Estimating a Dynamic Game of State Fiscal Policies under Partisan Governments

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Motivation

- Partisan control of government systematically influences state spending and taxation levels in the U.S.
- 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?
- 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 issues.

The Model

- We consider a dynamic game of state government spending and taxation under a balanced budget rule.
- There are policy-makers from two parties with conflicting preferences over expenditures and taxes.
- These parties compete in competitive elections. The party in power implements fiscal policies.
- Parties are forward-looking and infinitely lived, and understand that future policy-makers may have different objectives.

Contributions to the Dynamic Games Literature in PE

- Policy-makers face a balanced budget requirement.
- 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.
- We explicitly model the four periods in each term of an administration. Thus, our model captures that parties face different incentives in election years than in non-election years.

Estimation

- 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.
- 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 derivatives of the value functions of policy makers from both parties.

More on Estimation

- A full solution nested fixed point algorithm – in the spirit of Rust (1987) – is computationally challenging.
- Hence, we follow Bajari, Benkard and Levin (2007) and use a forward-simulation approach to compute the value functions and their derivatives
- This approach ultimately rests on our ability to estimate the policy functions of both parties before estimating the parameters of the structural model.

Some Key Papers in the Literature

- Dynamic games in PE: survey by Duggan and Martinelli (2017).
- Strategic fiscal policy: Song, Storresletten and Ziliboti (2008), Battaglini and Coate (2008).
- Estimation of dynamic models based on Euler Equations: Hansen and Singleton (1982), Berry and Pakes (2000).
- Forward simulation algorithms: Hotz, Miller, Sanders and Smith (1994), Bajari, Benkard and Levin (2007).
- Estimation of dynamic games in PE: Merlo (1997), Diermeier, Eraslan, and Merlo (2003), ..., Sieg and Yoon (2017, 2022).

Notation

- We consider a stationary dynamic game with two infinitely lived political parties, denoted by Republicans R and Democrats D.
- Time is discrete $t = 1, 2, ..., \infty$.
- Elections are held every four years, while fiscal policies are determined annually.
- Let Δ_t denote the time that is left until the next election is held. 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 denote the reelection probability for Democrats.
- Define the state of the political world $\omega_t \in \{D, R\}$, which indicates which party is in power at time t.

The Budget Process

- Each period the party that is in power controls the government and determines budgeted spending s_t and a proportional income tax rate τ_t.
- To incorporate business cycle shocks, let us assume that income y_t follows a first-order Markov Process.
- There is a soft or ex-ante balanced budget requirement.
- Budget decisions made in t determine fiscal policies in year $t + 1$.
- To deal with ex-post deficits and surpluses, we assume that the government operates a small rainy day fund, which is financed by a small income surcharge denoted by δ_τ.

Balanced Budgets

- Given the timing of decisions, the annual budget needs to be balanced in expectations:

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

- This equation implies that tax rates are given by:

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

- Thus, taxes are given by a function of expenditures that is strictly monotonically increasing conditional on the state of the economy.
- Define $\tilde{\tau}_t$ to be the tax rate that finances the expenditures s_t in steady state:

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

The Rainy Day Fund

- The management of the rainy day fund is completely passive in our model.
- 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

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

Spatial Preferences

- We adopt a spatial model and assume that each party j has a bliss point denoted by s_{jt}. The bliss point of each party is subject to an idiosyncratic shock:

$$s_{jt} = s_j + \epsilon_{jt},$$

where ϵ_{jt}'s are iid shock across time and parties.

- 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:

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

Balanced-Budget Preferences

- Substituting the budget constraint and the definition of the balanced budget tax rates into the flow utility function, we obtain the balanced-budget preferences:

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

- Note that the balanced budget preferences only depend on s_t, y_t and ϵ_t.

Adjustment Costs and Flow Utility

- A key feature of the model is that adjustments of spending are sluggish and subject to costs.
- Most states have tax and expenditure limits that cause frictions in the adjustment of both spending and tax policies.
- We assume that the magnitude of these adjustment costs are party-specific and given by:

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

- The flow-utility of party j is given by:

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

where κ denotes the benefits of holding office.

