SENATE DYNAMICS IN THE SHADOW OF MONEY

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ABSTRACT. Incumbent politicians seeking reelection face an inherently dynamic problem: they observe the change in their poll standing and incoming contributions, and respond by adjusting their political stances and by spending money in political advertising. In this paper, we formulate a model that captures this problem and estimate the model using data for US senators. Our empirical strategy allows us to obtain an estimate of senators’ policy preferences that discounts pandering. This approach contrasts with current methods to estimate legislators’ ideal points, which assume that all votes are sincere expressions of preference. The difference is consequential: we find that while there are some truly extreme senators, the vast majority is actually relatively moderate, and appear extreme due to electoral pressures. This finding contrasts with the conventional wisdom on the polarization of elites in american politics.

1. Introduction

A guiding principle of nearly all writing on Legislative politics is that of the acting representative motivated partially, if not largely, by the desire to retain office. As Mayhew (1974) put it more than forty years ago, “Whether they are safe or marginal, cautious or audacious, congressmen must constantly engage in activities related to reelection. There will be differences in emphasis, but all members share the root need to do things – indeed, to do things day in and day out during their terms.”

Narrowing down what exactly this means for legislative policy-making is a complex task, as it requires understanding both characteristics of the representatives themselves, and of the environment in which they operate. First is, how much do elected representatives care about office relative to policy considerations? In the extreme, if office motivation dominates all policy considerations, representatives would not mind compromising their policy ideas to gain an electoral edge, even if slight. On the other hand, if they cared

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both about office and policy, adjusting their policy positions to please voters would be costly, and their actions would reflect a weighting of these two conflicting goals.

The optimal resolution of these tradeoffs depends on the cost and benefit of the actions available to incumbent politicians, notably position-taking and political advertising. How much do changes in position-taking affect voter support? Does this gain require adopting a position that is too costly for the representative, too removed from her ideal policy position? A similar calculus holds for political advertising. If advertising is effective, the politician can substitute changes in her policy position with ads. How effective is political advertising to change voter support? Does the politician have enough funds to finance a strong TV ad campaign, both now and in months to come?

The political science literature has studied some of these questions exhaustively. First, a number of papers focused on studying the effect of position-taking on electoral results, and on estimating the effect of TV advertising on electoral results. Other papers focused on whether and how representatives adjust their positions; in particular whether incumbents moderate their policy positions when they are safe and when they face competitive elections. There is also a large and well established literature on estimation of legislators’ preferences. As a whole, however, the literature is spotty and not well connected. We are not aware of a paper connecting the electoral returns of position-taking with how much legislators adjust their policy positions, or of a paper studying whether and how spending in political advertising affects position taking. Similarly, we are not aware of a paper estimating the weight of career concerns vs. policy considerations, and thus of a paper connecting how career concerns affect position-taking. Finally, we are not aware of a paper estimating legislators’ ideal points that disentangles preferences from strategic position-taking (pandering).

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1See Canes-Wrone et al. (2002) and references therein, see also Ansolabehere and Jones (2010).
To attack this problem, we formulate a model that captures the key elements of the incumbent’s problem, and then estimate the model using monthly data on voting, TV ads, polls, and contributions for 74 standing Senators over the years 2000-2010.

Since the incumbent’s problem is inherently dynamic, so is our model. At the beginning of each month incumbents observe the change in their poll standing and incoming contributions, and respond by adjusting their political stances and the amount of money spent in political advertising. Their choices, in turn, affect stochastically their position in the polls and future campaign contributions. Senators have both electoral and policy considerations. In particular, they have an ideal policy $\theta$, and obtain a payoff $\omega > 0$ if they get reelected with a small margin, and an additional payoff of $\alpha > 0$ if they win by a landslide. Optimal choices of when to spend or save, and of how to change their policy stance at any point in time depend on the senator’s characteristics (how much she cares about getting reelected, how costly it is for her to adopt a policy that increases voter support), the environment (how responsive is voter support to changes in policy position and tv ads), and the particular situation the senator faces at the time (the value of the poll advantage and accumulated war chest).

