Estimating a Dynamic Game of State Fiscal Policies: Partisan Governments and Balanced Budgets*

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Abstract

We develop and estimate a new dynamic game of state fiscal policies under partisan governments. In our model policy-makers' preferences over expenditures and taxes systematically vary by party affiliation and are subject to idiosyncratic shocks which reflect differences over policy within a party. The state government faces a binding ex-ante balanced budget constraint. Hence, taxes are a function of expenditures as well as the business cycle. We also account for adjustment costs that arise due to institutional constraints in the budget process and political gridlock. Our estimation approach exploits first-order conditions that optimal expenditures must satisfy along the equilibrium path. It also exploits a forward simulation algorithm to compute the value functions and their derivatives based on the estimated policy functions. We estimate the model using a panel of 45 states during the past three decades. Our empirical results provide new insights into the systematic effects of partisan government on state fiscal policies. Our results suggest that adjustment costs are large and primarily reflect institutional constraints on the budget process. It takes up to eight years to adjust expenditures from one party's bliss point to the other party's bliss point. Our policy counterfactuals suggest that the impact of increased polarization on the volatility of expenditures may be dampened by institutional constraints.

Keywords: State Fiscal Policies, Balanced Budget Requirements, Polarization, Adjustment Costs, Estimation of Dynamic Games, Forward Iteration Algorithm.

1 Introduction

Partisan control of government systematically influences state spending and taxation levels in the U.S. (Alt and Lowry, 2000). This raises critical questions: if voters seek to alter the size of the state government by changing the ruling party, how significant can the resulting fiscal changes be, and how quickly might they occur? Furthermore, how do institutional constraints, such as balanced budget requirements, shape the pace of these policy adjustments? Despite substantial research on the relationship between political control and fiscal policy, these questions remain insufficiently understood. To address this gap, we develop and estimate a new dynamic model of state fiscal policies under partisan governments, providing fresh insights into these important research questions.

We develop a new dynamic game that considers an economy in which policymakers with different preferences alternate in office as a result of competitive elections. Preferences over taxes and expenditures systematically vary by party affiliation and are subject to random shocks which reflect differences in preferences over fiscal policies within a party. Competitive elections determine the party in power. Policy makers are rational and forward-looking and understand that future policy-makers may have different preferences than themselves. As a consequence, policy choices not only reflect the desire to implement policies that are close to the ideal point of the policy-maker but also reflect a strategic desire to influence the policies of future policy-makers.

Our model differs from previous dynamic games in political economy in four important aspects.[2] First, we assume that the state government faces a balanced budget constraint. Almost all states in the U.S. have constitutional or statutory limitations

[2]See Duggan and Martinelli (2017) for a recent survey.

restricting their ability to run deficits in the state's general fund.[3] Hence, there is no scope for strategic debt policies in our model.[4] With a balanced budget requirement, tax rates are a function of expenditures and the state of the economy (business cycle). Second, we assume that each government faces adjustment costs, which are a function of previous policies and may depend on the institutional environment. Moreover, adjustment costs may vary across the election cycle which provides strategic opportunities for policy-makers to make larger adjustments when adjustment costs are lower. Each government cannot easily implement its bliss point as a fiscal policy since adjustment costs matter. As a consequence, the current policymaker's decisions are constrained by the policies of previous governments. Hence, the evolution of fiscal policies is sluggish.[5] Third, we explicitly model the four periods in each term of an administration. In our model, parties face different incentives in election years than in non-election years. This feature of the model allows us to endogenously generate a political business cycle for expenditures. Political business cycles may also arise if expenditure policies influence the incumbent's reelection probability. Finally, there is a disagreement between current and future policymakers. Hence, electoral changes imply volatility in fiscal policies. Moreover, adjustment costs imply that current expenditures are strategically used by each government to influence the choices of its successors.[6] Disagreement amongst alternating policymakers and uncertainty about who will be appointed in the future prevent the current government from implement-

[3]Balanced budget limitations may be either prospective (beginning-of-the-year) requirements or retrospective (end-of-the-year) requirements. In addition, most states require that the government has to set aside a certain fraction of revenues for a rainy day fund. The seminal paper on the impact of budget rules on state fiscal policies is Bohn and Inman (1996). For a more recent discussion of the literature see Rueben, Randall and Boddupalli (2018).

[4]Important early papers that study debt policy with a partisan model are Alesina and Tabelini (1999) and Persson and Svensson (1999). More recent papers are Song, Storresletten and Ziliboti (2008) and Battaglini and Coate (2008)

[5]Differences in adjustment costs could also be the result of a divided government. See Alesina and Rosenthal (1996), for a formal analysis of divided government.

[6]This strategic component of policy also arises in models of debt policy where debt may be used to tie the hands of future governments.

ing its preferred policies. Instead, the model inherently generates an overshooting mechanism in which policymakers tend to prefer policies that are more extreme than their bliss points.

To estimate the magnitude of these effects, we turn to quantitative analysis. We show that a flexible specification of the model can be estimated based on moment conditions, which can be derived from the optimality conditions that expenditures have to satisfy in equilibrium.[7] The error of the model can be interpreted as a preference shock that temporarily shifts the bliss point of the current policy maker. Since parties are forward-looking in our model, one key econometric challenge arises because the first-order conditions depend on the level and the derivative of the value functions of policymakers from both parties. A full solution nested fixed point algorithm – in the spirit of Rust (1987) – is computationally challenging.[8] Hence, we follow Bajari, Benkard and Levin (2007) and use a forward-simulation approach to compute the value functions and its derivatives.[9] This approach ultimately rests on our ability to estimate the policy functions of both parties before estimating the parameters of the structural model.

We estimate the model using expenditure data from 45 U.S. states for the period 1990-2018.[10] One problem encountered in matching the model to the data is that our dynamic game is stationary while the data exhibit significant stochastic growth. Hence, we need to detrend that data, a problem that is commonly encountered in macroeconomic business cycle analysis. Here we follow the quantitative literature in time series econometrics and explore different filtering algorithms such as the HP

[7]The estimation of dynamic non-linear model based on first order conditions is dues to Hansen and Singleton (1982). It was extended to the context of dynamic games by Berry and Pakes (2000).

[8]Doraszelski and Pakes (2007) for a survey on how to solve dynamic games.

[9]Hotz, Miller, Sanders and Smith (1994) proposed a forward simulation estimator for dynamic discrete choice models.

[10]This period follows the realignment of the two major parties in the U.S. that followed the passage of the civil rights legislation.

filter and the Hamilton filter.[11] We show that our main findings are robust to the specifics of the detrending algorithm.

Our empirical results confirm that tax and expenditure policies are shaped by the political conflict between the two parties in the U.S. In particular, we find that differences in bliss points among parties are statistically significant and economically meaningful. However, the estimated magnitude of the differences in bliss points is smaller than one might expect given the large degree of polarization between parties at the federal level. Preferences are decreasing in tax rates which most likely reflects voters aversion to taxation. Our findings thus indicate that state expenditure policies are less polarized than federal fiscal policies in the U.S. This moderation is likely due to the fact that balanced budget requirements force parties to pay for expenditures on a pay-as-you basis, i.e. the state governments, in contrast to the federal government, are severely limited in their abilities to pass the tax burden to future generations by issuing debt. An increase in expenditures, holding economic conditions fixed, needs to be financed by an increase in tax rates. Our empirical results suggest that these tax increases impose significant costs on both parties.

We also find that the party-specific preference shocks are large. These reflect variations in policy over time that cannot be explained by economic shocks. These shocks partially reflect differences in preferences within parties and administrations of the same party (i.e. different governors from the same party) as previously documented by Sieg and Yoon (2017). We also investigate how fast policies adjust to new partisan fiscal targets after changes in party control. We find that adjustments are quite sizable. It takes up to eight years to adjust expenditures from one party's bliss point to the other party's bliss point.

[11] Hodrick and Prescott (1981) and Hamilton (2018). These procedures are preferable to using just a combination of state time fixed effects which ultimately rests on the assumption that states face common business cycles which is not that plausible.

We find some compelling evidence that expenditures are larger in election years, which can be rationalized by assuming that reelection probabilities depend on the budgeted expenditures. Voters reward incumbents for higher expenditures, which provides some incentives to the party in power to increase expenditures in election years thus generating a political business cycle. Overall, we find that that these effects are statistically significant and moderate in magnitude.

Finally, we turn to policy analysis. We find that the volatility of taxes and expenditures tends to be larger (i) the more polarization we observe among parties, (ii) the smaller the adjustment costs of policies, (iii) the flexibility states have in dealing with business cycle shocks. From a positive point of view, the results reported above contribute to explaining why different states pursue different expenditure and tax policies under similar economic conditions.

The rest of the paper is organized as follows. Section 2 presents the new dynamic game that guides our empirical investigation. Section 3 discusses identification and estimation. Section 4 provides details about the data and the detrending algorithms used in this paper. Section 5 discusses the estimation of the policy functions. Section 6 provides the key empirical results. Section 7 focuses on policy analysis. Section 8 concludes and discusses future research. The appendices provide additional detail about the computational and estimation approach taken in this paper.

2 A Dynamic Game of Fiscal Policies under Partisan Governments and Balanced Budget Constraints

We consider a dynamic game of state government spending and taxation under a balanced budget rule. There are two parties that have conflicting preferences over expenditures and taxes and compete in competitive elections. The party in power implements fiscal policies facing a balanced budget constraint. Parties are forward-looking and infinitely lived, and understand that future policy-makers may have different objectives. We assume that each government faces adjustment costs, which are a function of previous policies and may depend on the institutional environment. Disagreement amongst parties and uncertainty about which party will hold office in the future prevent the current government from implementing its preferred policies.

2.1 Parties and Elections

We consider a stationary dynamic game with two infinitely lived players (parties), denoted by Republicans R and Democrats D. Time is discrete $t = 1, 2, ..., \infty$. Elections are held every four years, while fiscal policies (taxes and expenditures) are determined annually. Let Δ_t denote the time left until the next general election. Note that $\Delta_t \in \{3, 2, 1, 0\}$ and that $\Delta_t = 0$ denotes election years, while $\Delta_t \neq 0$ denotes non-election years. Let P_D (P_R) denote the reelection probability, i.e. the probability that a Democratic (Republican) administration wins reelection.[12] Define the state of the political world $\omega_t \in \{D, R\}$, which indicates which party is in power at time t.

[12] In the first period of the model the election outcome is determined by an unconditional election probability.