The Timing of Decisions

The timing of decisions within any period t is 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 $\omega_{t+1} = \omega_t$.

Markov Perfect Equilibrium

- 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 $j \in \{D, R\}$ in term $i \in \{0, 1, 2, 3\}$.
- Next, we characterize the decision problems that are faced by the parties and derive the FOCs that hold in equilibrium.

The Decision Problem of the Party in Power

- To accomplish this task, it is useful to solve the model starting in the last term denoted by $\Delta_t = 0$.
- Assume for the sake of concreteness that a Democratic administration is in power $\omega_t = D$.
- We can express the optimization problem recursively as:

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

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}.

The Value Function for the Opposition Party

- Since the Democrats are in power, the Republicans are in opposition and, therefore, passive.
- The value function of the Republicans can be recursively defined as:

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

where $s_{t+1} = \mu_D(s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_t = 3)$.

Optimal Decisions

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

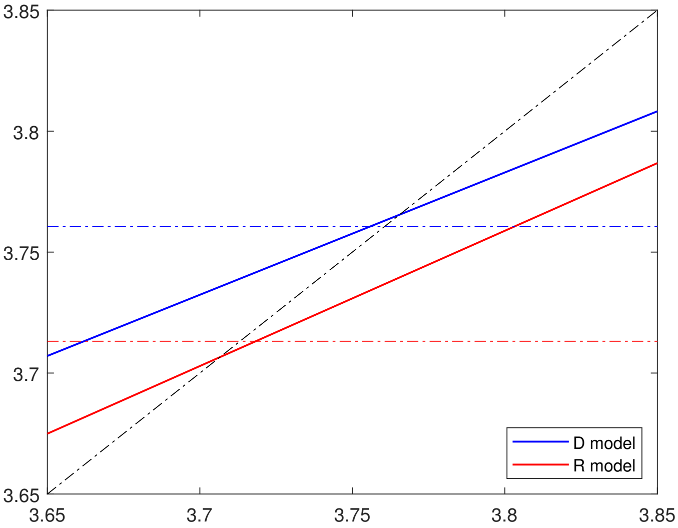
$$
\begin{aligned}
0 &= -(s_t - s_D - \epsilon_{Dt}) - \eta_D \left(\frac{1}{E[(1-\delta_\tau)y_{t+1}|y_t]} - \frac{1}{E[(1-\delta_\tau)y_{t+1}]} \right) \\
&- \alpha_D \left(s_t - s_{t-1}\right) \\
&+ \beta \left\{ P_D \; E_t \left[\frac{\partial V_D(D, s_t, y_{t+1}, \epsilon_{Dt+1}, \Delta_{t+1} =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

where

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

- The last term of the FOC captures the strategic aspect of problem: a Democratic administration can tie the hands of a future Republican administration.
- Because of adjustment costs the Republican administration will have to incur costs to undo the spending increases implemented by Democrats.

Policy Function: Overshooting



Some Comments

- The FOCs for non-elections years are similar. The main difference is that there is no uncertainty about who will be in power in the next period.
- In general, the equilibria of this model can only be computed numerically.
- Exact solutions exist for some versions of the model, particularly when the value functions are quadratic in the state variables, resulting in linear policy functions.

Endogenous Election Probabilities

- We can extend the model and treat the election probability as endogenous, i.e. it depends on the policy choices at the beginning of the period.
- In our application, we assume the following functional form for each party $j \in \{D, R\}$:

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

- If $\lambda_{1j} > 0$ voters reward the party in power for high expenditures.

Endogenous Election Probabilities

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

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

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

Estimation

- Rewrite the optimality condition for the last term ($\Delta_t = 0$) if Democrats are in office as:

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

- We assume that preference shocks satisfy the following standard assumption:

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

Comments on Estimation

- We can thus construct orthogonality conditions based on the first-order conditions and estimate the model using GMM.
- The first-order conditions depend on the level and the derivative of the value functions of policy-makers from both parties.
- 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 simulate the value functions and their derivatives.