In order to estimate the model, we put together a monthly dataset with information on voting records, TV ad expenditures, poll advantage, and campaign contributions for 74 standing Senators over the years 2000-2010. An attractive feature of having data on both voter support and position taking for each senator at a monthly frequency is that this increases vastly the individual level variation in the data on position-taking and voter support. This allows us to study the connection between voting records and evolution of support in a way that is simply not possible when we have a single observation of position-taking and electoral results by senator/electoral cycle. Contrary to previous findings for cross sectional data on voting and electoral returns, our results suggest that incumbents are not generally penalized for ideological extremity. In particular, we find that this is indeed the case for republican senators in democratic states and democratic senators
in republican states, but not for democratic incumbents in democratic strongholds or republican incumbents in republican strongholds.

The estimation of our dynamic model follows the approach pioneered by Rust (1987). As usual in this literature, we estimate the model in two steps. In the first we estimate the transition functions: how policy positions and TV ads affect future polls and contributions. In the second step we estimate the ideology and career concern parameters solving the problem of each senator for every trial value of the parameters, and then searching for the values that maximize the likelihood function.

Our ideal point estimates differ significantly from the ideal points estimated in previous literature. Despite widespread recognition (and detailed estimation) of patterns of pandering over the electoral cycle, existing work on the distribution of legislative preferences is based on estimates that ignore the fact that there is systematic variation in how incumbents balance competing pressures in casting particular votes. Our estimation strategy allows us to determine which votes are likely to serve a sincere representations of a legislatures underlying preferences over policy and which votes are likely the result of strong pressures to pander to constituent interests. This difference proves consequential: we find that while there are some truly extreme senators, the vast majority is actually relatively moderate, and appear extreme due to electoral pressures. This finding contrasts with the conventional wisdom on the polarization of elites in american politics.

Our estimates of the career concerns parameters (ω, α) are new in the literature. These estimates are valuable because they allows us to compute the degree of responsiveness of each senator as a function of their electoral advantage and available war chest.

2. Literature Review

Our paper is related to three strands of literature. At the core, our paper relates to the literature on the responsiveness of legislators’ voting records to voters’ preferences, and in particular to the debate on voter and elite polarization. On the technical side, our paper
builds on the literature on estimation of dynamic decision problems, and contributes to the literature on the estimation of legislators’ policy preferences (i.e., ideal points).

Since the seminal work of Mayhew (1974), a large literature in political science has studied how reelection concerns shape position-taking by incumbent politicians. A few papers focused on whether legislators are more responsive to constituency preferences as the election approaches (see Elling (1982), Thomas (1985), see also Levitt (1996)). The bulk of this literature, however, developed around the so-called marginality hypothesis; i.e., the hypothesis that legislators in competitive elections are more responsive to constituency interests than their colleagues in safe districts. The overall evidence to support the marginality hypothesis is mixed, both in terms of under what conditions legislators would be responsive to voters, and in terms of who how legislators would be responsive to.

Fiorina (1974) argues that in more competitive districts incumbents will cater to their core supporters instead of the median voter. Elling (1982) finds that there is no strong relationship between electoral vulnerability and ideological moderation. Bartels (1991) shows that incumbents in safe districts can be as responsive to public opinion as incumbents in competitive districts (safe incumbents are as responsive as incumbents in competitive districts in defense spending in 1982). This is also the finding of Lee et al. (2004), who study voting data for a larger period (1946-1995) using a regression-discontinuity design. Ansolabehere et al. (2001) shows that candidates’ responsiveness to their constituents ideological shadings (how their estimated ideal policies changed with the Republican share of the presidential vote) changed significantly throughout the 20th century. Griffin (2006), on the other hand, provides evidence that supports the marginality hypothesis. His approach is to regress d-nominate scores on district competitiveness, district liberalness, and an interaction term, including representative fixed effects. He finds that legislators
become more responsive to change in their district’s liberalism as competitiveness within districts increases.\textsuperscript{5}

Most of these papers implicitly assume that legislators’ policy stances affect voting outcomes. A large literature focused on whether moderate or extreme stances affect incumbents’ vote shares. The general finding is that incumbents are penalized for ideological extremity; i.e., holding district ideology constant, Democrats lose electoral support by voting more liberally and Republicans lose electoral support by voting more conservatively (see Canes-Wrone et al. (2002) and references within). Survey evidence, moreover, also suggests that constituents can and in fact do hold their representatives accountable for roll-call votes. In particular, using two national surveys conducted in 2005 and 2006, Ansolabehere and Jones (2010) find that survey respondents know how they themselves would vote on major bills, have precise beliefs about how their representatives voted on these bills, and are more likely to vote for them the more they agree with their policy positions.