2.2 The Budget Process

Each period the party that is in power controls the government and determines the budgeted spending level s_t and a proportional income tax rate τ_t. There is a one-period lag in the budgeting process. The budgeted spending in t determines the expenditures in $t+1$.

To incorporate business cycle shocks, let us assume that income y_t follows a first-order Markov Process. In our application, we assume income follows an AR(1) process:

$$y_t = \alpha_y + \rho_y y_{t-1} + \epsilon_y \tag{1}$$

where ρ is the autocorrelation parameter.[13]

We consider the case of a soft or ex-ante balanced budget requirement. Recall that budget decisions in t determine fiscal policies implemented in $t+1$. Income y_{t+1} is realized at the beginning of $t+1$. As a consequence, there may be an ex-post deficit or a surplus at the end of the budget period. To deal with the problem of ex-post deficits and surpluses, we assume that the government operates a small rainy day fund.[14] The rainy day fund is financed by a (small) income surcharge denoted by δ_τ. This fund is then used to account for any unexpected surpluses or deficits at the end of the period.

Incorporating the rainy day fund into the budget process, expenditures and taxes need to satisfy the following ex-ante balanced budget constraint:

$$s_t \;=\; \tau_t\, E[(1-\delta_\tau)\, y_{t+1}|y_t] \tag{2}$$

[13] Note that $E[y_t] = \frac{\alpha_y}{1-\rho_y}$, $Var[y_t] = \frac{\sigma_y^2}{1-\rho_y^2}$, $E[y_t|y_{t-1}] = \alpha_y + \rho_y y_{t-1}$.

[14] Rainy day funds are also used in practice to cover unforeseen expenditures that are not explicitly modeled here.

which implies that the balanced-budget tax rates are given by:

$$\tau_t(s_t, , y_t) \quad = \quad \frac{s_t}{E[(1-\delta_\tau)\ y_{t+1}|y_t]} \tag{3}$$

Thus, taxes are given by a function of expenditures that is strictly monotonically increasing conditional on the expected state of the economy.

Define $\tilde{\tau}_t$ to be the tax rate that finances the expenditures s_t in steady state, i.e. $\tilde{\tau}_t^s$ is given by:

$$\tilde{\tau}_t(s_t) \quad = \quad \frac{s_t}{E[(1-\delta_\tau)\ y_{t+1}]} \tag{4}$$

We can think of $\tilde{\tau}_t$ as the balanced-budget tax rate in the absence of economic shocks, i.e. as the tax rate that decentralizes expenditures if income in the economy is at the mean. The gap between actual and steady state tax rates is denoted by $\tau_t - \tilde{\tau}_t$. This gap captures the costs (benefits) associated with financing the preferred expenditures due to higher (lower) than expected tax rates.

The management of the rainy day fund is completely passive in our model.[15] Let a_{t+1} be the stock of assets at the end of $t+1$ in the rainy day fund, i.e. after the budget deficit or surplus has been realized. Hence, the law of motion for the balance of the rainy fund is given by

$$a_{t+1} \quad = \quad \tau_t\ (1-\delta_\tau)(y_{t+1} - E[y_{t+1}|y_t]) \ + \ (1+r)\ a_t + \delta_\tau y_{t+1} \tag{5}$$

If there is a positive shock, $(y_{t+1} - E[y_{t+1}|y_t] > 0)$, then the government saves and accumulates assets in the rainy day fund. If there is a negative shock $(y_{t+1} - E[y_{t+1}|y_t] < 0)$, the government runs a deficit and decreases the amount of assets in the rainy day

[15] Hence, while a_t is a state variable it does not affect the decisions of the parties.

fund. If assets are negative, the government is in debt.[16]

2.3 Flow Utilities and Adjustment Costs

We assume that each party has preferences defined over spending s_t and the income tax rate τ_t. We adopt a spatial model and assume that each party j has a bliss point denoted by s_{jt}. The bliss points of both parties are not constant but are subject to idiosyncratic shocks. Hence, we adopt the following specification:

$$s_{jt} \;=\; s_j \;+\; \epsilon_{jt}, \tag{6}$$

Note that ϵ_{jt} is an i.i.d. shock.[17] It is plausible to conjecture that $s_D > s_R$. Hence, there is a partisan conflict over expenditure and tax policies.

We assume that preferences are quadratic in the gap between expenditures and the bliss point and linear in the gap between actual and steady state tax rates. Hence, preferences can be written as:

$$\tilde{B}_j(s_t, \tau_t, \tilde{\tau}_t, \epsilon_{jt}) = -\frac{1}{2}\left(s_t \;-\; s_{jt}\right)^2 \;-\; \eta_j \left(\tau_t \;-\; \tilde{\tau}_t\right) \tag{7}$$

where $\eta_j > 0$ reflects the aversion of party j (and tax payers) to higher levels of taxation.

Substituting the budget constraint and the definition of the balanced budget tax

[16] Our numerical simulations suggest that a very small value of δ_τ is sufficient that the government does not accumulate any debt in the long-run.

[17] In the empirical model, we assume that the shocks are normally distributed with zero mean and constant party-specific variance.

rates into the flow utility function, we obtain the balanced-budget preferences:

$$
\begin{aligned}
B_j(s_t, y_t, \epsilon_{jt}) &= \tilde{B}_j(s_t, \tau_t(s_t, y_t), \tilde{\tau}_t(s_t), \epsilon_{jt}) \\
&= -\frac{1}{2}\,(s_t - s_{jt})^2 \;-\; \eta_j \left(\frac{s_t}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{s_t}{E[(1-\delta_\tau) y_{t+1}]} \right)
\end{aligned} \tag{8}
$$

Note that the balanced budget preferences only depend on s_t, y_t and ϵ_t since the tax rates are completely determined by equation (3). Balanced budget preferences vary over the business cycle. Holding expenditures fixed, preferences increase in boom periods and decrease in recessions. This reflects the fact that, holding expenditure fixed, tax rates have to be higher in a recession and lower in an expansion, as implied by equation (3). Also note that s_j maximizes the flow utility of party j if $\epsilon_{jt} = 0$ and income is at the mean. In that sense s_j is the bliss point of party j.

Another key feature of the model is that adjustments of spending are sluggish and subject to costs. In addition to balanced budget requirements, most states have tax and expenditure limits which cause friction in the adjustment of both spending and tax policies. We assume that the magnitude of these adjustment costs is party-specific. Let us denote this cost function by:

$$
C_j(s_t, s_{t-1}) = \frac{\alpha_j}{2}\,(s_t - s_{t-1})^2 \tag{9}
$$

where α_D and α_R measure the magnitude of the adjustment costs.[18]

We assume that the adjustment costs are only borne by the party in power. Hence, the flow-utility of party j is given by:

$$
U_j(\omega_t, s_t, s_{t-1}, y_t, \epsilon_{jt}) = B_j(s_t, y_t, \epsilon_{jt}) \;+\; 1\{\omega_t = j\}\,(\kappa \;-\; C_j(s_t, s_{t-1})) \tag{10}
$$

[18] Without adjustment costs each party would implement its bliss point each period.

where κ denotes the benefits of holding office. We assume that the benefits of holding office are sufficiently high to compensate the party in power for the adjustment costs.

Parties are forward-looking maximizing expected lifetime utility with a constant discount factor β.

2.4 The Timing of Decisions and Equilibrium

To close the model, we assume that the budget decision is made before the election. The timing of decisions within any period t is then as follows:

1. Income y_t and preference shocks $(\epsilon_{Dt}, \epsilon_{Rt})$ are realized.

2. The party that is power determines s_t.

3. If $\Delta_t = 0$ an election is held which determines ω_{t+1}.
   If $\Delta_t > 0$, the ruling party stays in power, and hence $\omega_{t+1} = \omega_t$.

We restrict attention to a Markov Perfect Equilibrium in pure strategies. Let $\mu_j(s_{t-1}, y_t, \epsilon_{jt}, \Delta_t = i)$ denote the equilibrium strategy of party $j \in \{D, R\}$ and $i \in \{0, 1, 2, 3\}$.

2.5 Optimal Decisions in Equilibrium

Next, we characterize the decision problems faced by the parties and derive the first-order conditions that hold in equilibrium. To accomplish this task, it is useful to solve the model starting in the last period of the term, i.e. $\Delta_t = 0$. Assume for the sake of concreteness that a Democratic administration is in power $\omega_t = D$. (The case of a Republican administration is symmetric.) Note that the budget decision s_t is made before the election outcome is known. We can, therefore, express the optimization problem recursively as:

$$
\begin{aligned}
V_D(D, s_{t-1}, y_t, \epsilon_{Dt}, \Delta_t = 0) \;&=\; \max_{s_t} \Bigg\{ B_D(s_t, y_t, \epsilon_{Dt}) - C_D(s_t, s_{t-1}) + \kappa \\
&+\; \beta \Big[P_D \; E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)] \\
&+\; (1 - P_D) E_t[V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)] \Big] \Bigg\}
\end{aligned} \tag{11}
$$

where $s_{t+1} = \mu_R(s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta = 3)$. Expectations are with respect to future income y_{t+1} and future preference shocks ϵ_{Dt+1} and ϵ_{Rt+1}. All expectations are conditional on t. The expected value functions are therefore given by

$$
\begin{aligned}
E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)] \;&=\; \int V_D(D, s_t, y_t, \epsilon_{Dt+1}, \Delta_{t+1} = 3) \\
&\quad f(y_{t+1}|y_t) \; f(\epsilon_{Dt+1}) \; dy_{t+1} \; d\epsilon_{Dt+1} \\
E_t[V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)] \;&=\; \int V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3) \\
&\quad f(y_{t+1}|y_t) f(\epsilon_{Rt+1}) \; f(\epsilon_{Dt+1}) \; dy_{t+1} \; d\epsilon_{Rt+1} \; d\epsilon_{Dt+1}
\end{aligned} \tag{12}
$$

Since the Democrats are in power, the Republicans are in opposition and, therefore, do not make any decisions with respect to government spending in this period. The value function of the Republicans can be recursively defined as:

$$
\begin{aligned}
V_R(D, s_t, y_t, \epsilon_{Rt}, \Delta_t = 0) \;&=\; B_R(s_t, y_t, \epsilon_{Rt}) \;+\; \beta \Big[P_D \; E_t[V_R(D, s_{t+1}, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)] \\
&\quad + (1 - P_D) \; E_t[V_R(R, s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)] \Big]
\end{aligned} \tag{13}
$$

where $s_{t+1} = \mu_D(s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_t = 3)$. Again, the expectations can be written as

$$\begin{aligned} E_t[V_R(R, s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)] &= \int V_R(R, s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)\ f(y_{t+1}|y_t) \\ &\quad f(\epsilon_{Rt+1})\ dy_{t+1}\ d\epsilon_{Rt+1} \\ E_t[V_R(D, s_{t+1}, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)] &= \int V_R(D, s_{t+1}, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3) f(y_{t+1}|y_t) \\ &\quad f(\epsilon_{Dt+1})\ f(\epsilon_{Rt+1})\ dy_{t+1}\ d\epsilon_{Dt+1}\ d\epsilon_{Rt+1} \qquad (14) \end{aligned}$$