Data

- We assume that the party that controls the governorship is in power.
- 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), and New Hampshire, Vermont, and Rhode Island (which adopted different election cycles at least some periods between 1990 and 2018).
- We thus have $N\ T = 45\ 29 = 1305$ observations.
- There were 16 administrations that were headed by an independent governor and, as a consequence, our final sample is 1289.

Descriptive Statistics

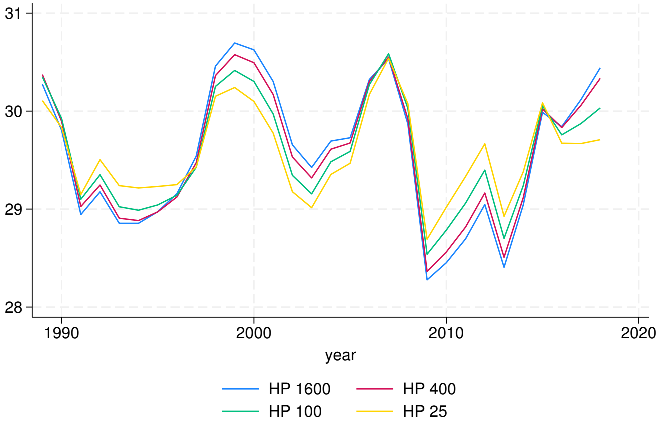
	Obs	Mean	Std. Dev.	Min	Max
Expenditures	1289	3.665	0.855	1.827	7.116
Income	1289	31.204	5.308	17.606	50.523
Democrats	1289	0.423	0.495	0	1
Election Year	1289	0.242	0.428	0	1
Change in Party	313	0.335	0.473	0	1

Filtering the Data

- 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 Hodrick Prescott filter and the Hamilton filter.

Weighted Real State Expenditure Per Capita

Weighted Real State Income Per Capita



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.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Summary: Estimated Policy Functions

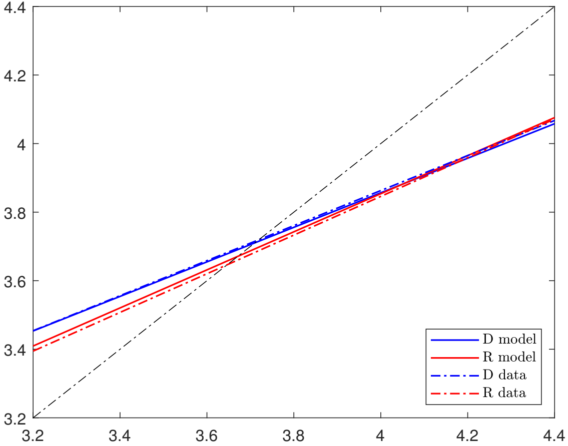
- The average unconditional differences in expenditures are $46. These differences are smaller than one may have expected given the polarized nature of politics in U.S. states.
- The estimate of lagged expenditures is approximately 0.57 which suggests the presence of strong autocorrelation. Hence adjustment costs are likely to be large and economically meaningful.
- The income coefficient is statistically significant and economically meaningful. Democrats respond stronger to income changes than Republicans.
- Republicans respond stronger to election-year effects than Democrats.

Structural Parameter Estimates

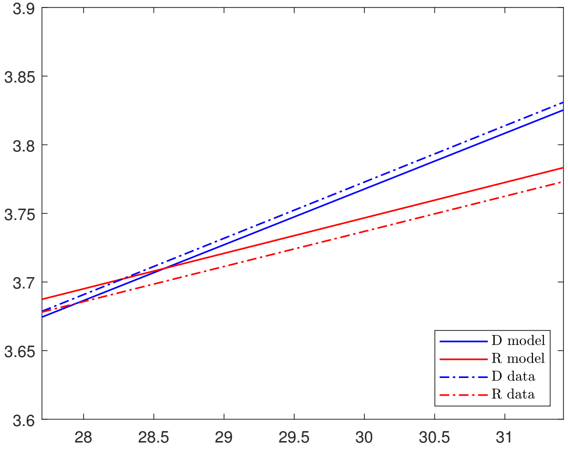
		I	II
bliss	s_D	3.761	3.729
points	s_R	3.713	3.685
tax	η_D	129	136
effect	η_R	99	100
adjustment	α^e_D	1.700	1.958
costs	α^e_R	2.285	2.644
standard deviation	σ_D	0.461	0.504
preference shocks	σ_R	0.464	0.509
	λ^0_D	0.477	-2.636
reelection	λ^1_D	0	0.831
probability	λ^0_R	0.864	-2.765
	λ^1_R	0	0.979
marginal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

