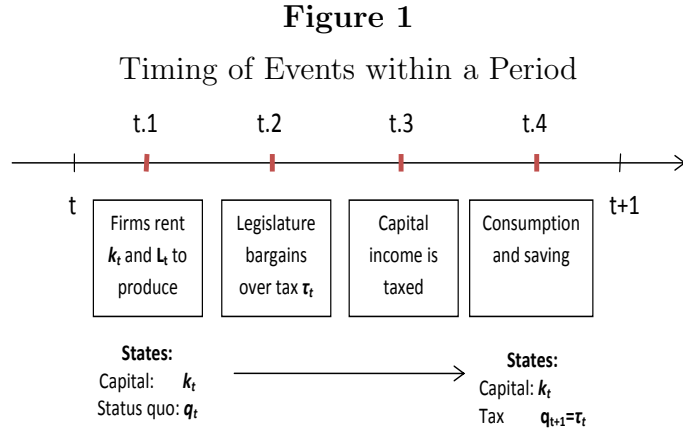
Throughout, we focus on Markov Perfect equilibria where strategies depend on the payoff-relevant state variable. At time t , the state variable in the political game is given by the predetermined level of capital k_t and the status quo level of taxation q_t , where $q_t = \tau_{t-1}$. Any equilibrium of the political game can be represented by a stochastic Markov process with $\Gamma(\tau_t|q_t, k_t)$ determining the probability of a tax rate τ_t given a capital stock k_t and status quo q_t .

¹²Among other papers in the endogenous status-quo literature, Bernheim *et al.* (2006), and Diermeier & Fong (2010), Riboni & Ruge-Murcia (2008), Nunnari (2012), and Dziuda & Loeper (2012).

¹³When legislators are risk-neutral, this result does not hold anymore. Kalandrakis (2004) considers a dynamic divide-a-dollar game and shows that in each period the agenda setter extracts all surplus. As a result, he obtains great variance of policies over time.

Consumers at time t make savings decisions after observing the political outcome τ_t . Therefore, the state variable in the consumers' problem is given by the current level of taxation (the status quo for next period) and the current level of capital k_t . Given initial capital, any competitive equilibrium can be summarized by the law of motion of aggregate capital, denoted by $G(k_t, \tau_t)$.

In Section 3.2, we describe the competitive equilibrium given an arbitrary stochastic process for policies. In Section 3.3, we describe the political game. In Section 4, we present a simple example to help build intuition. In Section 5, we present the numerical solutions. Section 6 concludes.



3.2. The Economy

Time is infinite and indexed by $t = 0, 1, \dots$. There is a continuum of consumers of measure one. Consumers are heterogenous in their initial wealth (capital). Consumers of type i are initially endowed with $k_0^i = \theta^i k_0$ units of capital, where $\theta^i \in \Theta$ denotes their wealth share at time 0, and k_0 is the initial aggregate (and mean) stock of capital. Let $\tilde{\mu}_t(k_t)$ be the measure of consumers over holdings of capital k_t and let $\mu(\theta^i)$ be the measure of shares θ^i . Notice that $E(\theta^i) = 1$.

Consumers are endowed with one unit of labor, which is inelastically supplied. Their total income is the sum of real wage w_t , a lump-sum transfer from the government T_t , and the after tax return on capital holdings k_t^i . Markets are incomplete in the sense that agents can only transfer resources across periods through capital, a non state-contingent asset. The proportional tax on the returns from capital holdings is τ_t . Therefore, when choosing allocations

consumers are subject to the following budget constraints:

$$\begin{aligned} c_t^i + k_{t+1}^i &= w_t + T_t + R_t k_t^i \\ k_{t+1}^i &\geq 0, \quad \forall t \end{aligned} \tag{1}$$

where

$$R_t = 1 + (r_t - \delta)(1 - \tau_t), \tag{2}$$

is the gross return on capital after taxes and r_t is the before-tax return on capital.

At time t consumer i orders stochastic sequences of consumption according to the expected utility that they deliver:

$$E_t \left(\sum_{j=t}^{\infty} \beta^{j-t} u(c_j^i) \right), \tag{3}$$

where $E_t(\cdot)$ denotes the expectation conditioned on time t information, $\beta \in [0, 1)$ is the discount factor and per-period utility is of the constant risk relative aversion (CRRA) type. As will be explained in Section 3.3, the only source of uncertainty in this economy comes from the political process: it concerns the identity of the executive and whether or not the executive's proposal is accepted.

There is a single firm that rents capital and labor services to produce the unique consumption good. Production combines labor with capital using the following constant-returns-to-scale production function:

$$f(k_t) = k_t^\alpha. \tag{4}$$

Since there is perfect competition, the firm chooses capital and labor services to satisfy the following conditions:

$$r_t = f'(k_t) \tag{5}$$

$$w_t = f(k_t) - k_t f'(k_t) \tag{6}$$

The government does not issue debt or consume, so the government budget's constraint is:

$$\tau_t (r_t - \delta) k_t = T_t \quad \forall t \tag{7}$$

Given $\tilde{\mu}_0$, a law of motion for the distribution of capital $G(\tilde{\mu}_t, \tau_t)$, and an arbitrary Markov

process for taxes, $\Gamma(\tau_t|\tau_{t-1}, \tilde{\mu}_t)$, it is possible to generate a stochastic path for any τ_t and wealth distribution. We now define the competitive equilibrium of our economy for a given sequence of policies.

Competitive Equilibrium Definition: *Let $\Gamma(\tau_t|\tau_{t-1}, \tilde{\mu}_t)$ and the initial distribution of wealth be given. A Competitive Equilibrium is a stochastic sequence of fiscal policies $\{T_t, \tau_t\}_{t=0}^{\infty}$ allocations $\{c_t^i, k_t^i\}_{t=0}^{\infty}$ for all θ^i , prices $\{w_t, r_t\}_{t=0}^{\infty}$ and a law of motion $G(\tilde{\mu}_t, \tau_t)$ for the distribution of wealth such that:*

- 1) *Given prices, $G(\tilde{\mu}_t, \tau_t)$ and $\Gamma(\tau_t|\tau_{t-1}, \tilde{\mu}_t)$, the allocation for every consumer θ^i maximizes (3) subject to (1).*
- 2) *Factor prices satisfy firms' first order conditions (5) and (6).*
- 3) *Given prices and aggregate allocations, the sequence of fiscal policies is generated by $\Gamma(\tau_t|\tau_{t-1}, \tilde{\mu}_t)$ and the government's budget constraint.*

4) *Markets clear:*

$$c_t + k_{t+1} - (1 - \delta)k_t = f(k_t), \quad (8)$$

where

$$c_t = \int_{\Theta} \mu(\theta^i) c_t^i d\theta^i \quad \text{and} \quad k_{t+1} = \int_{\Theta} \mu(\theta^i) k_{t+1}^i d\theta^i.$$

5) $\tilde{\mu}_{t+1} = G(\tilde{\mu}_t, \tau_t)$ *is generated by agents' optimal decisions.*

Using the government's budget (7) and equilibrium prices in the consumer's budget constraint, in equilibrium (1) can be written as:

$$c_t^i + k_{t+1}^i = f(k_t) + (1 - \delta)k_t + (\theta_t^i - 1)[1 + (1 - \tau_t)(f'(k_t) - \delta)]k_t, \quad (9)$$

where θ_t^i denotes the wealth-share of consumer i at time t . The right-hand side of (9) is consumer i 's cash on hand at period t , which sheds lights on the redistributive effects of capital taxation. Agents with $\theta_t^i < 1$ gain with positive taxes –the smaller θ_t^i , the larger the gain. Agents with $\theta_t^i > 1$ are worse off when capital is taxed –the larger θ_t^i , the larger their loss.

If a consumer with initial share θ^i were able to choose at $t = 0$ and once and for all (i.e., with commitment) a sequence $\{\tau_t\}_{t=0}^{\infty}$, what would her optimal choice be? The answer to this

question is the solution to the problem of maximizing (3) subject to (9), (8) and the Euler equations

$$u'(c_t^i) = E_t[(1 + (1 - \tau_{t+1})(r_{t+1} - \delta))u'(c_{t+1}^i)]; \quad \forall t \geq 0, i \in [0, 1]$$

The key observation is that τ_0 does not enter in any constraint but (9) at $t = 0$. Thus, any agent would set τ_0 in a corner to either maximize the gain from capital taxation or minimize the loss. In particular, if $\theta^i < 1$ we have that τ_0 is at the upper bound, while if $\theta^i > 1$ the initial tax is zero. Since capital is fully inelastic in the first period and completely elastic in the distant future, it is optimal to raise as much tax revenue as possible at the beginning. Concerning long-run taxes, Bassetto & Benhabib (2006) show that legislators want to minimize distortions caused by capital taxation. Taxes are generally decreasing over time and converge to zero.¹⁴

However, *the optimal plan is time-inconsistent*: legislators who sequentially vote on capital taxes would have the temptation to increase capital taxes every period. Potentially, in the absence of commitment this may lead to a “bad” policy outcome in which taxes are at the upper bound in all t and savings are low. We stress that all agents with $\theta_t^i < 1$ share this temptation. The lower θ_t^i , the higher the temptation to raise taxes ex-post.

Equilibrium state space. In what follows, as stated in Section 3.1, we consider a state space that includes only the past tax (the status quo) and the average stock of capital. Therefore, we replace $\tilde{\mu}_t$ with k_t in the functions G and Γ .