The first-order condition for optimal spending of the Democrats is given by:

$$\begin{aligned} 0 \;=\; & -(s_t - s_D - \epsilon_{Dt}) \;-\; \eta_D \left(\frac{1}{E[(1-\delta_\tau) y_{t+1}|y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \;-\; \alpha_D\ (s_t - s_{t-1}) \\ & + \beta \left\{ P_D\ E_t \left[\frac{\partial V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_t} \right] \right. \qquad (15) \\ & \left. \quad + (1 - P_D)\ E_t \left[\frac{\partial V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_{t+1}} \frac{\partial s_{t+1}}{\partial s_t} \right] \right\} \end{aligned}$$

where

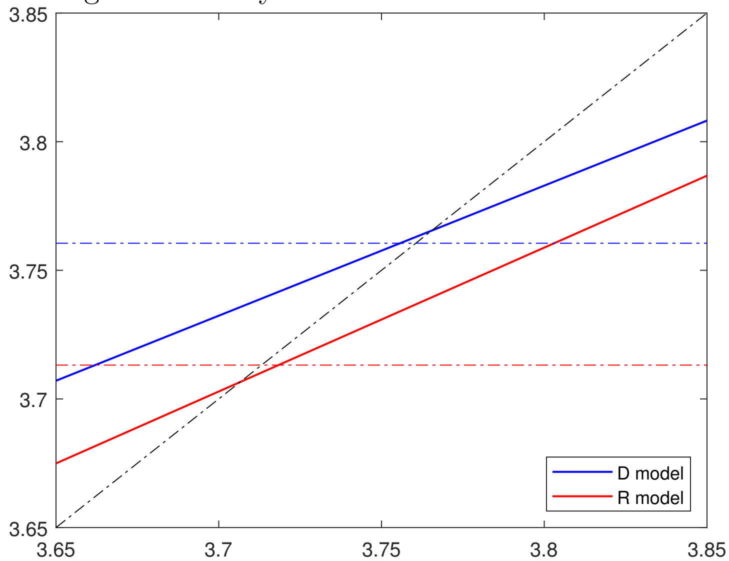
$$\frac{\partial s_{t+1}}{\partial s_t} = \frac{\mu_R(s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = 3)}{\partial s_t} \qquad (16)$$

Note that the previous equation captures the effect that a Democratic administration can tie the hands of future Republican administrations by increasing spending. Because of the adjustment costs the future Republican administration will have to incur costs to undo the spending increases implemented by the previous Democratic administration. This effect thus captures the strategic interaction and competition among the parties.

Figure 1 illustrates the policy functions in our model during an election period.[19]

[19]We use the estimated parameters from Column I of Table 4.

Figure 1: Policy Function in an Election Year



from o The two functions are given by the blue and red solid lines. The dashed line represents the bliss point of the party (assuming that the idiosyncratic shock is zero and income is at the mean.) The black line indicates the 45-degree line. Without any strategic aspects, the policy functions would intersect the 45-degree line at the bliss points. However, Figure 1 shows that this is not the case. Instead, the strategic aspect of decision-making implies an overshooting mechanism: Democrats tend to favor expenditures exceeding their bliss point in election years, while Republicans prefer policies below their bliss point. This overshooting arises because policies are set before the election outcome is known. Each party, anticipating the possibility of losing the election, rationally adopts slightly more extreme policies to constrain the next government's actions. Notably, this overshooting effect becomes more pronounced when adjustment costs are high, as our estimation results demonstrate (discussed further below).

Next, we consider decisions in non-election years. Hence, we know that $\Delta_t = i > 0$ (i.e. $i = 1, 2, 3$). Since there are no elections during this period, there is no uncertainty regarding the party that will be in power next period. Again, we can express the optimization problem of the Democrats recursively as:

$$\begin{aligned} V_D(D, s_{t-1}, y_t, \epsilon_{Dt}, \Delta_t = i) &= \max_{s_t} \Big\{ B_D(s_t, y_t, \epsilon_{Dt}) - C_D(s_t, s_{t-1}) + \kappa \\ &+ \beta\, E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = i-1)] \Big\} \end{aligned} \tag{17}$$

The first-order condition for the Democratic party is now given by:

$$\begin{aligned} 0 \;=\; & -(s_t - s_D - \epsilon_{Dt}) \;-\; \eta_D \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \;-\; \alpha_D\, (s_t - s_{t-1}) \\ & + \beta\;\; E_t \left[\frac{\partial V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = i-1)}{\partial s_t} \right] \end{aligned} \tag{18}$$

The main difference between equation (18) and equation (15) is that there are only two instead of three terms in the first-order condition. The Democrats know that they will be in power the next period. The Republican party is again in opposition and passive. Hence, we have:

$$\begin{aligned} V_R(D, s_t, y_t, \epsilon_{Rt}, \Delta_t = i) &= B_R(s_t, y_t, \epsilon_{Rt}) \\ &+ \beta\, E_t[V_R(D, s_{t+1}, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i-1)] \end{aligned} \tag{19}$$

where $s_{t+1} = \mu_D(s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_t = i-1)$.

2.6 Endogenous Reelection Probabilities

We have seen that our model generates an overshooting mechanism in election years. We can also generate a political business cycle by assuming that the reelection probability is endogenous and depends on the budgeted spending chosen by the administration. To illustrate let $P_D(s_t)$ denote the probability that the democratic party will be re-elected in the next election. Thus the election probability is endogenous and depends on the policy choices at the beginning of the period. In our application, we assume the following functional form for each party $j \in \{D, R\}$:

$$P_j(s_t) = \frac{\exp(\lambda_{0j} + \lambda_{1j} s_t)}{1 + \exp(\lambda_{0D} + \lambda_{1D} s_t)} \tag{20}$$

If $\lambda_{1j} > 0$ voters reward the party in power for high expenditures. In this case, the overshooting and the reelection effect go in the same direction for Democrats and in opposite directions for Republicans. If $\lambda_{1j} < 0$ voters punish the party in power for high expenditures. In that case, the overshooting and the reelection effects go in opposite directions for Democrats and in the same direction for Republicans.

Assuming an interior solution, the first-order condition that characterizes optimal spending for Democrats is given by:

$$\begin{aligned}
0 \;=\; & -(s_t - s_D - \epsilon_{Dt}) \;-\; \eta_D \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \;-\; \alpha_D \, (s_t - s_{t-1}) \\
& + \beta \left\{ P_D \; E_t \left[\frac{\partial V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_t} \right] \right. \\
& \qquad \left. + (1 - P_D) \; E_t \left[\frac{\partial V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_{t+1}} \frac{\partial s_{t+1}}{\partial s_t} \right] \right\} \\
& + \frac{\partial P_D(s_t)}{\partial s_t} E_t \Big[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3) - V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3) \Big] \Big\}
\end{aligned} \tag{21}$$

The first three terms are as in the baseline model above. The fourth and last term captures the strategic incentives that are generated by the endogenous reelection probability.

2.7 Computation of Equilibria

In general, the equilibria of this model can only be computed numerically. The detailed procedure for computing equilibrium strategies is provided in Appendix A. It is worth noting that exact solutions are possible for some versions of the model, particularly when the value functions are quadratic in the state variables, resulting in linear policy functions. For more complex cases, our algorithm can be used to approximate equilibria. With this framework established, we now turn to the estimation of the model parameters.

3 Estimation

The structural parameters of the model are the parameters of the AR(1) process for income, the variances of the preferences shocks (σ_D^2 and σ_R^2), the parameters of the preferences ($s_D, s_R, \alpha_D, \alpha_R, \eta_D, \eta_R, \kappa$), and the parameters of the reelection probabilities, ($\lambda_{D0}, \lambda_{D1}, \lambda_{R0}, \lambda_{R1}$). Note that the parameters of income process and the parameters of the reelection probabilities can be estimated outside the model. We can estimate the remaining structural parameters of the model based on the orthogonality conditions that are derived from the first-order conditions that optimal spending needs to satisfy in equilibrium. Consider our extended model. Rearranging terms, we can rewrite the optimality condition for the last term ($\Delta_t = 3$) of a Democratic administration as:

$$\begin{aligned}
\epsilon_{Dt} \;=\; & (s_t - s_D) \;+\; \eta_D \left(\frac{1}{E[(1-\delta_\tau)y_{t+1}|y_t]} - \frac{1}{E[(1-\delta_\tau)y_{t+1}]} \right) \;+\; \alpha_D \,(s_t - s_{t-1}) \\
& -\beta \left\{ P_D(s_t)\; E_t \left[\frac{\partial V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_t} \right] \right. \\
& \quad +(1 - P_D(s_t))\; E_t \left[\frac{\partial V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)}{\partial s_{t+1}} \frac{\partial s_{t+1}}{\partial s_t} \right] \\
& \left. + \frac{\partial P_D(s_t)}{\partial s_t} E_t \Big[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3) - V_D(R, s_{t+1}, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3) \Big] \right\}
\end{aligned} \tag{22}$$

Recall that parties are forward-looking and recognize that future policy-makers may have different preferences than they have. As a consequence, the first-order conditions depend on the levels and derivatives of the value functions of policymakers from both parties.

We assume that preference shocks satisfy the following standard conditional moment assumption:

$$E[\epsilon_{jt}|s_{t-1}, y_t, \Delta_t] \;=\; 0 \quad j = D, R \tag{23}$$

Preference shocks are purely idiosyncratic and uncorrelated with lagged spending and current income. They are i.i.d. across time and parties. We also account for the fact that each administration serves four terms which produce slightly different orthogonality conditions.