Our paper contributes to both strands of literature. In terms of legislators’ responsiveness, we do not impose a priori a particular pattern of behavior, both in terms of under what conditions senators would be responsive (when challenged or not, if early in the cycle or late) or how (if towards the center or the extreme). Instead, in our structural model, predicted behavior in each time period, budget level and poll level is determined from optimal play for the estimated structural parameters. On the voters’ side, we estimate the effect of position-taking and political advertising on voter support. Differently to previous literature, we exploit a substantial amount of individual-level variation which comes as a result of having information on polls, position-taking and tv-ads at the monthly level.

The estimation of our dynamic model follows the approach pioneered by Rust (1987) and is mostly standard from an econometrics’ perspective (for a survey of this literature, see Aguirregabiria and Mira (2010)). Three other papers use a similar approach to study

\textsuperscript{5}Poole (2007) argues that representatives’ policy positions are time invariant. The exercise here is not to check whether policy positions are responsive to changes in the environment or not, but that estimating nominate scores by session does not add much explanatory power to estimating it pooling all data.
other issues in legislative behavior. Diermeier et al. (2005) estimate a dynamic model of the career decisions of a member of Congress, Kawai (2014) studies how money affects election outcomes, and Garcia-Jimeno and Yildirim (2015) study the strategic interaction between candidates and the media.

A fundamental product of our estimation is a new estimate of senators’ ideal points. Differently to the predominant methods to estimate ideal points (Poole and Rosenthal (1985), Poole and Rosenthal (1991), Heckman and Snyder (1997), Clinton et al. (2004)), which assume that votes are a sincere expression of politicians’ preferences, our approach takes into account the effect of both preferences and position-taking.

3. Data

Our main data consists of monthly observations for polls, campaign contributions, voting records, and expenditures in tv advertising for 74 incumbent senators who ran for reelection at least once in the period 2000-2010, including 15 races in the 1999-2000 electoral cycle, 10 in 2001/02, 12 in 2003/04, 20 in 2007/08, and 17 in 2009/10.

The pointlead of a senator $i$ in month $t = 1, \ldots, 12$, measures the difference between the approval rate of the incumbent senator and the challenger $t$ months before the election. The variable is constructed using public opinion data on electoral races for the U.S. Senate and incumbent’s approval rates at the state level.

The stance of a senator $i$ in month $t = 1, \ldots, 72$, measures senator $i$’s policy position $t$ months before the election. A critical difference with previous literature is that we do not assume that senators’ votes reflect their preferences sincerely. Instead, we only assume that voting records reflect senators’ position-taking, which can arise as a combination of posturing and preferences. In this spirit, we measure the stance of a senator $i$ in month $t$ as the senator’s “ideal point” estimate in a Bayesian Quadratic Normal model (Clinton et al. (2004)) for all roll call votes taken in the previous 12 months (in a sample of all roll
call votes from $t$ to $t + 12$). The income ($c_{it}$) of a senator $i$ in month $t = 1, \ldots, 72$ is the total monthly campaign contributions for senator $i$ $t$ months before the election.

The expenditure in TV-ads ($e_{it}$) of a senator $i$ in month $t = 1, \ldots, 72$ measures senator $i$’s expenditure in political ads $t$ months before the election. Data for other expenditures is not available at a monthly level. In the estimation of the structural model, we assume that other campaign expenditures are perfect complements to TV-ad expenditures, and adjust TV-ad expenditures so that budget is balanced at election time. With this adjustment, the variable budget ($b_{it}$) measures the balance of money in the bank for each senator at the beginning of each month; i.e, $b_{it} \equiv \sum_{s=1}^{t} m_{is} - \sum_{s=1}^{t-1} m_{is},$ $t = 1, \ldots, 72$.