Why does the state space not include the entire distribution of wealth? Since we assume that markets are incomplete and consumers cannot insure against political shocks, exact aggregation is not generally obtained. However, Krusell & Smith (1998) have shown that this type of economies exhibit *approximate aggregation* in the sense that using only the first moment of the distribution leads to a minimal loss of information. Further, in our economy there are no idiosyncratic shocks, only aggregate political shocks that do not change agents’ ranking: as a result, the mean agent always has the average wealth. This makes additional moments even less necessary. In Appendix A.4, we show that for many arbitrary population’s distribution the implied aggregate law of motion of capital is almost indistinguishable from the one that would arise in a representative-agent economy. Consequently, we assume that

¹⁴For a similar result in an economy with aggregate uncertainty and complete markets see Piguillem & Schneider (2013).

prices depend only on average capital and the status quo.¹⁵

3.3. Legislative Bargaining

We focus on post-election legislative bargaining and abstract from the election stage. There is a continuum of legislators with different levels of wealth. Each legislator is indexed by her current share of asset wealth $\theta \in \Theta_L$. We assume that legislators act in order to maximize the utility of the consumers with their same level of wealth. Legislators' wealth shares are distributed with density $\mu^l(\theta)$ with support $\Theta_L = [\underline{\theta}, \bar{\theta}]$. In order to make our problem tractable we assume that the distribution $\mu^l(\theta)$ is constant over time. In the absence of this assumption, income inequality is a political state variable since the current tax affects the relative wealth of legislators and, consequently, their incentives to tax in the future. Azzimonti *et al.* (2006) shows that in the median voter model, it is enough to keep track of the assets of the mean and median agents (that is, "political" aggregation is obtained). In our model, however, every legislator can be selected to be agenda setter. Therefore, if the distribution $\mu^l(\theta)$ were not constant, we would have to keep track of the entire distribution of wealth within the legislature. This would make our computational analysis unfeasible.

The policy choice that is voted upon is the capital tax for the *current* period. Once the capital tax is selected, the lump-sum transfer is residually determined using equation (7). Let q_t denote the current status quo. At each t , legislative bargaining unfolds as follows.

(i) A randomly selected member of the legislature (the agenda setter) makes a take-it-or-leave-it offer.

(ii) All legislators simultaneously cast a vote: either "yes" or "no".

(iii) Proposals pass with probability equal to the measure of legislators who vote "yes".

(iv) If the proposal is accepted, it becomes the capital tax for the current period, τ_t , and the default option for next period: $\tau_t = q_{t+1}$.

If the proposal is rejected, q_t is implemented.

¹⁵In an earlier version of this paper we assumed the existence of a complete set of state-contingent assets and obtained economic aggregation. The results are virtually the same as the ones obtained here.

As is standard in the legislative bargaining literature, we suppose that some legislators have “agenda-setting powers”: they have the ability to determine which bills are considered on the floor.¹⁶ Note that in each period only one legislator has the right to propose a tax. The identity of the agenda setter θ^s changes in each period and is a continuous random variable with density function $\mu^s(\theta^s)$ in the interval $[\underline{\theta}, \bar{\theta}]$. Thus, recognition probabilities are *i.i.d.* over time.

Point *(iii)* deserves some discussion. Note that acceptance is probabilistic: the higher the number of legislators that favor the proposal, the higher the probability of acceptance. This implies that proposals may be rejected even if a simple majority (over 50%) of legislators are in favor of it. In a typical legislature, this may happen when minority legislators have the ability to delay or veto the approval of the bill. Point *(iii)* also implies that a proposal may pass (although with smaller probability) when it is favored by a minority in the legislature. In some other circumstances, this might be the result of vote trading across issues or party discipline. For instance, suppose that there is a party which has a majority of seats and that its policy stance is decided by the median legislator within the party. Then, if there is strict discipline within the party, a policy change may pass with the support of only 25 percent of the legislature. Acceptance is certain only when all legislators prefer the proposal to the status quo, and rejection is certain when all legislators prefer the status quo. We defend the probabilistic acceptance on two grounds. First, the assumption captures the idea that some uncertainty is inherent in the political process. In a richer model, uncertainty as to whether the bill will pass could arise when the agenda setter does not perfectly observe legislators’ preferences. Second, probabilistic acceptance introduces an additional source of uncertainty to our model besides the one concerning the agenda setter’s identity. The extra noise makes numerical computations more tractable. Notice that probabilistic acceptance is not essential for our argument: to stress this, in Section 4 we present an example where simple majority rule is assumed.

Finally, point *(iv)* states that the current policy becomes the default option in case of disagreement in the next legislative session.¹⁷

¹⁶The chairs of important committees (such as, the Rules Committee in the US House) are usually endowed with agenda-setting powers. Also, legislatures often cede agenda-setting powers to executive offices, such as, the president or premier.

¹⁷Tsebelis (2002, p. 8) argues that the status quo is often the explicit or *de facto* outside option in actual budget negotiations. Rasch (2000) identifies the countries where this provision is part of the formal rules.

We focus on pure Markov strategies. Since strategies are stationary, the problem can be formulated in a recursive way, and in what follows we drop the time index. A proposal strategy for agenda setter θ^s is a function of aggregate capital k , and the status quo q : $\tau(\theta^s) : \mathfrak{R}_+ \times [0, \bar{\tau}] \rightarrow [0, \bar{\tau}]$. After observing the proposal, legislator θ votes according to a voting rule $\alpha(\theta) : \mathfrak{R}_+ \times [0, \bar{\tau}] \times [0, \bar{\tau}] \rightarrow \{yes, no\}$.

Given k_0 , the law of motion for aggregate capital $G(k, \tau)$, the law of motion of individual θ , and the equilibrium Markov process for taxes, $\Gamma(\tau|q, k)$, it is possible to compute $V(k, \tau, \theta)$, which denotes the value function for an individual θ who starts with assets θk and an initial capital tax τ .

As is commonly assumed in the voting literature, legislator θ supports proposal τ against the status quo if and only if τ provides higher utility than q . That is,

$$\alpha(k, q, \tau; \theta) = \begin{cases} \text{“yes”} & \text{if } V(k, \tau, \theta) \geq V(k, q, \theta), \\ \text{“no”} & \text{otherwise.} \end{cases} \quad (10)$$

We let $A(k, q, \tau)$ denote the set of legislators who support the proposal,

$$A(k, q, \tau) = \{\theta \in \Theta_L : V(k, \tau, \theta) \geq V(k, q, \theta)\}. \quad (11)$$

We denote the probability that proposal τ is accepted given the pair (k, q) by $Pr^a(k, q, \tau)$. As assumed in point (iii), $Pr^a(k, q, \tau)$ is equal to the measure of set $A(k, q, \tau)$.

$$Pr^a(k, q, \tau) = \begin{cases} \int_{A(k, q, \tau)} \mu^l(\theta) d\theta & \text{if } \tau \neq q \\ 1 & \text{if } \tau = q \end{cases} \quad (12)$$

Note that when $\tau = q$ the probability of acceptance is one. In fact, rejecting the proposal would not make any difference: the policy q would be adopted regardless of the vote.

Since consumers make decisions after the legislature votes, saving decisions depend on current capital and on the current capital tax τ . Note, however, that τ does not change the current income of the average agent. Thus, τ affects aggregate savings only because it constitutes the default option in the next legislative session.

If legislator θ^s is randomly chosen as the agenda setter, her optimal proposal maximizes the expected present value of utility given the current stock of capital and the current status

quo:

$$\tau(k, q; \theta^s) = \arg \max_{\tau \in [0, \bar{\tau}]} Pr^a(k, q, \tau)V(k, \tau, \theta^s) + (1 - Pr^a(k, q, \tau))V(k, q, \theta^s) \quad (13)$$

subject to

$$k' = G(k, \tau); \quad \forall \tau \quad (14)$$

The first term of the objective function is the utility of implementing τ multiplied by the probability that τ is accepted. The second term is the utility of keeping the status quo, multiplied by the probability that τ is rejected. Note that this is a non-trivial problem since the agenda setter must realize the consequences of her proposal on the current and future probabilities of acceptance, on proposal rules of future agenda setters and on savings decisions.

Using the proposal rule and the probability of acceptance, the probability that each τ is implemented given a state is:

$$\Gamma(\tau|q, k) = \begin{cases} Pr^a(k, q, \tau) \int_{\tau=\tau(k, q; \theta^s)} \mu^s(\theta^s) d\theta^s & \text{if } \tau \neq q \\ \int_{q=\tau(k, q; \theta^s)} \mu^s(\theta^s) d\theta^s + \int_0^{\bar{\tau}} \left(\int_{\tau'=\tau(k, q; \theta^s)} (1 - Pr^a(k, q, \tau')) \mu^s(\theta^s) d\theta^s \right) d\tau' & \text{if } \tau = q \end{cases} \quad (15)$$

Expression (15) has a simple interpretation. From the first line, the probability of making a policy change to τ is equal to the measure of agenda setters that would propose τ multiplied by the probability that the proposal is accepted. The second line is the probability of maintaining the status quo. This can happen when q is proposed, the first term, and when other proposals are rejected, the second term. Notice that the latter term is what explains endogenous policy persistence in the model.

We now proceed to define the *Politico-Economic Equilibrium*. We require the Markov process for taxes implied by the political game to be optimal given the law of motion of aggregate capital implied by the competitive equilibrium, and vice versa.

Politico-Economic Equilibrium Definition: *A politico economic equilibrium is: value functions for all legislators $V : \mathfrak{R}_+ \times [0, \bar{\tau}] \times \Theta \rightarrow \mathfrak{R}$, proposal rules for all legislators $\tau(\theta^s)$*

$: \mathfrak{R} \times [0, \bar{\tau}] \rightarrow [0, \bar{\tau}]$, voting rules for all legislators $\alpha(\theta) : \mathfrak{R}_+ \times [0, \bar{\tau}] \times [0, \bar{\tau}] \rightarrow \{yes, no\}$, a Markov process for taxes characterized by $\Gamma(\tau|q, k)$, the law of motion of aggregate capital $G : \mathfrak{R}_+ \times [0, \bar{\tau}] \rightarrow \mathfrak{R}_+$, laws of motion of individual capital $G(\theta) : \mathfrak{R}_+ \times [0, \bar{\tau}] \times \Theta \rightarrow \mathfrak{R}_+$ such that

a) Given $\Gamma(\tau|q, k)$, V and the laws of motion of capital are generated in the competitive equilibrium.

b) Given $G(k, \tau)$ and V ,

b.1) Voting rules satisfy (10).

b.2) The tax proposal solves problem (13).

b.3) $\Gamma(\tau|q, k)$ is generated by equation (15).