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

Model Fit: Policy Function by Previous Period Spending



Model Fit: Policy Function by Income



Decomposition of the Volatility of Expenditures

- There are three types of shocks in our model that generate volatility in expenditures:
  1. an income shock which captures the impact of the economic business cycle on expenditures;
  2. a preference shock which reflects idiosyncratic heterogeneity in preferences within parties and across time;
  3. a political shock that is due to the uncertainty of elections.
- We assess the relative importance of each shock.

	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

Summary: Parameter Estimates and Fit

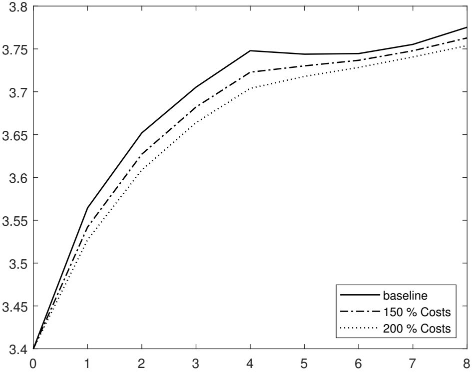
- We find that the estimated bliss points differ among parties by approximately $50 which is slightly more than the difference in average policies.
- We find that the fit of the model is quite excellent. The differences between the policy functions generated by our model and those estimated in the previous section are small.
- We find that idiosyncratic preference shocks contribute the largest fraction to expenditure volatility. They account for 80 percent of all volatility.
- In contrast income and political shocks only account for 20 percent of the total volatility of expenditures.

Policy Analysis

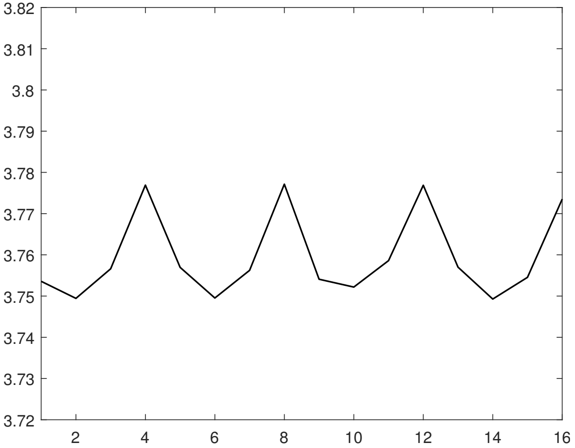
Next, we focus on the following three topics that have drawn considerable interest in the literature:

- Institutional Barriers to the Speed of Adjustment
- The Political Business Cycle and Endogenous Reelection Probability
- Polarization and Gridlock

Institutional Barriers to the Speed of Adjustment



The Political Business Cycle



Polarization and Adjustment Costs

- 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.

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

The volatility is measured in $1000.

Summary of Policy Analysis

- We find that it takes a Democratic administration up to 8 years – or two full terms – to reach a level of expenditures that is approximately equal to its average bliss point.
- Our model generates a political business cycle. The magnitude of the fluctuations crucially depends on the adjustment costs. High adjustment costs tend to dampen the political business cycle.
- Increases in polarization among the parties also increases volatility. Adjustment costs also provide a mechanism that smoothes expenditures in a polarized society.

Conclusions

- State fiscal policies depend on the degree of political polarization and the institutional constraints that determine the flexibility of the government decision process concerning public expenditures and revenues.
- Strategic election incentives give rise to overshooting of expenditures and a political business cycle.
- Adjustment costs are important since they give rise to strategic incentives and allow current policy-makers to tie the hands of future policy-makers.
- Adjustment also tends to reduce policy volatility.