We also incorporate various senator and race specific characteristics, including Republican (1 if senator is republican, 0 if democrat), Female (1 if senator is female, 0 otherwise), Seniority (number of years of service in the Senate), com_leader (1 if the senator held a leadership position in a senate committee, 0 otherwise), and leader (1 if the senator was minority or majority leader, 0 otherwise). The variable presdem.margin is the average vote spread for the period 2000-2008 between the Republican and Democrat candidates in the presidential election at the state level.

Tables A.1 and A.2 in the Appendix summarize these data. Together, the data present a number of facts which to the best of our knowledge are new in the literature. We describe the main features of the data in Section 3.1.

### 3.1. Key Facts

Figure 1 documents three key facts about money in elections for Senate seats. First, as it has been highlighted before, money plays a fundamental role in American politics (see for example Krasno et al. (1994)). The left panel of Figure 1 plots the empirical distribution of the total campaign contributions received by US senators running for office in our

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6 This is also the approach of Clinton (2006). To compute this estimate we assume normal priors for the ideal points and compute the joint posterior density for all model parameters with a MCMC procedure.

7 In the estimation of transition functions, we also include as a control data the challenger’s period $t$ expenditure in political ads and TV ad expenditure for and against the incumbent from third parties.
sample. On average, incumbent senators receive 5.4M US$ along each electoral cycle, with the top 75% receiving more than 2.5 M and the top 25% receiving more than 6.8 M.

The right panel plots the dynamics of income and expenditures across the electoral cycle for Senators in our sample. The dashed lines plot the proportion of contributions received by a typical senator $t$ months before the election $t = 1, 2, \ldots, 12$. We distinguish between Senators with a “low” (in the bottom 25 %) and “high” (in the top 25%) level of total contributions. The plot shows that contributions arrive gradually throughout the electoral cycle, starting well before election year, with high income senators receiving 50% of their total budget 7.5 months before the election, and low income senators receiving 50% of their total budget 10 months before the election.

The solid lines plot the proportion of total expenditures in TV advertising by a typical senator $t$ months before the election $t = 1, 2, \ldots, 12$. In stark contrast with the dynamics of contributions, almost all senators tend to concentrate expenditures in the last 6 months before the election, and typically spend more than 50% of their total TV ads expenditures in the last three months before the election. But there is also considerable variability in the active TV ad period, with a number of senators starting to spend in the third or fourth month before the election. The figure shows, in particular, that high income senators typically starting to spend earlier than their poorer counterparts.

The fundraising incumbency advantage is matched by an advantage in voter support at election time. This incumbency advantage has been extensively documented elsewhere (Erikson (1971), Gelman and King (1990), Levitt and Wolfram (1997), Ansolabehere et al. (2000)) However, we know less about the early indicators of voter support, and their evolution throughout the electoral cycle. The left panel of Figure 2 plots the empirical distribution of the pointlead for all senators in the sample in each of the last twelve months before the election. On average, across time and senators, incumbents enjoy an advantage in the polls of close to 18 p.p. There is however significant heterogeneity in poll advantage, both across and within legislators. To illustrate this, we plot in the right panel of Figure 1 the empirical distribution of the change in pointlead, $\Delta^i_{t+1} = p^i_{t+1} - p^i_t$. 
across $i,t$. This shows that the current value of \texttt{pointlead} is a good predictor of the \texttt{pointlead} in the next period; i.e., the point lead of each senator is a martingale. The figure also shows that the point lead changes significantly over time for given senators.\footnote{These results can also be seen in Figure A.1 in the Appendix, which plots the evolution of the median change in the point lead for democrats and republicans in three given electoral cycles, as well as the ten and ninety percentiles. The figure, again, indicates a significant variability of the point lead both across and within senators and periods before the election.}

The evolution of senators’ point lead throughout the electoral cycle is due to both exogenous and endogenous factors. On the one hand, polls change in response to news that affect the candidate favorably or unfavorably, changes in unemployment or crime in the state, and other shocks outside of the control of the candidate. On the other hand, voter support also responds systematically to factors under the control of the candidates, most importantly their position-taking in relevant policy issues (\texttt{stance}) and their political advertising (\texttt{tv-ads}).
We saw in Figure 1 that political ads tend to be concentrated in the last few months before the election. As we discussed in Section 2, several papers suggest that changes in position-taking become more prominent when the election approaches (e.g., Elling (1982), Thomas (1985), Levitt (1996)). The literature also points out, however, that there is significant variation in position-taking that is not associated with senators moderating their positions as the election gets closer (Elling (1982), Wood and Andersson (1998)).