For more details about the algorithm used in the computations see Section 5.1 and Appendix A.1.

4. Example

In this section we present a simple example to explain the mechanism behind the full dynamic model presented in Section 3. The underlying economy is identical to the one described in Section 3.2. To keep the example tractable, throughout this section we assume logarithmic utility, that depreciation is 100% and is not tax deductible. We simplify the legislative bargaining process along three dimensions. First, we assume that the legislature chooses taxes only in periods 0 and 1. The tax that is chosen in period 0 is implemented at time 0, while the tax chosen at time 1 stays in place at all $t \geq 1$.¹⁸ Second, the legislature includes only two types of legislators with capital shares $\theta^p < \theta^m < 1$. We impose that politicians are poorer than the average to emphasize that in our setting legislative bargaining disciplines politicians even when all legislators are tempted to raise taxes.¹⁹ The percentage of seats occupied by legislators of type θ^p and θ^m are $\gamma < 1/2$ and $1 - \gamma$, respectively. Thus, θ^m has a majority. Concerning the probability of being recognized agenda setter, we assume that it

¹⁸Here policy persistence is assumed; in the full model policy persistence will arise in equilibrium.

¹⁹At the end of this section, we suppose that some legislators are richer than the average.

coincides with the share of seats in the legislature. Third, instead of assuming that acceptance is probabilistic, proposals are approved by simple majority rule. Since θ^m 's measure is larger than $1/2$, it follows that a proposal passes if and only if θ^m favors it.

4.1. Legislative Bargaining at $t = 1$

We proceed backwards. First, we solve the bargaining game at time $t = 1$ for any given possible state. Since the tax chosen at $t = 1$ stays in place for all $t \geq 1$, using standard guess-and-verify methods we obtain that

$$k_{t+1} = (1 - \tau_1)\alpha\beta k_t^\alpha, \quad t \geq 1. \quad (16)$$

It can be shown (see for instance Bassetto & Benhabib, 2006) that for all $t \geq 1$ an individual with share of capital equal to θ consumes a constant fraction of average consumption, where

$$\phi_1(\tau_1, \theta) = 1 + (1 - \beta)\alpha \frac{(1 - \tau_1)(\theta - 1)}{1 - (1 - \tau_1)\alpha\beta}, \quad (17)$$

is the constant of proportionality. Let $V_1(\tau_1, k_1, \theta)$ be the time-1 value function of legislator θ , given initial capital k_1 :

$$V_1(\tau_1, k_1, \theta) = \frac{\log(\phi_1(\tau_1, \theta))}{1 - \beta} + V_1(\tau_1, k_1, 1) \quad (18)$$

where

$$V_1(\tau_1, k_1, 1) = \frac{\alpha \log(k_1)}{1 - \beta\alpha} + \frac{1}{1 - \beta} \left[\log(1 - (1 - \tau_1)\alpha\beta) + \frac{\beta\alpha \log((1 - \tau_1)\alpha\beta)}{1 - \beta\alpha} \right]. \quad (19)$$

Expression (19), which denotes the value function of the average consumer, is decreasing in τ_1 . This result is intuitive: the average agent ($\theta = 1$) does not benefit from redistribution and only bears the distorting cost on saving decisions of positive taxation. However, agents with $\theta < 1$ benefit from redistribution: for them the first term of (18) is increasing in τ_1 . As a result, the optimal tax for legislators who are poorer than the average optimally trades off efficiency costs and redistributive gains. Note that when preferences are logarithmic and $\delta = 1$, taxes and capital enter (18) separately, and therefore the optimal tax does not depend on the current level of capital.

In Figure 2a we draw the value functions of legislators θ^m and θ^p and show that both are

single peaked in τ_1 . Let τ_i^* be the optimal tax of an individual with share θ^i . Figure 2a shows that $\tau_p^* > \tau_m^*$: not surprisingly, the preferred constant tax by the poorer legislator is above the preferred tax of the relatively richer legislator.

Let $\tau_1(\theta^i) : [0, 1] \rightarrow [0, 1]$ be the proposal rule of legislator i (with $i = p, m$) at $t = 1$. As discussed above, because of the functional forms assumed in this example, the proposal only depends on the status quo, not on capital. What is the outcome of the political game at $t = 1$? Because the recognized agenda setter has a monopoly power over the agenda, the policy outcome depends on the agenda setter's type at $t = 1$. Two cases must be considered: 1) θ^m is the recognized agenda setter (with probability $1 - \gamma$), and 2) θ^p is the recognized agenda setter (with probability γ).

The first case is immediate. When the majority legislator is also the agenda setter, θ^m solves an unconstrained problem: τ_m^* is proposed and the proposal passes. In Figure 2b we illustrate the proposal of θ^m (vertical axis) as a function of the status quo τ_0 (horizontal axis) and show that the proposal does not depend on the status quo.

When instead the minority legislator θ^p is the recognized agenda setter, θ^p chooses the tax policy that maximizes her utility subject to the constraint that the proposal is acceptable to θ^m , meaning that θ^m must prefer the proposal to maintaining the status quo. This constrained maximization problem is simple to solve. The location of the status quo affects policy outcomes since it determines θ^m 's reservation utility. When the status quo τ_0 lies between τ_p^* and τ_m^* (see the shaded interval in Figure 2a), it is impossible to increase the utility of legislators θ^p without decreasing the utility of legislators θ^m . As a result, no policy change is possible and the proposal rule of θ^p lies on the 45-degree line (see Figure 2b). When instead the status quo lies outside the shaded interval, a policy change is possible. In particular, notice that when τ_0 is above τ_p^* all legislators want to decrease the tax. In this case, the acceptance constraint is not binding: the bargaining power of θ^p is sufficiently strong that she is able to pass her preferred policy τ_p^* . Finally if $\tau_0 < \tau_m^*$ both legislators want higher taxes. The agenda setter θ^p uses her monopoly power over the agenda to threaten the legislature with facing the consequences of keeping a low status quo policy. This allows θ^p to pass a higher policy than τ_m^* . In particular, when the status quo is sufficiently low (below a threshold denoted by τ_L), the constraint is not binding and, consequently, θ^p is able to

pass her preferred policy.²⁰ When instead τ_0 is between τ_L and τ_m^* , θ^p chooses a policy that leaves θ^m indifferent between accepting and rejecting. The lower the status quo, the higher θ^p 's bargaining power: this explains why the proposal rule by θ^p is strictly decreasing in this range.

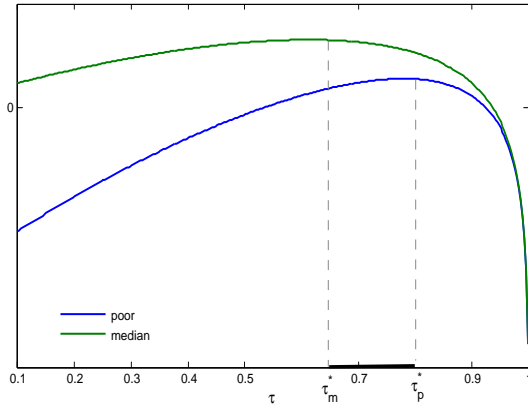
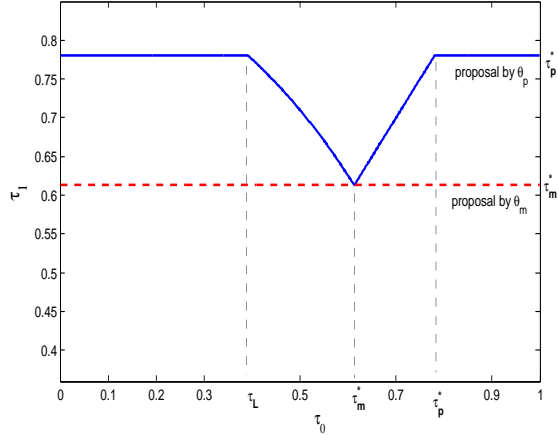
Figure 2aIndirect Utilities of Legislators θ^p and θ^m **Figure 2b**Policy Proposals at $t = 1$ 

Figure 2b illustrates two important facts. First, not surprisingly, poor legislators propose on average higher taxes than rich legislators. Second, the proposal of the minority legislators depends on the status quo. For instance, note that when the status quo is close to 1, the proposal by θ^p is strictly above the one preferred by θ^m . As shown in the next section, the latter channel gives θ^m an incentive to moderate her proposal at $t = 0$.

The expected proposal at $t = 1$ will be an average, with weights given by γ and $1 - \gamma$, of the proposals of the two types of agenda setter. Since in this example there is no uncertainty as to whether the proposal passes, expected proposal and expected tax coincide.²¹

4.2. Time $t = 0$.

We now move backwards to period 0. It is relatively simple to compute aggregate savings at $t = 0$:

$$k_1 = \frac{A}{1+A} k_0^\alpha, \quad \text{where } A \equiv \left[(1-\gamma) \frac{(1-\tau_1(\theta^m))\alpha\beta}{1-(1-\tau_1(\theta^m))\alpha\beta} + \gamma \frac{(1-\tau_1(\theta^p))\alpha\beta}{1-(1-\tau_1(\theta^p))\alpha\beta} \right] \quad (20)$$

²⁰We define τ_L as the status quo policy that makes θ^m indifferent between rejecting and accepting τ_p^* .

²¹In the full model, instead of simple majority we assume that acceptance is probabilistic. This will induce agenda setters to propose more gradual policy changes.

Expression (20) shows that aggregate savings negatively depend on the expected tax: higher proposals reduce savings at $t = 0$.