It is well-known that it is difficult to construct an efficient IV estimator for non-linear models (Newey, 1990). As a consequence, we convert the conditional moment restrictions into a sufficiently large number of unconditional moment restrictions. The details of this procedure are discussed in Appendix C. Hence, the structural parameters of the model are identified and can be estimated with a GMM estimator, if the value functions and their derivatives can be computed by the econometrician.[20]

The natural starting point to construct a feasible estimator is to use a full-solution nested fixed-point algorithm in the spirit of Rust (1987). However, this approach is computationally challenging since there are three continuous state variables that enter each party's value functions.[21] As such, it is desirable to adopt an estimation approach that is computationally less demanding. The basic idea here is that we can estimate the policy functions based on the observed data. We then use a forward simulation algorithm suggested by Bajari, Benkard, and Levin (2007) to compute the value functions and their derivatives. We find that this approach works well for our model specifications and that the approximations of the value functions and their derivatives are accurate. For details about the forward simulation algorithm see Appendix B.

To implement the forward simulation strategy, we need to overcome one additional identification problem. To illustrate this problem, let us, for simplicity, ignore the fact that the policy functions depend on the term i. Moreover, let us conjecture that the policy function of each party is approximately linear. Our computational analysis suggests that this is a reasonable conjecture for many specifications of our model. Hence, the policy function of Democrats can be written as:

$$s_t \;=\; \mu_D(s_{t-1}, y_t, \epsilon_{Dt}) \;=\; c_{D0} + c_{D1}\, s_{t-1} + c_{D2}\, y_t + c_{D3}\, \epsilon_{Dt} \tag{24}$$

and a similar equation holds for Republicans. It should be clear that the coefficient c_{D3} and the variance of the error term σ_D^2 are not separately identified in the reduced-form

[20] The estimation of dynamic non-linear model based on first order conditions is due to Hansen and Singleton (1982). Berry and Pakes (2000) discuss how to estimate dynamic games based on first-order conditions.

[21] For a discussion of how to solve dynamic games see, for example, Pakes and Doraszelski (2007) and Aguirregabiria, Collard-Wexler and Ryan (2021).

regression model above since the variance of the regression model is $\sigma_D^2 c_{D3}^2$. Hence, we can only identify the product of the two parameters from the regression model (24). To separately identify both parameters, note that σ_D^2 is also identified from the conditional variance of the first-order condition in equation (22). We can, therefore threat c_{D3} and c_{R3} as nuisance parameters during the structural estimation algorithm. Given values of σ_D^2 and σ_R^2, the slope parameter of the policy functions c_{D3} and c_{R3} are identified from the residual variance regression model in equation (24). We, therefore, need to add some orthogonality conditions to our GMM objective functions that are based on the residual variances of the first-order conditions.

We offer two additional observations. First, we only match the unconditional reelection probabilities when we apply the estimator to our data. We could also match the conditional reelection probabilities. However, we find that our reduced-form estimates of the marginal effects are noisy. As a consequence, we just verify ex-post that the structural estimates of the marginal effects are with a 95 percent confidence interval of the reduced-form estimates. Instead, we could impose these conditions ex-ante by adding two moment inequalities to the objective function. This procedure then makes sure that the parameters λ_{j1} are estimated based on the reduced form election probabilities and are consistent with the political business cycle of the expenditures observed in the data.

Second, the benefits of holding office, denoted by κ, need to large enough so that each party prefers to be in office, i.e. the benefits of holding office have to be larger than the adjustment costs along the full equilibrium bath. There is some scope for identifying κ in the extended model with endogenous reelection probabilities since the first-order conditions for optimal spending depend on the difference of the levels of the value functions, and hence on κ. In theory we could estimate κ. In practice, it is easier to calibrate κ so that the 95th percentile of adjustment costs is smaller than κ. We also estimated the model using other reasonable values for κ. All findings reported in this paper are robust to reasonable changes in κ.

In summary, we have shown that we can estimate the parameters of our dynamic game using a sequential estimator. First, we estimate the reduced-form policy functions in equation (24). Our estimation approach, therefore, conditions on the equilibrium that generated the data. Thus, our estimator does not rely on the fact the equilibria have to be unique for our model. Second, we construct a GMM estimator (Hansen,1982) for the structural parameters of the model that is based on moment conditions, which can be derived from the optimality conditions that expenditures have to satisfy in equilibrium. For computational tractability, we adopt a forward-simulation approach to compute the value functions and their derivatives. This approach exploits the fact that the estimated policy functions are known (up to a normalization) to the econometrician.[22]

4 Data

All U.S. states have constitutional or statutory limitations restricting their ability to run deficits in the state's general fund. Balanced budget limitations may be either prospective (beginning-of-the-year) requirements or retrospective (end-of-the-year) requirements. Importantly, the state limits apply only to the general fund, leaving other funds (capital, pensions, social insurance) as potential sources for deficit financing. We, therefore, focus on general fund expenditures in this paper.

Our dataset is based on all gubernatorial elections between 1990 and 2018 in the United States. Our sample is based on the 45 states excluding Alaska, Nebraska (which has a unicameral legislature), New Hampshire, Vermont, and Rhode

[22]Results from a Monte Carlo exercise a available upon request from the authors.

Island (which adopted different election cycles at least some periods between 1990 and 2018). We thus have a sample size equal to $N\ T = 45\ 29 = 1305$ observations. 16 administrations were headed by an independent governor and, as a consequence, our final sample is 1289. Data on the election cycle, party affiliation, and incumbency status of candidates in gubernatorial elections are based on a website called www.ourcampaigns.com. Total general expenditures, from the U.S. Census of Governments. Data on state personal income is obtained from the Bureau of Economic Analysis. We convert all variables into constant dollars using the CPI with base year 2000. Table 1 provides some descriptive statistics for our sample.

Table 1: Descriptive Statistics

	Obs	Mean	Std.	Min	Max
Expenditures	1289	3.665	0.855	1.827	7.116
Income	1289	31.204	5.308	17.606	50.523
Democrats	1289	0.423	0.495	0	1
Election Year	1289	0.242	0.428	0	1
Change in Administration	313	0.335	0.473	0	1

Income and expenditures are measured in \$1000.

One problem encountered in matching the model to the data is that our dynamic game is stationary while the data exhibit significant stochastic growth. Hence, we need to de-trend the data, a problem that is commonly encountered in macroeconomic business cycle analysis. Here we follow the quantitative literature in time series econometrics and explore different filtering algorithms.

We primarily use the HP filtering to remove any state-specific trends in per capita expenditure and personal income.[23] When we remove state-specific trends, we consider four different values of the HP smoothing parameter (1600, 400, 100, 25). We compute a different trend for each state. Hence, we allow each state to have different

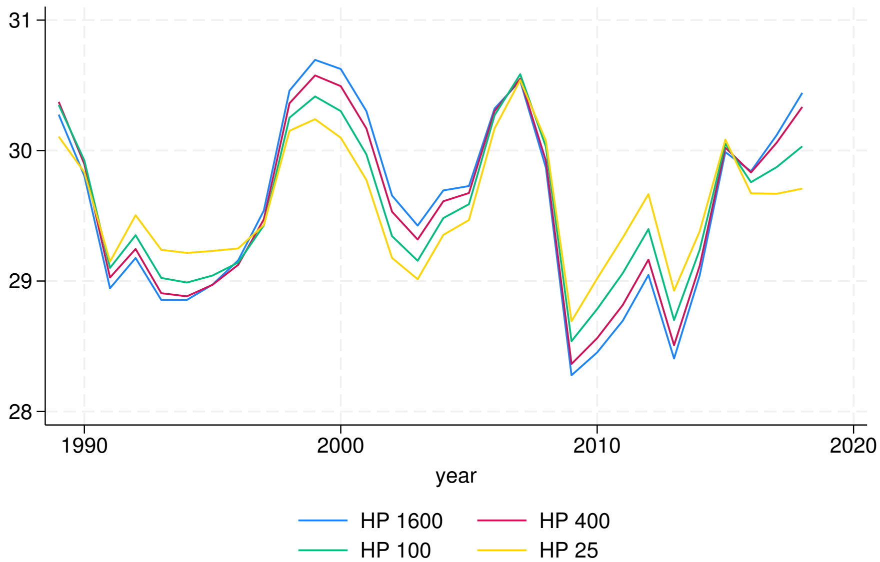
[23] We also experimented with Hamilton's (2018) filter and found similar results.

economic trends during the period that we study. Overall, this procedure generalizes the standard time and state fixed effect procedure which imposes fairly strong assumptions on the aggregate trends among states.

Figure 2: Weighted Real State Expenditure Per Capita (Detrended)

Overall, the qualitative business cycle patterns are similar for different smoothing papers. However, the magnitude of the fluctuations depends on the choice of the smoothing parameter. Figures 2 and 3 illustrate this finding and show the weighted average of the de-trended expenditure and income data. We adopt a bandwidth of 400 for our main analysis which is an intermediate value of the smoothing parameter. However, we also show that the main findings are fairly robust to other choices of the smoothing parameter.

Figure 3: Weighted Real State Income Per Capita (Detrended)



5 Empirical Results: Policy Functions

We estimated a number of different specifications of the policy functions of both parties. Our most relevant specifications are shown in Table 2. Column I only includes party dummies. Column II adds election year dummies for regular election years. Column III adds lagged expenditures, while Column IV also includes income and thus includes all our state variables.

Overall, we find significant differences in policy functions among the parties. Column I suggests that average unconditional differences in expenditures are $47 per capita. These differences are smaller than one may have expected given the polarized nature of politics in U.S. states. We will show below that the differences in bliss points are larger than the differences in observed average spending. Column II shows that differences in spending levels are larger in election years than in non-election years. Hence, there is evidence of a political business cycle in expenditures.

Table 2: Policy Function Estimates

	I	II	III	IV
	Expenditure	Expenditure	Expenditure	Expenditure
	HP 400	HP 400	HP 400	HP 400
Constant	3.697***	3.693***	1.588***	0.844***
	(0.00543)	(0.00622)	(0.121)	(0.191)
Dem	0.0462***	0.0417***	0.126	-0.226
	(0.00829)	(0.00950)	(0.172)	(0.278)
Rep Election		0.0180	0.0304***	0.0270***
		(0.0127)	(0.0106)	(0.0103)
Dem Election		0.0359**	0.0383***	0.0395***
		(0.0146)	(0.0121)	(0.0118)
Lagged Exp			0.567***	0.564***
			(0.0325)	(0.0317)
Lagged Exp x Dem			-0.0256	-0.0530
			(0.0461)	(0.0452)
Income				0.0256***
				(0.00516)
Income x Dem				0.0154*
				(0.00800)
Observations	1,289	1,289	1,289	1,289
R-squared	0.024	0.030	0.332	0.366

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Column III includes lagged expenditures. These should be included if adjustment costs are important. The estimate is approximately 0.57 which suggests the presence of strong autocorrelation. Hence adjustment costs are likely to be large and economically meaningful. In Column IV we also add income, which is both statistically and economically significant. Not surprisingly the coefficient is positive indicating that parties prefer to spend more in expansions than in recessions. In summary, our findings in Column IV indicate the presence of adjustment costs and the importance of controlling for the business cycle. Column IV also provides strong evidence that Democrats prefer slightly higher spending than Republicans as income increases. Column IV also suggests that both Democratic and Republican administrations prefer higher expenditures in election years than in non-election years.