Our policy stance variable reflects these observations. We illustrate this in Figure 3, which plots the evolution of the policy stance for selected senators in the last 20 months before the election. The figures on columns 1 and 2 are consistent with the pattern of convergence emphasized in Thomas (1985). Republican senators (top) take a more liberal policy stance as the election gets closer and democratic senators (bottom) take a more conservative policy stance as the election gets closer. In column 3, however, we see the opposite pattern, with the republican senator becoming more conservative and the democratic senator becoming more liberal in the last months before the election. In column 4, we see little evidence of convergence or divergence.
Figure 3. Position-Taking for selected senators. The policy stance of senators in columns 1 and 2 shows convergence to the political center as the election approaches. Column 3 exhibits divergence. Column 4 shows no discernible trend.

An attractive feature of having data on both voter support and position taking for each senator at a monthly frequency is that this increases vastly the individual level variation in the data on position-taking and voter support. This allows us to study the connection between voting records and evolution of support in a way that is simply not possible when we have a single observation of position-taking and electoral results by senator/electoral cycle, as it is the case in the previous literature.

To describe the conditional correlations in the data, we estimate the linear regression

$$p_{i,t+1} = \alpha^p + \beta_{0i,t}^p + \beta_1^p R_i + \beta_2^p x_{i,t} + \beta_3^p x_{i,t} \times R_i$$

$$+ \beta_4^p (x_{i,t} - \xi_i)^2 + \beta_5^p e_{i,t} + \beta_6^p e^{ch}_{i,t} + \beta_7^p Q_i + \epsilon_{i,t+1},$$

where $R_i = \text{republican}$, $\xi_i = \text{presdem.margin}$ and $Q_i$ is a vector of senator-specific controls including $\text{female, seniority, com_leader, leader}$, and Congress session.

Note that the monthly panel structure of our data allows us to control by the lagged level of budget and polls within an electoral cycle, which significantly alleviates causal inference concerns that are widespread in the previous literature.
The main inference problem in this context is the following. Suppose (1) voter support for the candidate decreases in response to a shock, (2) the senator adjusts position-taking towards the voter (say a liberal move), and (3) the change in position-taking increases voter support from what it would have otherwise been, but does not fully compensate the initial shock to polls. Regressing voter support on position-taking can lead us to incorrectly infer a negative effect of the liberal move. (The argument is the same for TV ads instead of position-taking.) This is a very valid concern if an observation reflects the entire electoral cycle for a given senator, as it is generally the case in the previous literature. The issue is less pressing, however, when higher frequency data for policy stances and voter support is available. In this case, voter support for the candidate decreases in period $t$ and the senator adjusts position-taking towards the voter in period $t$, but the change in position-taking increases voter support in period $t+1$. The temporal data allows us to distinguish the positive effect of ads/position-taking (reflected in period $t+1$ polls) from the initial effect of the shock on polls in period $t$.\(^9\)

Note also that equation (1) allows the effect of position-taking on next period polls to differ both based on the party of the senator and on partisan preferences at the state level, through the quadratic difference between $x_{it}$ and \texttt{presdem.margin}.\(^{10}\) Thus, taking a more conservative position can increase voter support in a conservative (liberal) state but decrease voter support in a liberal (conservative) state. This is a more natural specification than assuming that voter support is monotonically increasing or decreasing in the policy stance $x$, as it is assumed in other papers.