The tax policy that is negotiated at time 0 only applies to the current period. However, the legislator must internalize the consequences, via the status quo, of the current choice on bargaining at time 1 and on saving decisions. To save space, we will focus on the trade-off faced by the majority legislator θ^m . The time-0 value function of legislator θ^m is given by:

$$\log(c_0^m) + \beta E_0 V_1(\tau_1, k_1, \theta_1^m) \quad (21)$$

Since proposals rule are differentiable almost everywhere, we can take the first order condition of (21) with respect to τ_0 . At an interior solution, using the consumer's first order condition, the optimal proposal must satisfy:

$$\frac{r_0 k_0 (1 - \theta^m)}{c_0^m} + \beta \left(\gamma \frac{\partial V_1(\tau_1, k_1, \theta_1^m)}{\partial \tau_1} \frac{d\tau_1(\theta^p)}{d\tau_0} + E_0 \frac{\partial V_1(\tau_1, k_1, \theta_1^m)}{\partial k_1} \frac{dk_1}{d\tau_0} \right) = 0 \quad (22)$$

The first term of (22) represents the marginal effect of τ_0 on current utility. The other term captures, instead, the two channels through which τ_0 affects future payoffs. First, τ_0 directly affects the future bargaining process. For instance, high taxes give θ^p a strong bargaining power: Figure 2b illustrates that when the status quo is close 1, θ^p has enough leverage to pass her preferred policy. As long as the recognition probability of θ^p is strictly positive, θ^m finds it valuable to choose τ_0 in order to manipulate future decisions. Second, by changing future proposals, τ_0 indirectly affects k_1 through the saving equation (20).

In Appendix A.2, we show that (22) can be written as:

$$\underbrace{\frac{(1 - \theta^m)}{\frac{\phi_0(\theta^m)}{(1+A)}}}_{\text{today's gain}} + \beta \gamma \underbrace{\left[\frac{1 - \theta_1^m}{g_1(\tau_1(\theta^p), \theta_1^m)} - \frac{\beta \tau_1(\theta^p)}{(1 - \tau_1^p) g_2(\tau_1^p)} \right] \frac{d\tau_1(\theta^p)}{d\tau_0}}_{\text{bargaining channel}} + \underbrace{\frac{\beta}{k_1} E_0 \left[\frac{1}{1 - \beta \alpha} - \frac{(1 - \tau_1) \theta_1^m}{g_3(\tau_1, \theta_1^m)} \right] \frac{dk_1}{d\tau_0}}_{\text{Aggregate capital's channel}} = 0 \quad (23)$$

Where $\phi_0(\theta^m)$ is such that $c_0^m = \phi_0(\theta^m) c_0$ and $g_1(\tau, \theta_1^m)$, $g_2(\tau)$ and $g_3(\tau, \theta_1^m)$ are all strictly positive for any $\tau \in [0, 1]$.²² The first term of (23) represents the gain from redistribution,

²²See Appendix A.2 for closed form solutions for ϕ_0 , g_1 , g_2 and g_3 .

which is positive when $\theta^m < 1$, and increasing in θ^m .²³ Thus, when looking at the redistribution effect, θ_0^m wants to choose the maximum possible tax. The poorer the median, the larger the temptation. The effect on the bargaining process is represented by the second term of (23). It is the expected cost (with probability γ) of ending up with a tax different than τ_m^* . This cost is zero when $\tau_1^p = \tau_m^*$ and negative for any other value of τ_1^p . When $\tau_1^p > \tau_m^*$ the term between parenthesis is negative and $\frac{d\tau_1^p}{d\tau_0}$ is positive while the reverse is true when $\tau_1^p < \tau_m^*$.²⁴ Finally, the last term of (23) captures the indirect effect through capital accumulation. An increase in τ_0 increases future expected taxes which lowers aggregate savings via equation (20). This implies lower wages, whose cost is $\frac{\alpha}{(1-\beta\alpha)k_1}$, and a higher interest rate, whose benefit is $-\frac{\alpha(1-\tau_1)\theta_1^m}{k_1 g_3(\tau_1, \theta_1^m)}$. It is possible to show the wage effect always dominates in this example.²⁵

The incentives of θ^m to raise τ_0 depend on the political and institutional environment. In general, using (23), it is not possible to find a closed-form solution for the preferred τ_0 . However, as stated below, it is possible to determine the circumstances under which the tax preferred by θ^m is the maximum one.

RESULT : *At $t = 0$ an agenda setter of type θ^m chooses maximum taxes if one (or more) of the following conditions is met: (i) the recognition probability of θ^p is zero; (ii) the two types of legislators have the same wealth: $\theta^p = \theta^m$; (iii) the status quo is exogenously fixed.*

The intuition for condition (i) is the following. When θ^p is never recognized as agenda setter, there is no separation of power: the majority legislator always controls the agenda. Since θ^m is never constrained by the status quo, the dynamic linkage created by the status quo disappears. This explains why θ^m has no incentives to moderate her proposal at $t = 0$. Condition (ii) concerns wealth inequality within the legislature. To understand the role of this condition, note that when θ^p and θ^m are close, legislators have similar wealth and, consequently, do not disagree much on the policy that should be chosen at time 1. In the

²³As shown in Appendix A.2 $\phi_0(\theta)$ is increasing in θ .

²⁴Note that this does not depend on $\theta^p < \theta^m$. If $\theta^p = 1$, for instance, the signs of the components of this term would reverse, but it will still be negative.

²⁵It is clear from (20) that $\frac{dk_1}{d\tau_0}$ is proportional to k_1 . Thus, all the terms in (23) are independent of the capital stock. The fact that the wage effect is dominating would not be necessarily true if the utility is not logarithmic and/or there is partial depreciation. An agent with $\theta < 1$, but close enough to one, may want to choose zero taxes because of that.

absence of disagreement, θ^m would not care about lowering her bargaining power. Thus, when $\theta^p - \theta^m$ goes to zero, maximum taxes are chosen at $t = 0$. Finally, it is important that the default in the legislative bargaining is endogenous. If the default is fixed, the political cost of raising taxes at $t = 0$ is null since bargaining at time 1 would not depend on the previously decided policy.

We stress that our argument does not rely on having poorer than average legislators. In Figure A4 (see Appendix A2), we illustrate the proposal rules when the minority legislator is richer than the average: $\theta^p > 1$. When the status quo is close to 1, it is still the case that high taxes at $t=0$ reduce the bargaining power of θ^m . In fact, θ^p is able to pass her preferred policy proposal, which is equal to zero. Since this is costly for θ^m , the preferred proposal by θ^m at $t = 0$ will not be at the upper bound.

In Section 5.2, when we numerically solve the equilibrium, we start the iterations assuming a transition function for taxes with full persistence. That is, as if legislators had to choose taxes once and for all (as in period $t = 1$ of this example). This generates a new transition function for taxes that does not necessarily exhibits full persistence. We then update the expected transition function for taxes and solve a new bargaining problem, until the transition function converges.

5. Quantitative Exercise

5.1. Computational Strategy

The numerical problem consists of solving one fixed point, the *Politico-Economic Equilibrium* (PEE) characterized by $\Gamma(\tau|q, k)$, which depends on another fixed point, the *Competitive Equilibrium* (CE), characterized by the law of motion of aggregate capital $G(k, \tau)$. Loosely speaking our strategy amounts to first solving the CE given $\Gamma(\tau|q, k)$. This generates an aggregate decision rule and new value functions. Then, we use the outputs from the CE to generate a new $\Gamma(\tau|q, k)$ and we repeat this procedure until convergence. In Appendix A.1, we describe the algorithm, but some details are worth mentioning.

We solve the CE using a variant of Carroll (2006)'s endogenous grid method. As we explained in Section 3.2 we solve for the law of motion of capital of a representative-agent economy. We start the iterations assuming a $G(k, \tau)$ and then apply the Carroll (2006) method to the saving problem of the average agent. Then, we set $G(k, \tau)$ equal to the saving

policy function of the mean agent and repeat the procedure until the aggregate saving rule is consistent with the saving rule of the mean agent. The main difference from the solution of a standard CE problem is that fiscal policies are endogenous, thus implying that the future tax depends on the future stock of capital. This can create problems for equilibrium existence and convergence of numerical algorithms (when the equilibrium exists). However, as shown by Coleman (1991) and Greenwood & Huffman (1995), when the tax function is monotone increasing in the level of capital the problem disappears. We confirm in the numerical solutions that the tax function is indeed monotone increasing in the capital stock.²⁶

To shed light on the relevance of the assumed distribution of wealth for the computation of the CE in Appendix A.4 we plot the computed law of motion of capital and compare it to the one arising from aggregating individual savings using as weights the population's distribution. We can see that both laws of motions are almost identical for most levels of aggregate capital. We have performed similar calculations with alternative distributions of net worth arriving to the same conclusion. This indicates that the wealth distribution has little or no impact for the CE and that all the effects of the distribution stem from the political equilibrium.

We stress that at least one PEE generally exists. To see this, consider the following extreme cases. First, assume that the legislature only includes politicians with pre-tax income above the mean: in this case, it is immediate that there exists a PEE where taxes are set at zero in all periods. Second, and more interestingly, consider a legislature where all legislators gain from redistribution. In this case, there at least exists the “bad equilibrium” where the legislature sets the tax at the upper bound in every period, and agents invest foreseeing this strategy. Intuitively, when all legislators are expected to choose maximum taxes regardless of the current state, the aggregate law of motion of capital is completely inelastic to the current tax policy. Thus, it is optimal for the agenda setter to propose the highest possible tax and for the legislature to approve it. Therefore, the “bad equilibrium” is self-confirming. Since we are interested in equilibria in which aggregate savings react to the tax policies, we start the iteration of the PEE assuming that for all τ we have $\Gamma(\tau|k, \tau) = 1$. That is, it is initially assumed that taxes always remain at the same level. This allows us to search for the equilibrium where savings actually react to current taxes: as shown below, in this equilibrium

²⁶See Figure 8. Santos, (2002) discusses the existence of Markov Equilibria in non-optimal economies. The main difference between our economy and the ones in those papers is the inclusion of the past tax as a state variable. For this reason, we cannot apply those results directly to our model.

taxes are generally below the upper bound.