We also experimented with non-linear specifications. However, none of the higher-order terms were significant. We thus conclude that a simple linear specification of the policy function in all the relevant state variables fits the data well.

We also estimated the policy functions using a value of 1600 for the HP filter which is closer to the number preferred by many business cycle analysts. Table 3 summarizes the results. Overall, the findings are similar. If anything, the differences among parties are slightly more pronounced when you use 1600 as the filtering parameter.[24]

Finally, we also explored two-way, fixed-effect panel models that are commonly used in the literature.[25] The results are summarized in Appendix D. Overall, we find that the main findings are same if we use this simpler approach that imposes common growth trends among the states in our sample.

[24]We also explored including variables that measured divided government along the lines suggested by Alt and Lowry (2000). We did not find any evidence in favor of these hypotheses during our period. Alt and Loury (2000) study expenditures between 1952 and 1995, while we focus on 1990 to 2019. The differences in periods probably explain the differences in findings.

[25]See, for example, Besley and Case (1995) for an early use of this method and Sieg and Yoon (2017) for a more recent survey of the literature.

Table 3: Policy Function Estimates: Robustness Check

	I	II	III	IV
	Expenditure	Expenditure	Expenditure	Expenditure
	HP 1600	HP 1600	HP 1600	HP 1600
Constant	3.696***	3.690***	1.288***	0.524***
	(0.00604)	(0.00691)	(0.110)	(0.174)
Dem	0.0516***	0.0482***	0.172	-0.160
	(0.00922)	(0.0106)	(0.160)	(0.251)
Rep Election		0.0222	0.0341***	0.0305***
		(0.0141)	(0.0109)	(0.0106)
Dem Election		0.0357**	0.0382***	0.0401***
		(0.0162)	(0.0125)	(0.0121)
Lagged Exp			0.648***	0.637***
			(0.0297)	(0.0288)
Lagged Exp x Dem			-0.0372	-0.0691*
			(0.0428)	(0.0418)
Income				0.0272***
				(0.00488)
Income x Dem				0.0153**
				(0.00740)
Observations	1,289	1,289	1,289	1,289
R-squared	0.024	0.029	0.421	0.459

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Parameter Estimates and Model Fit

Table 4 provides the estimates and estimated standard errors of the structural parameters of two different specifications of our model. Standard errors are estimated using a bootstrap algorithm that accounts for the fact that the income process and the policy functions are estimated sequentially. All specifications are based on the policy function reported in Column IV of 2.

We estimate the baseline model in Column I. Recall that reelection probabilities are exogenous in this model. In Column II we relax that assumption and allow for endogenous reelection probabilities. This specification provides further evidence in favor of the political business cycle hypothesis.

Table 4: Structural Parameter Estimates

		I	II
bliss	s_D	3.761	3.729
points	s_R	3.713	3.685
tax	η_D	129	136
effect	η_R	99	100
adjustment	α_D^e	1.700	1.958
costs	α_R^e	2.285	2.644
standard deviation	σ_D	0.461	0.504
preference shocks	σ_R	0.464	0.509
	λ_D^0	0.477	-2.636
reelection	λ_D^1	0	0.831
probability	λ_R^0	0.864	-2.765
	λ_R^1	0	0.979
marginal effects (λ_j^1)	D		0.194
	R		0.204

$\alpha_y = 9.350(1.0284)$, $\rho_y = 0.623(0.0351)$, $\sigma_y = 0.619(0.0237)$.

We find that the estimated bliss points differ among parties by \$48 per capita in the baseline model and \$44 in the model with endogenous election probabilities, evaluated at the mean income in the sample. Note that the (detrended) mean expenditures in our sample are \$3,710. The differences in spending are thus less than two percent of total average expenditures. However, the magnitude of differences in bliss points varies over the business cycle. The estimates of η_D and η_R suggest that spending of both parties is responsive to the business cycle. This finding is consistent with our reduced form results reported in Table 2. Our findings suggest that the difference in preferred spending between the two parties increases significantly during boom periods and decreases during recessions. An increase of the expected income by \$1,000 increases the preferred spending of Democrats by \$129 and Republicans by \$99 in the baseline model and \$136 and \$100 in the model with endogenous election probabilities.

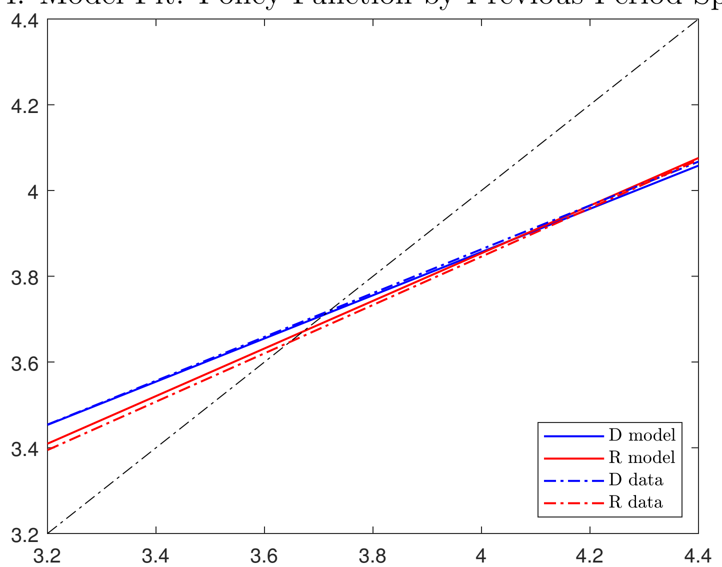
The estimates of the adjustment costs are large. Republicans have higher adjustment costs than Democrats. This stems from the fact that the estimated autocorrelation parameters reported in Table 2 are larger for Republicans than Democrats.

Comparing the estimates in Column II with those in Column I, we find some evidence in support of the hypothesis that reelection probabilities are endogenous. Our estimate that captures the slope of the reelection probability is 0.83 for Democrats and 0.98 for Republicans. Thus an increase of expenditures by \$50 yields a marginal increase in the reelection probability of approximately 1 percentage point. These results are broadly consistent with the reduced form estimated reported in Appendix E.

The estimates of the standard deviations of the preference shocks show that there are large idiosyncratic shocks to the bliss points which can easily move the bliss points by a few hundred dollars. The shocks are likely due to the fact that the identity of the governor changes with a change in the administration and more generally reflect heterogeneity in preferences within parties. It is consistent with previous results that there is a large variation in ideology within parties at the state level (Sieg and Yoon, 2017).

The model fit can be assessed by the difference between the estimated and predicted policy functions. Figure 4 plots the policy functions during the last term of an administration as a function of the lagged expenditures holding income at the median. The blue line is for a Democratic administration while the red line is for a Republican administration. The dotted lines indicate the bliss points for both parties. We find that the fit of the model is quite excellent. The differences between the policy functions generated by our model and those estimated in the previous section are small.

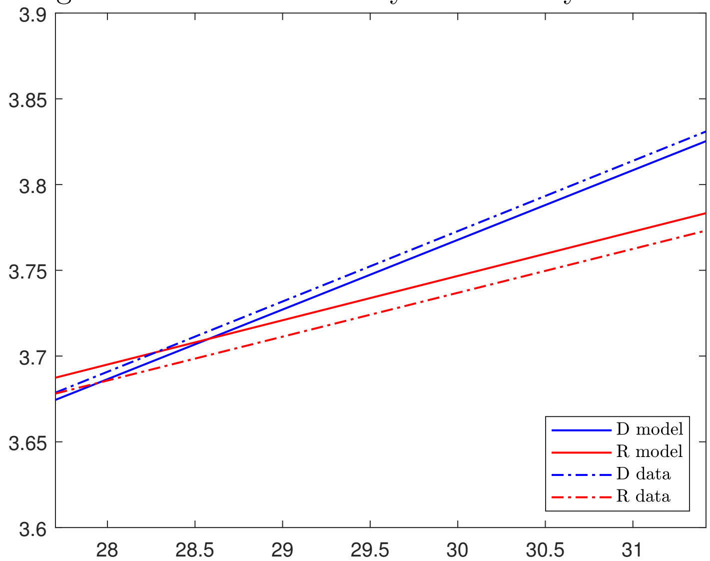
Figure 4: Model Fit: Policy Function by Previous Period Spending



The slope of both policy functions reflects the magnitude of the adjustment costs. The larger the slope, the larger the adjustment costs. Table 4 indicates that Republicans face larger adjustment costs than Democrats which then generates a steeper policy function. Thus differences in party behavior are larger the smaller the expenditures in the previous period.

Figure 5 repeats the exercise and shows the policy functions as a function of

Figure 5: Model Fit: Policy Function by Income



income. Again we find that policy functions generated by our model closely match those estimated in the previous section. The slope of the policy function is determined by the parameter η_j. As we have seen above, Democrats have a larger coefficient than Republicans. As a consequence, the slope of the Democratic policy function is larger than the one of the Republicans. This finding then implies that differences in preferred spending increase during boom periods and decrease during recessions. This result may also help to explain why we observe more polarization between parties in richer states than in poorer states.

We have seen above that there are three types of shocks in our model that generate volatility in expenditures. The first shock is an income shock which captures the impact of the economic business cycle on expenditures. The second shock is a preference shock which reflects idiosyncratic heterogeneity in preferences within parties and across time. Finally, there is a political shock which is due to the uncertainty of elections. We assess the relative importance of the three different types of shocks in our model. To accomplish this goal, we can simulate the model shutting down the different shocks. Again, we can measure the volatility of expenditures using the average standard deviation of expenditures.[26] Table 5 summarizes our findings.

Table 5: Decomposition of the Volatility of Expenditures

	bliss point shocks	income shocks	political shocks	all shocks
mean	3.71	3.71	3.73	3.73
volatility	0.131	0.040	0.022	0.151

Means and volatility are measured in $1000.