5.2. Results

5.2.1. Calibration. Throughout the numerical simulations we set $\beta = 0.96$, $\alpha = 0.3$ and $\delta = 0.08$. We present results with two alternative calibrations for the coefficient of risk aversion, $\sigma = 1$ and $\sigma = 2$, and show that the qualitative findings are similar in both cases. These parameters are standard in the literature. The upper bound for taxes is $\bar{\tau} = 0.95$. The results are not very sensitive to it.²⁷ Calibrating the distribution of wealth within the legislature, $\mu^l(\theta)$, requires making a stance on legislators' objectives. If we think that legislators are benevolent, or closely represent the population that elects them, the appropriate distribution of wealth would be the distribution of net worth in the whole population. Instead, if we think that politicians are self-interested, we should pick the distribution of wealth of the actual representatives. In what follows, we present results under two alternative calibrations.

First, we calibrate μ^l with the distribution of net worth in the U.S. economy using the *Survey of Consumer Finances* (SCF) for 2007. Since computing the acceptance probabilities requires a continuous function, we approximate the observed distribution of net worth with a *Frechet* distribution. Under this calibration we obtain that the median share is equal to 0.25 and $Prob(\theta > 1) = 0.20$. See Figure A.2 in the appendix for more details.

Second, we collect data from opensecrets.org and we compute the distribution of net worth for the U.S. representatives (see Appendix A.3 for more details). This data reveals that members of Congress are much richer than the population that they represent: in particular, more than 60% of the legislators are richer than the average citizen.²⁸ In our second calibration we repeat the approximating procedure discussed above using this database instead of the SCF.

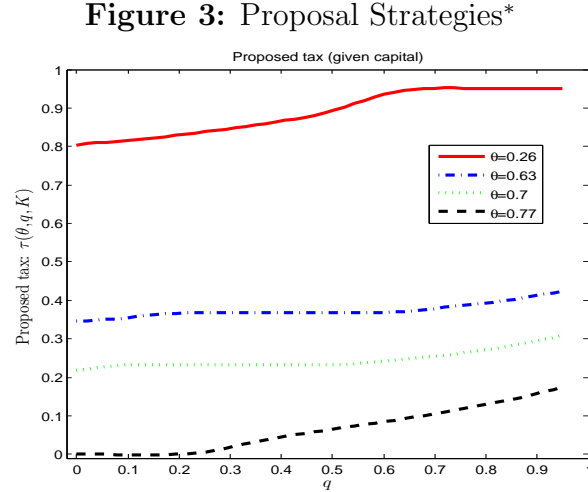
Concerning the distribution of agenda setting power, $\mu^s(\theta^s)$, in all our simulations we assume that it coincides with $\mu^l(\theta)$.

Before presenting the equilibrium average taxes it is informative to analyze the computed proposal and acceptance probabilities.

²⁷As expected larger values of $\bar{\tau}$ generate larger average taxes, but the effect diminishes as $\bar{\tau}$ approaches one. At $\bar{\tau} = 0.95$ the change on average taxes due to further increases in $\bar{\tau}$ is negligible.

²⁸This proportion is much higher when looking at the Senate only.

5.2.2. *Proposal and Acceptance Strategies.* The most important outputs of the numerical simulations are the proposal strategies and the acceptance probabilities. In Figure 3, we fix the level of capital and illustrate the proposed capital tax (on the vertical axis) as a function of the status quo for different values of θ^s , the share of wealth of the recognized agenda setter.²⁹



Computed assuming $\sigma = 2$ and a distribution of wealth as in SCF 2007

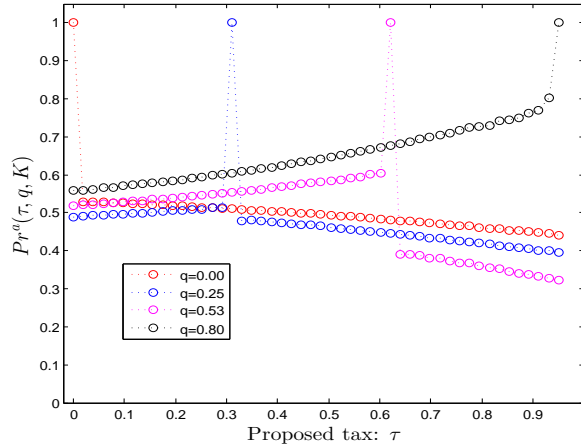
Three features of the proposal rules are worth noting. First, proposals are generally below the upper bound. Notice, for instance, that a proposer with share $\theta^s = 0.77$ proposes taxes close to zero even if, when looking at the current payoff, she has an incentive to choose maximal taxes. The reason is that she realizes that setting high taxes, through a change of the status quo, would increase the future bargaining power of poorer legislators. The second and related feature is that the poorer the legislator, the higher the proposed tax for any given status quo. This is because poor legislators gain more from redistribution and consequently are more willing to accept the long run distortions associated with an increase of the status quo. For instance note that a poor agenda setter ($\theta^s = 0.26$) often proposes $\bar{\tau}$, while a relatively richer agenda setter ($\theta^s = 0.77$) proposes much lower taxes. Third, proposal rules are monotone increasing in the status quo. For example, the upper curve in Figure 3 shows that a poor agenda setter proposes taxes lower than $\bar{\tau}$ when the initial status quo is around zero and that her proposal approaches $\bar{\tau}$ as q increases.

²⁹Figure 8 illustrates how proposals vary with capital, keeping fixed the status quo policy.

The positive slope of the proposal rule is an important element of our disciplinary mechanism. It provides the channel for strategic manipulation of future agenda setters: by passing low taxes current policymakers reduce the expected proposals of future agenda setters.

It is instructive to compare Figure 2b with Figure 3. The proposal rules in the latter figure are monotone, but not in Figure 2b. One of the reasons explaining this difference is that in the example proposals pass by simple majority rule, while in this section acceptance is probabilistic. Because of risk aversion, the agenda setter proposes more gradual policy changes in order to raise the acceptance probabilities. This leads to monotonic proposals that simplify the numerical analysis.

Figure 4: Acceptance Probabilities*



Computed assuming $\sigma = 2$ and a distribution of wealth as in SCF 2007

Figure 4 illustrates the acceptance probabilities as a function of all possible proposals. Thus, the vertical axis measures the probability of acceptance and the horizontal axis indicates the proposal τ . As before, we compute the probability for a given level of capital. Each line in Figure 4 corresponds to a different status quo policy. Note that acceptance probabilities are below one unless the proposal coincides with the status quo, as shown in equation (12). When the proposal coincides with the status quo, legislators have no other choice than accepting the proposal. When the proposal differs from the status quo, some legislators oppose the change, which makes the probability of rejection strictly positive and generates the jump discontinuity at $\tau = q$. The fact that rejection occurs with positive probability creates policy persistence. Since policymakers gain from high taxes today but they would like to commit to low taxes in the future, policy persistence attenuates the temptation to raise taxes.

It is worth noting that the probability of acceptance is decreasing in the distance between the status quo and the proposal. Large policy changes are less likely to be accepted because an increasing number of people are made worse off. To understand this, consider first a proposal to infinitesimally cut taxes. In this case, the legislators who oppose the change would be those who prefer a tax increase. Consider now a large tax cut and notice that the group of legislators opposing this change are not only those who prefer a tax increase, as before, but also some legislators who prefer a smaller tax cut.

Finally, note that in general there is an asymmetry between the left and the right jump from the status quo. For instance, when the status quo is 0.53 the probability of accepting a tax increase is smaller than the probability of accepting a tax cut. This is because a tax rate of 0.53 is too high from the perspective of the majority of legislators. When instead the status quo is relatively low, the asymmetry is in the opposite direction.

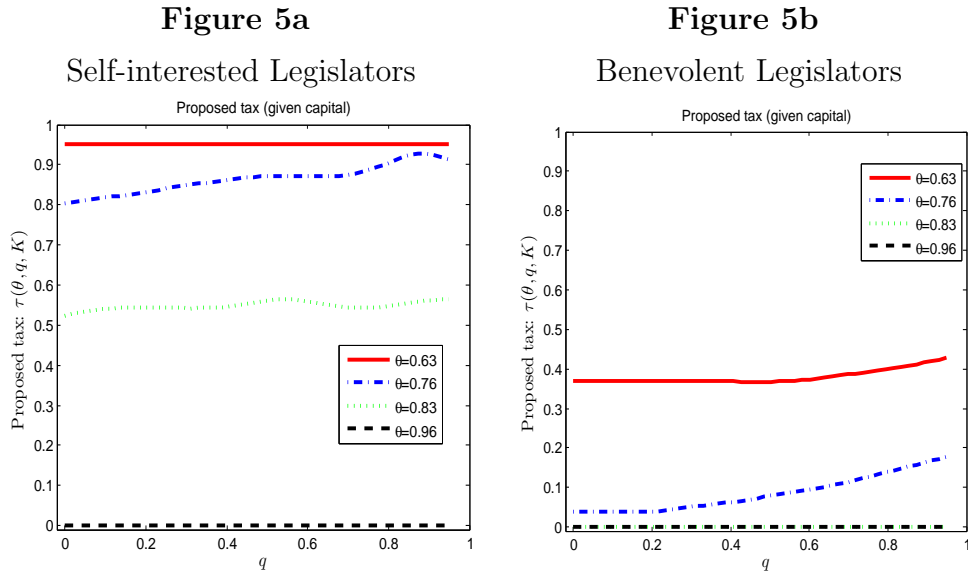
5.2.3. Average taxes. Table 1 presents summary statistics for 10000 simulated legislative sessions. Each row corresponds to a different calibration. We present in Column 2 the wealth share of the median legislator. In Columns 3 and 4, we show the average capital tax and the autocorrelation of the tax. In Columns 5 and 6 we report, respectively, the standard deviation of the tax and average consumption. The first two rows show that average taxes are around 50% when the distribution of wealth in the legislature coincides with the one in the population. We show results with two alternative calibrations, $\sigma = 1$ and $\sigma = 2$. In both cases the moments of the tax are very similar. Tax levels are well below the upper bound in spite of the fact that most legislators are poorer than the average.³⁰

Table 1. Summary Statistics.