We find that idiosyncratic preference shocks account for 84 percent of the volatility. In contrast income shocks only account for 26 percent of the total volatility of expenditures. The political business cycle accounts for 14 percent of the volatility. We thus find that idiosyncratic shocks account for a larger fraction of the volatility than income or political shocks.

In summary, we conclude that our model parameter estimates are quite plausible, and the fit of the model is excellent. We, therefore, turn to counterfactual policy analysis to illustrate some of the important properties of our model.

7 Policy Analysis

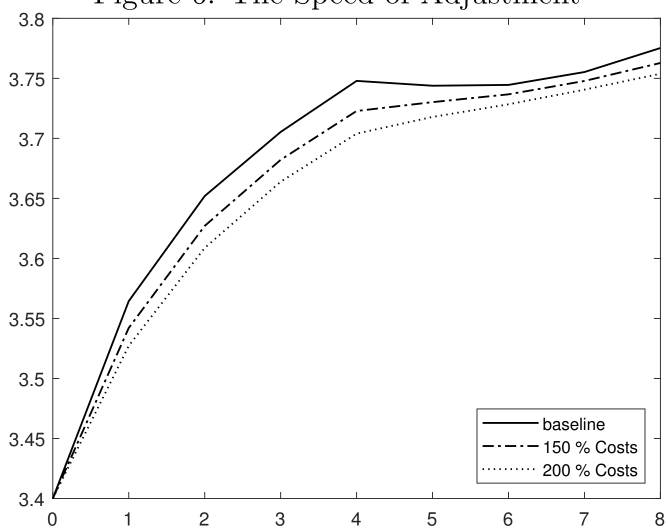
We have seen above that adjustment costs are statistically significant and economically meaningful. To illustrate the importance of adjustment costs we show in this section how they affect the speed of adjustment and the political business cycle. They also partially offset the effects of polarization.

[26] We simulate 1,000 paths over 1,000 years. The first 100 years serve as a burn-in period. I begin with the median income and expenditure, assuming the Democrats are the ruling party with $\Delta = 3$.

7.1 Institutional Barriers to the Speed of Adjustment

To illustrate the impact of adjustment costs on the speed of convergence, we consider the model with endogenous reelection probabilities as shown in Column II of Table 4. Suppose a new Democratic administration is elected and the previous expenditures are far away from the bliss point of the new Democratic administration (because the economy was in a recession). Figure 6 illustrates the expenditure path taken by the economy for three levels of adjustment costs. The path associated with the estimated adjustment costs is illustrated by the solid line in Figure 6.[27]

Figure 6: The Speed of Adjustment



We find that it takes the new Democratic administration 4 years – or one full term – to reach a level of expenditures that is approximately equal to the average bliss point. Next, we consider the case in which we increase the adjustment costs by 50 (100) percent. The path associated with the reduced adjustment costs is illustrated by the dotted lines in Figure 6. Note that the speed of adjustment decreases significantly.

[27]We use the specification in Column I of Table 4 for these exercises. We generate 10,000 simulation paths for eight years or two terms. We plot the average impulse response.

It now takes 6 to 8 years to adjust the spending levels to the target preferred by the new administration.

These adjustment costs primarily reflect institutional features of the budget process. Every state in the U.S. has some formal constraint on fiscal discretion, including requirements for governors to submit (and/or for legislatures to pass) a balanced budget, restrictions on rolling over the ex-post deficits across fiscal years, and line-item vetoes for governors. Many states also have recently acquired further restrictions on their ability to increase their sources of revenue. Finally, states have less fiscal autonomy than the federal government, because of federally mandated programs that are often not fully funded.[28] Some of these institutional features can be used by opposition parties to create gridlock.

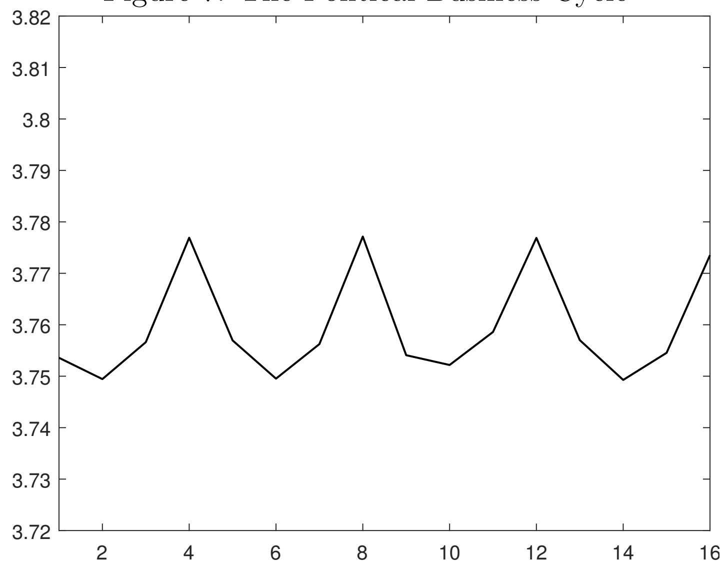
7.2 The Political Business Cycle

We find strong evidence in support of the hypothesis that both parties want higher spending levels in election years than in non-election years. Our baseline model cannot generate this pattern observed in the data. However, our extended model with endogenous reelection probabilities is consistent with this observation. This feature of the extended model is illustrated in Figure 7. Here, we simulate the expenditure path of a Democratic administration in a steady state.

We find that our model generates a political business cycle, expenditures are systematically higher in election years than in non-election years. Using the estimates in Column II of Table 4 we find that the magnitude of the political business cycle is approximately \$30. An increase in \$30 spending implies an increase in the reelection probability of less than 1 percentage point.

[28]For more details see Chubb (1985).

Figure 7: The Political Business Cycle



Moreover, the magnitude of the fluctuations crucially depends on the adjustment costs. High adjustment costs tend to dampen the political business cycle. We conclude that the magnitude of the political business cycle depends on the slopes of the reelection probabilities and the magnitude of the adjustment costs.

7.3 Polarization and Gridlock

Our model helps us to understand the impact of political polarization on expenditure policies. We can measure polarization by the difference in bliss points. To illustrate the relationship between polarization and gridlock, we consider nine different regimes that differ by polarization and adjustment costs. The first bliss point regime is the baseline economy. The second (third) case reflects an increase in polarization by \$100 (\$150). Similarly, we have three cases of adjustment costs, low, baseline, and high. We consider a sequence in which a one-term Democratic administration is followed by a one-term Republican administration. Table 6 summarizes our main findings from our simulations.

Table 6: Polarization and Adjustment Costs

		Polarization		
		baseline	\$100	\$150
adjustment costs	low (50%)	0.2083	0.2176	0.2253
	baseline	0.1508	0.1642	0.1750
	high (150%)	0.1226	0.1386	0.1513

The volatility is measured in \$1000.

Note that the baseline volatility is approximately \$150. Not surprisingly, an increase in polarization leads to significant increases in volatility in all scenarios. Moreover, higher adjustment costs tend to partially offset the increase in polarization. Gridlock thus leads to less volatile expenditures in a polarized world. We thus conclude that adjustment costs may be an effective tool in reducing volatility in environments with higher levels of polarization.

8 Conclusions

State fiscal policies depend on the degree of political polarization and the institutional constraints that determine the flexibility of the government decision process. To understand how these forces interact and shape observed policy outcomes, we need new quantitative models that allow us to disentangle the different mechanisms that shape public policy. Our analysis provides a step in this direction. We have developed a new dynamic game of state fiscal policies under partisan governments. In our model, policymakers with different preferences compete for office. Preferences systematically vary by party affiliation and are subject to random shocks which reflect differences in preferences over policy within each party. Since the state government faces a balanced budget constraint, preferences over expenditures also depend on the business cycle. Endogenous election probabilities give rise to a political business cycle for expenditures. We have shown how to account for adjustment costs that arise due to institutional constraints of the budget process as well as political gridlock. Adjustment costs are important since they give rise to strategic incentives and allow current policy-makers to tie the hands of future policy-makers.

We have developed a new estimator for the class of dynamic games studied in this paper. Our approach exploits first-order conditions that optimal expenditures must satisfy along the equilibrium path. It is based on a forward simulation algorithm to compute the value functions and their derivatives. We have estimated different specifications of the model using a panel of 45 states during the past three decades. Our empirical results provide new insights into the systematic effects of partisan government on state fiscal policies. There are statistically significant and economically meaningful differences in bliss points among the two major parties in the U.S. These differences are less than 2 percentage points of expenditures in steady state, but increase significantly during the business cycle across states. This finding may explain why we observe a larger degree of polarization in states with high levels of income. However, the differences in bliss points are smaller than one may expect given the polarized nature of political competition in the U.S. When it comes to state expenditures, there is a fair bit of common ground between the two parties. Within party heterogeneity in spending is also large and significant.

Adjustment costs are large and important features of the partisan government. Some of these costs may reflect political gridlock among the parties. However, we do not find any evidence that adjustment costs differ between divided and uniform control of the government. This suggests that the adjustment costs may primarily reflect institutional barriers to changing tax and expenditure policies. While adjustment costs are large, our results also indicate that it takes up to two full terms or eight years to adjust expenditures from one party's bliss point to the other party's bliss point. As such expenditures tend to ultimately reflect the preferences of the administration in power, especially if the administration is reelected to a second term. Adjustment costs, therefore, also present a mechanism that smoothes expenditures in a polarized society. Our policy counterfactuals suggest that an increase in polarization may be dampened if polarization also leads to more gridlock and thus higher adjustment costs. More research is needed to understand what mechanisms slow down the speed of policy adjustment.

Our study provides ample scope for future research. A promising extension of the model would account for the fact that state governments also receive revenues from intergovernmental grants. it would be nice to differentiate between own source revenues and intergovernmental transfers. Including such grants in the analysis is feasible, but increases the state space of the model. Another useful extension of the model would consider asymmetric adjustment costs. It might be easier to increase expenditures than decrease expenditures. Similarly, it may be easier to decrease taxes than to increase taxes. Alternatively, one can model the impact of term limits or other institutional constraints discussed above. Finally, one could try to build on Alesina and Tabellini (1990) and consider a multidimensional model in which conflicts also arise due to differences in preferences over the composition of spending, and not just the level of spending. This extension is computationally challenging since the state space increases linearly in the number of spending categories that one considers. More research is needed to understand how these channels affect tax and expenditure policies.

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A Computation of the Equilibrium Strategies

Here, we illustrate the key issues for the simplified model assuming $\eta_D = 0 = \eta_R$.