Calibration	θ^m	$E(\tau)$	$corr(\tau, \tau_{-1})$	$std(\tau)$	consumption
Benevolent Legislators ($\sigma = 1$)	0.25	0.51	0.51	0.39	0.96
Benevolent Legislators ($\sigma = 2$)	0.25	0.55	0.49	0.38	0.94
Self-interested Legislators ($\sigma = 1$)	1.76	0.25	0.47	0.46	1.09
Self-interested Legislators ($\sigma = 2$)	1.76	0.25	0.48	0.46	1.09

³⁰If we assume that *all* legislators have a wealth-share below one, we would still obtain that average taxes are below the upper bound. Results for this calibration are shown in a previous version of this paper.

When we assume that legislators are self-interested (using the actual distribution of wealth within the US Congress) most of the legislators are richer than the average agent in the economy. The share of the median legislator, θ^m , increases dramatically to 1.76. Under this alternative calibration taxes are considerably lower and average consumption higher. Under the median-voter approach taxes would drop to zero when the median legislator is richer than the average. In our setting, average taxes are still positive and non-negligible. There are two reasons for this.



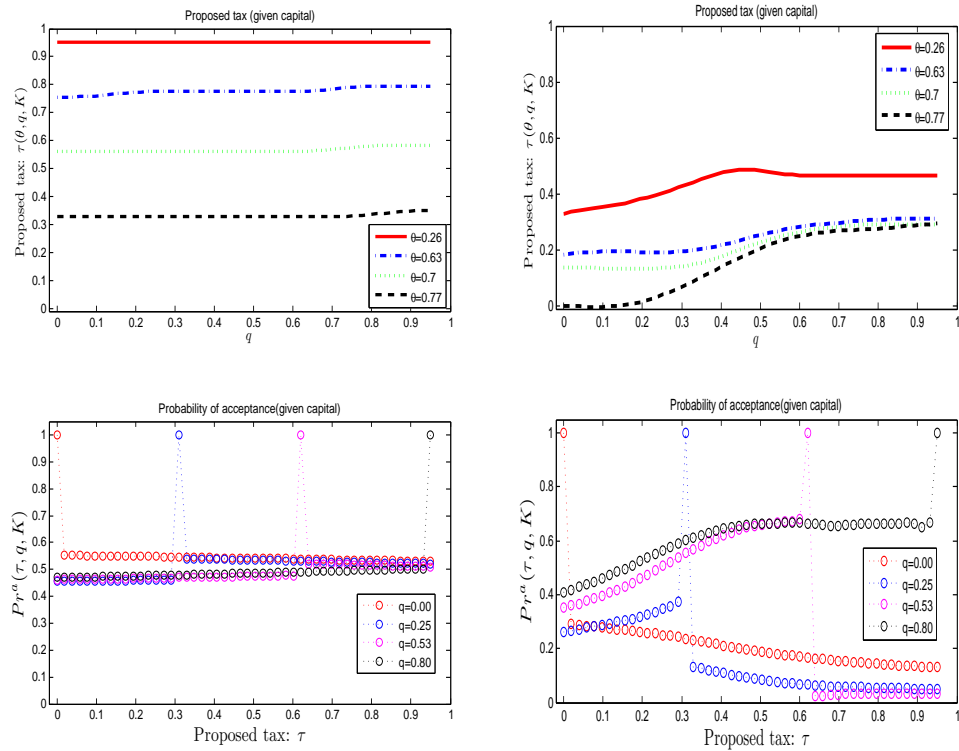
First, recall that recognition and acceptance probabilities reflect the entire wealth distribution. Even when we use the actual wealth distribution in the US Congress, the poor legislators' recognition probability and the acceptance probability for tax increases remain strictly positive. Second, there is an effect on equilibrium strategies. A legislator with the same wealth-share behaves differently under the two calibrations. For instance, a legislator with share $\theta = 0.63$ proposes maximum taxes when she belongs to a legislature where most legislators are richer than average (Figure 5a), while she proposes more moderate taxes when she belongs to a legislature where most legislators are poorer (Figure 5b). The reason is that in a legislature with a larger proportion of poor legislators, high taxes are more persistent, which raises the cost of moving into the next period with a high status quo and increases the incentive to propose low taxes. All things being equal, a legislator becomes more disciplined when she belongs to a legislature that is eager for redistribution. Conversely, when the same legislator belongs to a Congress where most members are rich, she would have an incentive to

free-ride on others' responsibility and favor higher taxes. Assuming a much richer legislature does not dramatically decrease taxes because the larger number of rich legislators is partially compensated by the higher taxes proposed by poorer legislators.

It is interesting to note from Table 1 (Column 5) that when we use the actual wealth distribution in the US Congress policies are more volatile. The increased volatility is partly explained by the higher distance between legislators' ideal points (i.e., higher polarization) shown in Figures 5a and 5b.

5.2.4. *Additional Legislative Restrictions.*

Figure 6: Benchmark (Left Panels) vs Two Committees (Right Panels)



Until now we have assumed that to change the policy in place only one voting stage is required. However, in reality most policy changes require the approval of different institutional bodies. For instance, in bicameral systems changes to the tax code must be approved by the Senate and the House of representatives. Even in unicameral systems it is often the case that proposals must be approved by a committee before they can be presented to the floor. In order to capture the impact of these additional restrictions we assume that in order to pass, a proposal must be approved by two institutional bodies or committees. For simplicity, assume

that in the two committees, legislators' wealth shares are distributed according to the same density. As before, in each committee the probability of approval is equal to the measure of legislators who prefer the policy change. Since we assume that the two votes are independent, the overall probability that the proposal passes is simply the square of expression (12). Abusing terminology, the benchmark model is called unicameral system and the alternative system is called bicameral.

Figure 6 illustrates the proposal rules (upper panels) and acceptance probabilities (lower panels) in the two systems. Equilibrium behavior under bicameralism (unicameralism) is shown in the right (left) panels. As expected, we find that the constitutional change induces more status quo bias: policy changes less likely pass in a bicameral system.³¹ Moreover, it affects the slope of equilibrium proposal rules. In the bicameral legislature, proposals are closer to the 45 degrees line. This is because legislators propose taxes closer to the status quo in order to increase the probability of acceptance. Finally, by increasing policy persistence, bicameralism makes it more costly to go to the next period with a high status quo. As a result, proposal rules are in general lower. By comparing results in Tables 1 and 2, note that in our stylized bicameral system taxes are lower, autocorrelation increases and public policies are less volatile.

Table 2. Bicameralism.

Calibration	θ^m	$E(\tau)$	$corr(\tau, \tau_{-1})$	$std(\tau)$	consumption
Benevolent Legislators ($\sigma = 1$)	0.25	0.34	0.73	0.32	1.04
Self-interested Legislators ($\sigma = 1$)	1.76	0.12	0.68	0.41	1.13

The high policy persistence associated to the bicameral system has important consequences for the predicted path of aggregate capital (and GDP) and taxes. Figure 7 (upper panel) illustrates a sample path for capital taxes, starting with a high status quo. Interestingly, the lower panel of Figure 7 indicates that capital evolves according to a cyclical pattern

³¹Notice that the equilibrium probabilities of acceptance in the bicameral system are not not exactly equal to the square of the ones under unicameralism. This is because voting rules, as described in (10), are themselves affected by the constitutional change.

and that the period cycle lasts several decades.

Figure 7: Sample path: taxes and aggregate capital

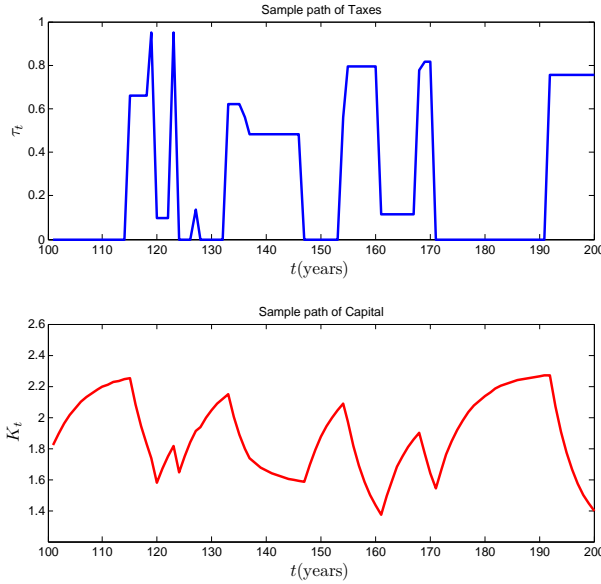
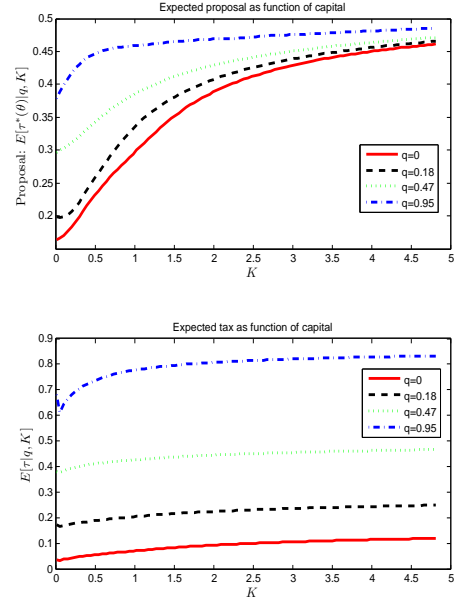


Figure 8: Expected tax and proposal



The intuition behind these “political growth cycles” is provided in Figure 8, where we show that the expected proposal (upper panel) and the expected tax (lower panel) are both monotonically increasing in current capital (represented on the horizontal axis). This feature arises because a larger capital stock increases the tax base, strengthening the temptation to raise capital taxes for redistribution purposes. Then, when capital is low, low taxes are more likely to be proposed (and pass) than high taxes. Since taxes are expected to persist, we obtain that consumers foresee several periods with low taxes and accumulate more capital. However, as the economy grows, legislators become increasingly tempted to raise taxes. Eventually, high taxes pass in the legislature, leading to a low investment rate and a reduction of the capital stock, so that the cycle begins again.³²

6. Conclusions

We have studied a macroeconomic model where redistribution is decided in a post-election bargaining process rather than by the median voter. This point of departure from the literature is key to generate a rich set of predictions.

³²Policy persistence is key to generate these cycles. In unreported results we obtained that in the unicameral system (where persistence is lower) political cycles are less pronounced.

Since current capital is sunk, legislators with pre-tax income below the average have time-inconsistent indirect preferences over redistribution and taxation: they have incentives to choose maximum taxes in every period. In spite of this temptation, we find that policymakers may not propose (or accept) high capital taxes because this increases the status quo, and thus, the bargaining power of low wealth agents in the next negotiations. This future political cost is enough to generate time consistent levels of capital taxation that are reasonably low. It is worth mentioning that we obtain these results without resorting to reputational arguments or introducing ad-hoc constraints on the governments' set of choices.

The political environment and the number of checks and balances specified in the constitution are key determinants of government size. We compute average taxes under two alternative calibrations. First, we assume that the wealth distribution in the legislature coincides with the distribution of net worth in the US population and find taxes above 50%. Second, we calibrate the distribution of legislators' wealth to match the distribution of wealth in the US Congress, which leads to lower taxes (25%) and to more polarization of policy preferences. Polarization increases because adding wealthier legislators changes equilibrium behavior of poorer legislators, who have a stronger incentive to demand more redistribution.

Next, we modify the bargaining process by adopting a bicameral system instead of an unicameral one. Requiring two concurrent votes to pass legislation aggravates status-quo bias and results into lower equilibrium tax rates. We also find that legislators propose more gradual policy changes in order to maximize the probability of acceptance.

Finally, we show that endogeneizing policy making may induce political cycles: periods with low taxes and growing capital are followed by periods with high taxes and decreasing capital (and vice versa).

The economic consequences of political institutions have been studied by several authors using stylized models, often in a partial equilibrium and static settings. Our paper is a first step toward understanding the effects of constitutional rules on economic outcomes in the context of a standard macroeconomic model. However, much remains to be done in order to capture more realistic features of policymaking. This constitutes an important direction for future research.

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Appendix

A.1. Algorithm

Given a measure μ^s of agenda setters and μ^l of median legislators, construct grids \mathcal{K} , \mathcal{T} , and Θ for, respectively:

1. Capital stock $k \in [k_{min}, k_{max}]$.
2. Tax $\tau \in [0, \bar{\tau}]$.
3. Share of average capital $\theta \in [0, \theta_{max}]$.

Remarks. The convergency and robustness of the numerical results are not sensitive to the grid sizes for k and τ . In contrast, if the grid for θ is not fine enough the algorithm may fail to converge. In particular, the tolerance for convergency must be adjusted to the coarseness of the grid.

Guess an initial Markov process for taxes $\Gamma_0(\tau|q, k) : \mathcal{T} \times \mathcal{T} \times \mathcal{K} \rightarrow [0, 1]$ and an initial law of motion of aggregate capital $G_0(k, \tau) : \mathcal{T} \times \mathcal{K} \rightarrow \mathcal{K}$. We pin down the competitive equilibrium with persistence by starting the simulations with $\Gamma_0(\tau|\tau, k) = 1$ for all k, τ . See Section 4 for a discussion about this choice. Further, in order to preserve the persistence of the transition function we assume that with some probability π_i (where the index i denotes the iteration) the legislature makes no decision and the current status quo stays in place. We let π_i go to zero as the number of iterations increases. Thus, at the solution it is always the case that $\pi_i = 0$. This transitory exogenous positive probability of staying in the status quo makes the convergency toward the equilibrium more stable.

Fix the tolerance level for the political game, $\epsilon > 0$ and $\pi_0 > 0$.

Step 1 (*Solve Competitive Equilibrium*) Given Γ_0 solve for the equilibrium law of motion for capital: $k' = G(k, \tau)$ for $(k, \tau) \in \mathcal{K} \times \mathcal{T}$, using the endogenous grid method of Carroll (2006).

Starting for a given $G_0(k, \tau)$ solve the optimal decision of the average agent, which delivers an individual policy function $g(k, \tau)$. Then, replace $G_0(k, \tau)$ with $g(k, \tau)$ and solve for a new individual policy function. Iterate until convergency. Since the fixed grid is \mathcal{K} , the output from this step would be the matrix $k_0 \in \mathbb{R}^2$ such that $k = \tilde{G}_1(k_0, \tau)$ for all $(k, \tau) \in \mathcal{K} \times \mathcal{T}$. Using linear interpolation we obtain the mapping $G_1 : \mathcal{K} \times \mathcal{T} \rightarrow \mathbb{R}$.

Let $d_G = \text{norm}(G_0 - G_1)$.

We update $G_0 = \alpha G_1 + (1 - \alpha)G_0$ for some $\alpha \in (0, 1)$. In general α is close to 1. We use values between 0.8 and 0.9. This slow updating avoids overshooting of the transition matrix for taxes.

Step 2 (*Compute value functions*) Given Γ_0 and G_0 compute the value function for each agent, $V(k, \tau, \theta)$, using the standard iteration of the value function (starting with $V(k, \tau, 1) = \theta$) and interpolating for values of k outside the grid.

Step 3 (*Update Markov process for taxes*) Using equation (11) we compute, for each k and q , the set of legislators who prefer a new policy τ to the status quo q . Then, the probability of acceptance of a tax τ given status quo q and capital stock k , is given by (12). In addition, given the acceptance probability, $V(k, \tau, \theta)$ and $G_0(k, \tau)$ we can compute the optimal choice for each agenda setter using equation (13): $\tau(k, \tau, \theta)$. Since we are not certain about the properties of the objective function we use a global method to choose the maximum. That is, we evaluate the objective function for all possible combinations of k and τ and choose the maximum value.

Both $Pr^a(k, q, \tau)$ and $\tau(k, \tau, \theta)$ then imply a new Markov process for taxes using a modified version of (15) as follows:

$$\Gamma_1(\tau|q, k) = \begin{cases} (1 - \pi_i) Pr^a(k, q, \tau) \int_{\tau=\tau(k, q; \theta^s)} \mu^s(\theta^s) d\theta^s & \text{if } \tau \neq q \\ (1 - \pi_i) \left[\int_{q=\tau(k, q; \theta^s)} \mu^s(\theta^s) d\theta^s + \int_0^{\bar{\tau}} \left(\int_{\tau'=\tau(k, q; \theta^s)} (1 - Pr^a(k, q, \tau')) \mu^s(\theta^s) d\theta^s \right) d\tau' \right] + \pi_i & \text{if } \tau = q \end{cases}$$

Step 4 (*Updating*) Check the distance between the assumed process for taxes and that implied by the policy game. Define $d_\Gamma = \text{norm}(\Gamma_0 - \Gamma_1)$.

If $\max(d_G, d_\Gamma) < \epsilon$ and $\pi_i = 0$ stop: the equilibrium has been found. Otherwise go to Step 1, updating Γ_0 with $\alpha\Gamma_1 + (1 - \alpha)\Gamma_0$ for some $\alpha \in (0, 1)$ and $\pi_{i+1} = \max\{\pi_0(n_\pi - i)/n_\pi, 0\}$. Where $n_{pi} < \text{max number of iterations}$ makes sure that π_i is eventually zero.

A.2. Rich agenda setter

Figure A.1.1

Indirect Utilities of Legislators θ^p and θ^m

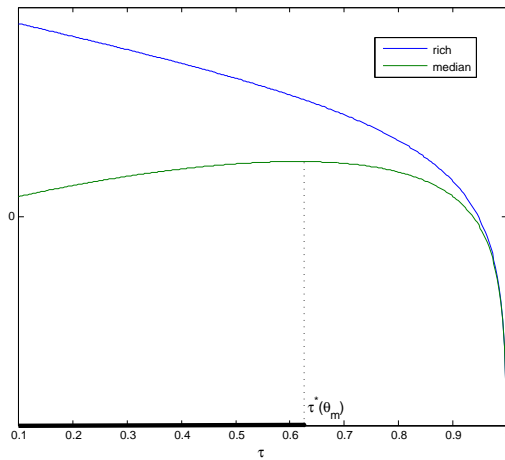
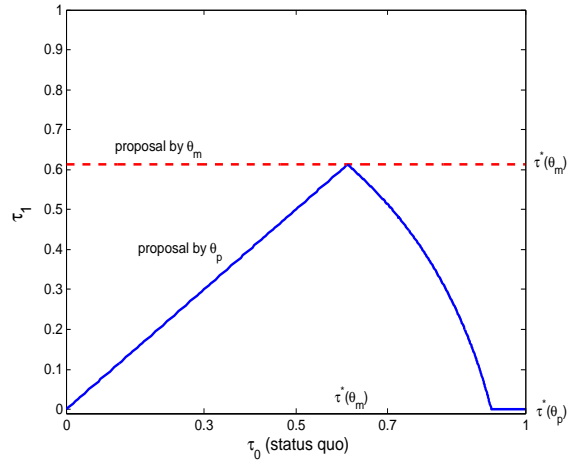