We can approximate the value functions by quadratic functions in s_{t-1}, y_t and ϵ_{Dt}:

$$\begin{aligned}
V_D(D, s_{t-1}, y_t, \epsilon_{Dt}, \Delta_t = i) &= a^i_{DD0} + a^i_{DD1}\ s_{t-1} + \frac{1}{2} a^i_{DD2}\ s^2_{t-1} + a^i_{DD3}\ y_t + \frac{1}{2} a^i_{DD4}\ y^2_t + a^i_{DD5}\ \epsilon_{Dt} \\
&+ \frac{1}{2} a^i_{DD6}\ \epsilon^2_{Dt} + a^i_{DD7}\ s_{t-1}\ y_t + a^i_{DD8}\ s_{t-1}\ \epsilon_{Dt} + a^i_{DD9}\ y_t\ \epsilon_{Dt} \\
&+ a^i_{DD10}\ s_{t-1}\ y_t\ \epsilon_{Dt} \\
V_D(R, s_t, y_t, \epsilon_{Dt}, \Delta_t = i) &= a^i_{DR0} + a^i_{DR1}\ s_t + \frac{1}{2} a^i_{DR2}\ s^2_t + a^i_{DR3}\ y_t + \frac{1}{2} a^i_{DR4}\ y^2_t + a^i_{DR5}\ \epsilon_{Dt} \\
&+ \frac{1}{2} a^i_{DR6}\ \epsilon^2_{Dt} + a^i_{DR7}\ s_t\ y_t + a^i_{DR8}\ s_t\ \epsilon_{Dt} + a^i_{DR9}\ y_t\ \epsilon_{Dt} + a^i_{DR10}\ s_t\ y_t\ \epsilon_{Dt}
\end{aligned}$$

Hence, the derivatives have analytical solutions:

$$\begin{aligned}
\frac{\partial V_D(D, s_{t-1}, y_t, \epsilon_{Dt}, \Delta_t = i)}{\partial s_{t-1}} &= a^i_{DD1} + a^i_{DD2}\ s_{t-1} + a^i_{DD7}\ y_t + a^i_{DD8}\ \epsilon_{Dt} + a^i_{DD10}\ y_t\ \epsilon_{Dt} \\
\frac{\partial V_D(R, s_t, y_t, \epsilon_{Dt}, \Delta_t = i)}{\partial s_t} &= a^i_{DR1} + a^i_{DR2}\ s_t + a^i_{DR7}\ y_t + a^i_{DR8}\ \epsilon_{Dt} + a^i_{DR10}\ y_t\ \epsilon_{Dt}
\end{aligned}$$

First, consider period t and assume it is the last term of a Democratic administration, i.e. $\Delta_t = 0$ and $\omega_t = D$. Substituting into the first order condition, we obtain:

$$\begin{aligned}
0 \ = \ & -(s_t - s_D - \epsilon_{Dt}) \ - \ \eta_D \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \ - \ \alpha_D\ (s_t - s_{t-1}) \\
& + \beta\ P_D\ E_t \left\{ (a^3_{DD1} + a^3_{DD2}\ s_t + a^3_{DD7}\ y_{t+1} + a^3_{DD8}\ \epsilon_{Dt+1} + a^3_{DD10}\ y_{t+1}\ \epsilon_{Dt+1}) \right\} \\
& + \beta (1 - P_D)\ E_t \left\{ (a^3_{DR1} + a^3_{DR2}\ s_{t+1} + a^3_{DR7}\ y_{t+1} + a^3_{DR8}\ \epsilon_{Dt+1} + a^3_{DR10}\ y_{t+1}\ \epsilon_{Dt+1})\ \frac{\partial s_{t+1}}{\partial s_t} \right\}
\end{aligned}$$

Let us conjecture that the policy function of the Republican party is approximately linear:

$$\mu_R(s_{t-1}, y_t, \epsilon_{Rt}, \Delta_t = i) \;\; = \;\; c^i_{R0} + c^i_{R1}\; s_{t-1} + c^i_{R2}\; y_t + c^i_{R3}\epsilon_{Rt}$$

and hence:

$$\frac{\partial \mu_R(s_{t-1}, y_t, \epsilon_{Dt}, \Delta_t = i)}{\partial s_{t-1}} \;\; = \;\; c^i_{R1}$$

Substituting into the FOC:

$$\begin{aligned}
0 \;\; = \;\; & -(s_t - s_D - \epsilon_{Dt}) \; - \; \eta_D \; \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \; - \; \alpha_D \; (s_t - s_{t-1}) \\
+ \;\; & \beta \; P_D \; E_t \left\{ a^3_{DD1} + a^3_{DD2}\; s_t + a_{DD7}\; y_{t+1} + a^3_{DD8}\; \epsilon_{Dt+1} + a^3_{DD10}\; y_{t+1}\; \epsilon_{Dt+1} \right\} \\
+ \;\; & \beta (1 - P_D) \; E_t \Bigg\{ \Big[a^i_{DR1} + a^3_{DR2}\; (c^3_{R0} + c^3_{R1}\; s_t + c^3_{R2}\; y_{t+1} + c^3_{R3}\epsilon_{Dt+1}) + a^3_{DR7}\; y_{t+1} \\
+ \;\; & a^3_{DR8}\; \epsilon_{Dt+1} + a^3_{DR10}\; y_{t+1}\; \epsilon_{Dt+1} \Big] \; c^3_{R1} \Bigg\}
\end{aligned}$$

Hence, the FOC simplifies to

$$\begin{aligned}
0 \;\; = \;\; & -(s_t - s_D - \epsilon_{Dt}) \; - \; \eta_D \; \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \; - \; \alpha_D \; (s_t - s_{t-1}) \\
& + \beta \; P_D \; \left\{ (a^3_{DD1} + a^3_{DD2}\; s_t + a^3_{DD7}\; E[y_{t+1} \mid y_t]) \right\} \\
& + \beta (1 - P_D) \; \left\{ \left[a^3_{DR1} + a^3_{DR2}\; (c^3_{R0} + c^3_{R1}\; s_t + c^3_{R2}\; E[y_{t+1} \mid y_t]) + a_{DR7}\; E[y_{t+1} \mid y_t] \right] \; c^3_{R1} \right\}
\end{aligned}$$

Second, consider the case when the Democrats are in power at time t, and the time to the next election is $\Delta_t = 1$, i.e. we are in the third term of the administration.

Substituting into the first order condition, we obtain: Hence, the FOC simplifies to

$$\begin{aligned} 0 &= -(s_t - s_D - \epsilon_{Dt}) \; - \; \eta_D \; \left(\frac{1}{E[(1-\delta_\tau) y_{t+1} | y_t]} - \frac{1}{E[(1-\delta_\tau) y_{t+1}]} \right) \; - \; \alpha_D \; (s_t - s_{t-1}) \\ &+ \; \beta \; \left\{ a^0_{DD1} + a^0_{DD2} \; s_t + a^0_{DD7} \; E[y_{t+1} | y_t] \right\} \end{aligned}$$

Finally, the analysis for $\Delta_t = 2$ and $\Delta_t = 3$ proceeds as in the case when $\Delta_t = 1$.

The expected value functions can be computed as follows:

$$\begin{aligned} & E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = i)] \\ = & \int V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = i) \; f(y_{t+1} | y_t) \; f(\epsilon_{Dt+1}) \; dy_{t+1} \; d\epsilon_{Dt+1} \\ = & \; a^i_{DD0} + a^i_{DD1} \; s_t + \frac{1}{2} \; a^i_{DD2} \; s_t^2 + a^i_{DD3} \; E(y_{t+1} | y_t) + \frac{1}{2} a^i_{DD4} \; E((y_{t+1})^2 | y_t) + \frac{1}{2} a^i_{DD6} \; Var(\epsilon_D) \\ + & \; a^i_{DD7} \; s_t \; E(y_{t+1} | y_t) \\ & E_t[V_D(R, \mu_R(s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i), y_{t+1}, \epsilon_{Dt+1})] \\ = & \int V_D(R, \mu_R(s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i), y_{t+1}, \epsilon_{Dt+1}) f(y_{t+1} | y_t) \; f(\epsilon_{Rt+1}) \; f(\epsilon_{Dt+1}) \; dy_{t+1} \; d\epsilon_{Rt+1} \; d\epsilon_{Dt+1} \\ = & \; a^i_{DR0} + a^i_{DR1} \; (c^i_{R0} + c^i_{R1} \; s_t) + \frac{1}{2} \; a^i_{DR2} \; (c^i_{R0} + c^i_{R1} \; s_t)^2 + (a_{DR3} + a_{DR1} \; c_{R2}) \; E(y_{t+1} | y_t) \\ + & \; (\frac{1}{2} \; a^i_{DR4} + \frac{1}{2} \; a^i_{DR2} \; (c^i_{R2})^2 + a^i_{DR7} c^i_{R2}) E((y_{t+1})^2 | y_t) + \frac{1}{2} a^i_{DR6} \; Var(\epsilon_D) + \frac{1}{2} \; a^i_{DR2} \; (c^i_{R3})^2 \; Var(\epsilon_R) \\ + & \; (a^i_{DR7} + a^i_{DR2} \; c^i_{R2}) \; (c^i_{R0} + c^i_{R1} \; s_t) \; E(y_{t+1} | y_t) \end{aligned}$$

$$
\begin{aligned}
& E_t[V_R(R, s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i)] \\
= & \int V_R(R, s_t, y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i) \ f(y_{t+1}|y_t) \ f(\epsilon_{Rt+1}) \ dy_{t+1} \ d\epsilon_{Rt+1} \\
= & a^i_{RR0} + a^i_{RR1} \ s_t + \frac{1}{2} \ a^i_{RR2} \ s^2_t + a^i_{RR3} \ E(y_{t+1}|y_t) + \frac{1}{2} a^i_{RR4} \ E((y_{t+1})^2|y_t) + \frac{1}{2} a^i_{RR6} \ Var(\epsilon_R) \\
+ & a^i_{RR7} \ s_t \ E(y_{t+1}|y_t) \\
& E_t[V_R(D, \mu_R(s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = i), y_{t+1}, \epsilon_{Rt+1})] \\
= & \int V_R(D, \mu_R(s_t, y_{t+1}, \epsilon_{Dt+1}), y_{t+1}, \epsilon_{Rt+1}, \Delta_{t+1} = i) f(y_{t+1}|y_t) \ f(\epsilon_{Dt+1}) \ f(\epsilon_{Rt+1}) \ dy_{t+1} \ d\epsilon_{Dt+1} \ d\epsilon_{Rt+1} \\
= & a^i_{RD0} + a^i_{RD1} \ (c^i_{D0} + c^i_{D1} \ s_t) + \frac{1}{2} \ a^i_{RD2} \ (c^i_{D0} + c^i_{D1} \ s_t)^2 + (a^i_{RD3} + a^i_{RD1} \ c_{D2}) \ E(y_{t+1}|y_t) \\
+ & (\frac{1}{2} \ a^i_{RD4} + \frac{1}{2} \ a^i_{RD2} \ (c^i_{D2})^2 + a^i_{RD7} c^i_{D2}) E((y_{t+1})^2|y_t) + \frac{1}{2} a^i_{RD6} \ Var(\epsilon_R) + \frac{1}{2} \ a^i_{RD2} \ (c^i_{R3})^2 \ Var(\epsilon_D) \\
+ & (a^i_{RD7} + a^i_{RD2} \ c^i_{D2}) \ (c^i_{D0} + c^i_{D1} \ s_t) \ E(y_{t+1}|y_t)
\end{aligned}
$$

B Forward Simulation of the Expected Value Functions

To see how this works lets us assume – for simplicity – that the policy functions can be approximately by linear functions (as we do in our application). In that case, we have when Democrats are in power for $j = 0, ..., 3$:

$$
\begin{aligned}
s_t &= \mu_D(s_{t-1}, y_t, \epsilon_t, \Delta_t = j) \\
&= c^j_{D0} + c^j_{D1} \ s_{t-1} + c^j_{D2} \ y_t + c^j_{D3} \ \epsilon_{Dt} \\
&= c^j_{D0} + c^j_{D1} \ s_{t-1} + c^j_{D2} \ y_t + \epsilon^j_{Dt}
\end{aligned}
$$

where $\epsilon^j_{Dt} = c^j_{D3}\ \epsilon_{Dt}$ and hence $\epsilon^j_{Dt} \sim N(0, (c^j_{D3})^2\sigma^2_D)$. Note that these policy functions can be estimated using OLS. As consequence c^j_{D0}, c^j_{D1} and c^j_{D2} are identified. Moreover, given a value of σ^2_D, the c^j_{D3} are identified from the residual variances.

Similarly, when a Republican administration is in power

$$\begin{aligned} s_t &= \mu_R(s_{t-1}, y_t, \epsilon_t, \Delta_t = j) \\ &= c^j_{R0} + c^j_{R1}\ s_{t-1} + c^j_{R2}\ y_t + c^j_{R3}\ \epsilon_{Rt} \\ &= c^j_{R0} + c^j_{R1}\ s_{t-1} + c^j_{R2}\ y_t + \ \epsilon^j_{Rt} \end{aligned}$$

where $\epsilon^j_{Rt} = c^j_{R3}\ \epsilon_{Rt}$.

Since we can consistently estimate the parameters of the policy functions, we can, therefore, treat them as known. (For given σ^2_D and σ^2_R which are estimated in the outer loop. So we can condition on them in the inner loop when we need to evaluate the orthogonality conditions.)

Consider, for example, the problem of simulating $E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 2)]$. The Democrats are in power and we are in state $(s_{t-1}, y_t, \epsilon_t)$ and $j = 3$ at time t.

1. For simulation $h = 1$ to H,

   (a) In period t, $j = 3$. Compute $s^h_t = \mu_D(s_{t-1}, y_t, \epsilon_t, \Delta_t = 3)$. (Note this does not change across simulations.)

   (b) In period $t + 1$, $j = 2$. Simulate y^h_{t+1} by drawing from the AR(1) process conditional on y_t. Simulate ϵ^h_{Dt+1}. Compute $s^h_{t+1} = \mu_D(s^h_t, y^h_{t+1}, \epsilon^h_{Dt+1}, \Delta_t = 2)$. Compute the flow utility:

$$U^h_{t+1} = B_D(s^h_{t+1}, y^h_{t+1}, \epsilon^h_{Dt+1}) - C_D(s^h_{t+1}, s^h_t) + \kappa$$

(c) In period $t+2$, $j=1$. Simulate y^h_{t+2}, ϵ^h_{t+2}, and compute $s^h_{t+2} = \mu_D(s^h_{t+1}, y^h_{t+2}, \epsilon^h_{Dt+2}, \Delta_t = 1)$. Compute the flow utility:

$$U^h_{t+2} = B_D(s^h_{t+2}, y^h_{t+2}, \epsilon^h_{Dt+2}) - C_D(s^h_{t+2}, s^h_{t+1}) + \kappa$$

(d) In period $t+3$, $j=0$. Simulate y^h_{t+3}, ϵ^h_{t+3}, and compute $s^h_{t+3} = \mu_D(s^h_{t+2}, y^h_{t+3}, \epsilon^h_{Dt+3}, \Delta_t = 0)$. Compute the flow utility:

$$U^h_{t+3} = B_D(s^h_{t+3}, y^h_{t+3}, \epsilon^h_{Dt+3}) - C_D(s^h_{t+3}, s^h_{t+2}) + \kappa$$

Since $j=0$ we also need to simulate the election outcome. For that, draw a $U(0,1)$. If the realization is less than P_D Democrats win, otherwise Republications win the election.

(e) In period $t+4$, $j=3$. Suppose the simulated election puts the Republicans in power. Simulate y^h_{t+4}, ϵ^h_{Rt+4}, and compute $s^h_{t+4} = \mu_R(s^h_{t+3}, y^h_{t+4}, \epsilon^h_{Rt+4}, \Delta_t = 3)$. Simulate ϵ^h_{DRt+4}, and compute

$$U^h_{t+4} = B_D(s^h_{t+4}, y^h_{t+4}, \epsilon^h_{Dt+4})$$

(f) Continue until the terminal period T.

(g) Compute the realized value function for simulation h

$$V^h_D = \sum_{r=t+1}^{T} \beta^{r-t-1} U^h_r$$

2. Compute the expected value function by averaging over the H simulations:

$$E_t[V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} = 3)] = \frac{1}{H} \sum_{h=1}^{H} V^h_D$$

Similarly, we can simulate all the other value functions.

C Moment Restrictions

We construct our objective function based on the following conditional moment restriction. For each $j \in \{D, R\}$,

$$E[\epsilon_{jt}|s_{t-1}, y_t, \Delta_t] = 0$$

The conditional moment restrictions above imply the following unconditional moment restrictions:

$$\begin{aligned} E[\epsilon_{jt}|\Delta_t] &= 0 \\ Cor[\epsilon_{jt}, s_{t-1} \mid \Delta_t] &= 0 \\ Cor[\epsilon_{jt}, y_t \mid \Delta_t] &= 0 \end{aligned}$$

We constructed different moment conditions for election years ($\Delta_t = 0, 2$) and non-election years ($\Delta_t = 1, 3$). We also imposed the model restriction that $Std(\epsilon_{jt}) = \sigma_j$ for $j = D, R$. To adjust for the difference in the scale of the moments, we divided the moments by $Std(\epsilon_{jt}) = \sigma_j$. Hence, the objective function of our estimator can be written as:

$$
\begin{aligned}
& Q(\theta_2; \widehat{\theta}_1, \widehat{\mu_D}, \widehat{\mu_R}) \\
= & \sum_{j \in \{D,R\}} \Bigg\{ [E(\epsilon_{jt}(\theta_2) \mid \Delta_t = 0,2)]^2 + [E(\epsilon_{jt}(\theta_2) \mid \Delta_t = 1,3)]^2 \\
+ & [Cor(\epsilon_{jt}(\theta_2), s_{t-1} \mid \Delta_t = 0,2)]^2 + [Cor(\epsilon_{jt}(\theta_2), s_{t-1} \mid \Delta_t = 1,3)]^2 \\
+ & [Cor(\epsilon_{jt}(\theta_2), y_t \mid \Delta_t = 0,2)]^2 + [Cor(\epsilon_{jt}(\theta_2), y_t \mid \Delta_t = 1,3)]^2 \\
+ & [\sigma_j - Std(\epsilon_{jt}(\theta_2)]^2 \Bigg\}
\end{aligned}
$$

D Reduced Form Estimates of the Policy Function: Robustness Analysis

Here we report some robustness analysis regarding the estimation of the policy function. We have also explored using panel data methods with two way fixed effects models, i.e. panel model with state and time' fixed effects. These type of models have been routinely used in the literature.[29] We argue above that these model are much restrictive than the models we estimate in this paper since they assume a common trend for all states in the sample. Nevertheless, it is useful to compare our results with those based on these simpler panel regressions.

Table 7: Policy Function Estimates with Two-way Fixed Effects

Variable	(1) Budgeted Expenditures	(2) Budgeted Expenditures	(3) Budgeted Expenditures
Constant	2.593***	0.427***	-0.157*
	(0.0354)	(0.0455)	(0.0826)
Dem	0.143***	0.0514***	0.0411***
	(0.0147)	(0.00826)	(0.00813)
Lagged Exp		0.844***	0.791***
		(0.0160)	(0.0168)
Income			0.0283***
			(0.00338)
Observations	1,289	1,289	1,289
R-squared	0.841	0.952	0.954
Number of states	45	45	45

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The results are summarized in Table 7. Column (1) reports the basic regression

[29] See for example the discussion of the relevant literature in Sieg and Yoon (2017).

with just a single dummy. Here we find that differences among parties are \$143 which is three times the estimate that we find when we use HP filters. In Columns (2) and (3) we add lagged expenditure and income as additional state variables. We find that the differences between parties shrink to \$41-51 which is comparable to our findings reported above.

We also explored specifications with more interaction effects. The main difference is that we find no evidence of election effects. The interaction between income and the democratic party is also not significant in the two way fixed effect model.

E Reduced Form Estimates of the Reelection Probabilities

Here we report the reduced form estimates of loigt models that capture the impact of budgeted policies on general elections in the states in our sample. The following table reports the parameter estimates of the reduced form reelection probabilities. Overall, we find that the slope parameters are estimated imprecisely. The estimate is positive for Republicans and negative for Democrats. Both estimates are not statistically different from zero. When we estimate the structural parameters of the model, we also exploit the variation of expenditures during the different terms of an administration to identify the slope parameters. We find that the structural estimates fall within the 95 confidence band of the reduced form estimates.

Table 8: Reduced Form Estimates of the Reelection Probabilities

	Republican	Democrats
Expenditure	1.088	-1.827
	(1.882)	(1.733)
Constant	-3.175	7.401
	(6.985)	(6.466)
Observations	165	148
Marginal Effects of $1000	0.227	-0.420
	(0.391)	(0.392)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1