Figure A.1.2

Policy Proposals: $t = 1$



A.2.0.5. *Example's first order condition..* Note that equation (17) can be written as:

$$\phi_1(\tau_1, k_1(\theta)) = 1 + (1 - \beta)\alpha \frac{(1 - \tau_1)(k_1(\theta) - k)}{(1 - (1 - \tau_1)\alpha\beta)k}, \quad (\text{A.1})$$

Using the above define $V_1(\tau_1, k_1, k_1(\theta))$ instead of (18). The first order condition for the problem can be written as:

$$\frac{1}{c_0^m} \frac{dc_0^m}{d\tau_0} + \beta\gamma \frac{\partial V_1}{\partial \tau_0}(\tau_1^p, k_1, k_1(\theta_1^m)) \frac{d\tau_1(\theta^p)}{d\tau_0} + \beta E_0 \frac{\partial V_1}{\partial \tau_0}(\tau_1, k_1, k_1(\theta_1^m)) \frac{dk_1}{d\tau_0} + \beta E_0 \frac{\partial V_1}{\partial k_1(\theta_1^m)}(\tau_1, k_1, k_1(\theta_1^m)) \frac{dk_1(\theta_1^m)}{d\tau_0} = 0$$

Note that $c_0^m + k_1(\theta_1^m) = w_0 + T_0 + (1 - \tau_0)rk_0(\theta_0^m) = (1 + \alpha(1 - \tau_0)(\theta_0^m - 1))k_0^\alpha = Y_0^m$. Therefore,

$$\frac{1}{c_0^m} \frac{dc_0^m}{d\tau_0} + \beta E_0 \frac{\partial V_1}{\partial k_1(\theta_1^m)} \frac{dk_1(\theta_1^m)}{d\tau_0} = \frac{1}{c_0^m} \frac{\partial Y_0^m}{\partial \tau_0} - \left[\frac{1}{c_0^m} - \beta E_0 \frac{\partial V_1}{\partial k_1(\theta_1^m)} \right] \frac{dk_1(\theta_1^m)}{d\tau_0} = \frac{rk_0(1 - \theta_0^m)}{c_0^m}$$

Where we have used the consumer's euler equation and the fact that $rk_0 = \alpha k_0^\alpha$. Introducing the last in the former delivers (22).

The consumption of agent θ_0 can be expressed as $c_0(\theta_0) = \phi_0 c_0$ and $k_1(\theta_1) = \theta_1 k_1$. Thus, ϕ_0 solves,

$$\phi_0 c_0 + k_1 \theta_1 = \phi_0 \frac{k_0^\alpha}{1+A} + \theta_1 \frac{A k_0^\alpha}{1+A} = (1 + \alpha(1 - \tau_0)(\theta_0 - 1))k_0^\alpha$$

which generates $\phi_0 = [1 + \alpha(1 - \tau_0)(\theta_0 - 1)](1 + A) - \theta_1 A$, where θ_1 solves:

$$\frac{A/(1+A)}{1 + \alpha(1 - \tau_0)(\theta_0 - 1) - A/(1+A)\theta_1} = E \left[\frac{1 - \tau_1}{1 - \alpha(1 - \tau_1)[1 - (1 - \beta)\theta_1]} \right]$$

This implies that θ_1 is increasing in τ_0 if $\theta_0 < 1$. Using the definition of A is possible to show that as long as $\tau_0 < 1$, $\theta_1 < 1$ if $\theta_0 < 1$ and $\theta_1^m > \theta_1^p$ if $\theta_0^m > \theta_0^p$. As a result the today's gain from redistribution is:

$$\frac{rk_0(1 - \theta_0)}{c_0^m} = \frac{\alpha(1+A)(1 - \theta_0^m)}{\phi_0^m}$$

which does not depend on the current stock of capital. Note that $\frac{1}{1+A} = 1 - s_0$, where s_0 is the aggregate saving rate. The above is the first term in equation (23).

Direct differentiation of (18) generates

$$\frac{\partial V_1}{\partial \tau_1}(\tau_1, k_1, \theta_1) = \frac{1 - \theta_1}{\phi_1} \left[\frac{\alpha}{[1 - (1 - \tau_1)\alpha\beta]^2} \right] + \frac{\alpha\beta}{1 - \beta} \left[\frac{1}{1 - (1 - \tau_1)\alpha\beta} - \frac{1}{(1 - \tau_1)(1 - \alpha\beta)} \right]$$

Using the definition of ϕ_1 :

$$\frac{\partial V_1}{\partial \tau_1}(\tau_1, k_1, \theta_1) = \frac{\alpha}{1 - (1 - \tau_1)\alpha\beta} \left[\frac{1 - \theta_1}{1 - (1 - \tau_1)\alpha(1 - \theta_1 + \theta_1\beta)} - \frac{\tau_1\beta}{(1 - \beta)(1 - \tau_1)(1 - \alpha\beta)} \right]$$

Collecting terms,

$$\frac{\partial V_1}{\partial \tau_1}(\tau_1, k_1, \theta_1) = \alpha \left[\frac{1 - \theta_1^m}{g_1(\tau_1, \theta_1)} - \frac{\beta\tau_1}{(1 - \tau_1)g_2(\tau_1)} \right]$$

where $g_1(\tau_1, \theta_1) = [1 - (1 - \tau_1)\alpha(1 - \theta_1 + \theta_1\beta)][1 - (1 - \tau_1)\alpha\beta] > 0$ and $g_2(\tau) = (1 - \beta\alpha)(1 - \beta)[1 - \alpha\beta(1 - \tau)] > 0$.

This is the second term in equation (23). Note that this term is zero when $\tau_1 = \tau_m^*$, positive when $\tau_1 < \tau_m^*$ and negative when $\tau_1 > \tau_m^*$. This follows from the definition of τ_m^* .

Finally, differentiating $V_1(\tau_1, k_1, k_1(\theta))$ we obtain:

$$\frac{\partial V_1}{\partial k_1} = \frac{\alpha}{k_1} \left[\frac{1}{1 - \beta\alpha} - \frac{(1 - \tau_1)\theta_1}{[1 - (1 - \tau_1)\beta\alpha]\phi_1(\theta_1)} \right]$$

Replacing ϕ_1 in the above,

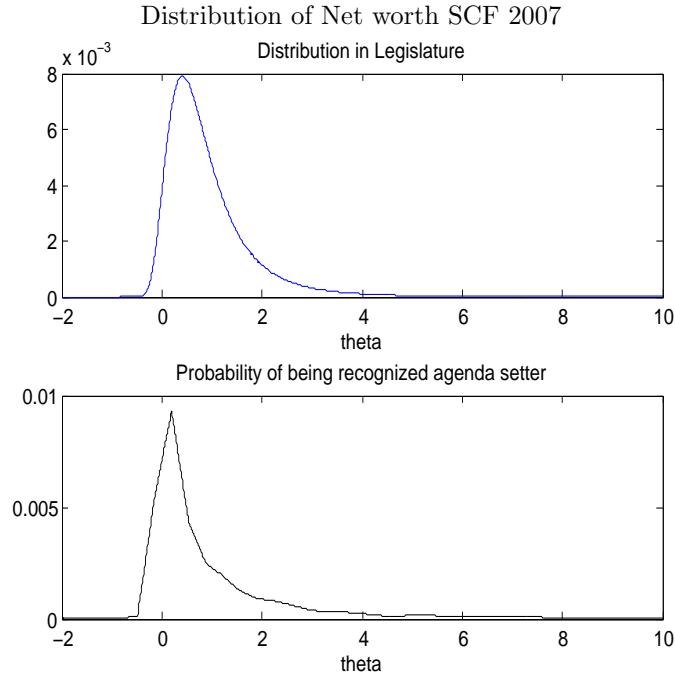
$$\frac{\partial V_1}{\partial k_1} = \frac{\alpha}{k_1} \left[\frac{1}{1 - \beta\alpha} - \frac{(1 - \tau_1)\theta_1}{[1 + \alpha(1 - \tau_1)[\theta(1 - \beta) - 1]]} \right]$$

Defining $g_3(\tau, \theta) = 1 + \alpha(1 - \tau)[\theta(1 - \beta) - 1]$ we obtain the last term of (23). This derivative is positive for all $\tau_1 \in [0, 1]$ and all $\theta_1 < 1$.³³

A.3. Distribution of net worth

Distribution of Net worth in the population

Figure A.2: Kernel Density and Frechet approximation.



³³All the terms in (23) are multiply by α , for that reason α has been eliminated from that equation.

Distribution of Legislators' net worth

Figure A.3: kernel density distribution of Net worth. Members of US Congress

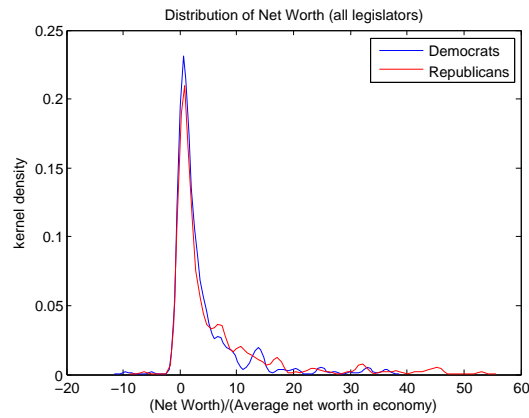


Table A.1: net worth for the U.S. members of Congress

	Democrats	Summary Republicans	Difference (%)
House			
Average	4,488,893	7,561,302	68%
Median	654,006	848,035	30%
Prop richer than average	0.58	0.61	
Senate			
Average	19,383,524	7,153,985	-63%
Median	2,579,507	3,025,002	17%
Prop richer than average	0.85	0.83	
Boths Chambers together			
Average	7,209,600	7,491,000	4%
Median	891,506	1,075,002	21%
Prop richer than average	0.63	0.65	

A.4. Precision of forecasted prices

Figure A.4: Compare Implied vs. guessed interest rate