The estimated effect of position-taking on polls is represented in Figure 4. (The full set of coefficient estimates is presented in Figure A.2 in the appendix). We find that democratic

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\(^9\)Our specification reduces but does not eliminate all inference problems. The problem in our specification are unobserved shocks to $p_t$ that are permanent (have effect on $p_s$ for $s > t$ but only the direct effect is captured in $p_t$ (say for example the politician hires a better adviser, voters don’t know about this, so get constantly positively surprised by the good quality statements of the politician). Temporary shocks are fine, even if unobserved. Permanent shocks that are captured in $p_t$ are also fine (as for example if voters know that the politician hired the better adviser).

\(^{10}\)Using the republican vote in presidential elections to measure partisan preferences at the state level is standard in the literature. See for example Levitt (1996), Griffin (2006), Ansolabehere et al. (2001), and Canes-Wrone et al. (2002).
incumbents in democratic states on average gain voter support when they take a position to the left of the political center and lose voter support when they take a position to the right of the political center. Similarly, republican incumbents in republican states on average gain voter support when they take a position to the right of the political center and lose voter support when they take a position to the left of the political center. To the contrary, both democratic incumbents in republican states and republican incumbents in democratic states on average lose voter support as they move away from the political center.

![Figure 4. Electoral Consequences of Position-Taking](image)

Our results partially contrast with the findings of the literature, where the general finding is that incumbents are penalized for ideological extremity (see Section 2). We find that this is indeed the case for republican senators in democratic states and democratic senators in republican states, but not for democratic incumbents in democratic strongholds or republican incumbents in republican strongholds.

Via equation (1), we also estimate the effect of tv-ads on the senator’s poll advantage. Again, the monthly panel structure of our data alleviates causal inference concerns that apply to advertising. We find a positive and statistically significant effect of current
We also estimate the effect of changes in position-taking and political advertising on new contributions. To do this, we estimate the same type of regression as in (1) but for next period’s contributions as dependent variable; i.e.,

\[
m_{i,t+1} = \alpha^m + \beta^m_0 p_{i,t} + \beta^m_1 R_i + \beta^m_2 x_{i,t} + \beta^m_3 x_{i,t} \times R_i + \beta^m_4 (x_{i,t} - \xi_i)^2 + \beta^m_5 e_{i,t} + \beta^m_6 e^{ch}_{i,t} + \beta^m_7 Q_i + \varepsilon^m_{i,t+1},
\]

We find a positive and statistically significant effect of expenditures and a small but significant effect of position taking on next period’s contributions. We also find a large effect of the challenger’s expenditures on the incumbent’s next period contributions (See Figure A.3 in the Appendix).

4. The Model

We consider the decision-making problem of an incumbent politician \( t \) months away from the election, \( t = 1, \ldots, T \). At the beginning of each period \( t \), the incumbent observes polls in her district, \( p_t \in P \), and incoming contributions \( m_t \in M \) for finite sets \( P = \{p^1, p^2, \ldots, p^K\} \) and \( M = \{m^1, \ldots, m^L\} \). We let \( s_t \equiv (p_t, b_t) \), and \( S \equiv P \times M \). After observing \( s_t \equiv (p_t, b_t) \), the incumbent decides (i) her \( t \)-period policy position \( x_t \in X \) and (ii) her expenditure in TV ads, \( e_t \in E \), for finite sets \( X, E \).

\[
(p_t, m_t) \quad (x_t, e_t) \quad (p_{t+1}, m_{t+1})
\]

**Figure 5.** Sequence

The choices \( y_t = (x_t, e_t) \) in period \( t \) have both direct and indirect effects on payoffs, as they affect next period’s polls and contribution receipts (stochastically), and erodes the budget (deterministically). Let \( z_t \equiv (y_t, s_t) \). We assume the vector of observable state variables \( s_t = (p_t, b_t) \) is determined by a Markov process

\[
q_{k\ell}(z_t) \equiv \Pr(s_{t+1} = (p^k, b^\ell)|z_t) \quad \text{for all} \quad (p^k, b^\ell) \in S
\]
and let \( q^p_k(z_t) = \Pr(p_{t+1} = p^k|z_t) \) and \( q^m_k(z_t) = \Pr(m_{t+1} = m^k|z_t) \). In addition, the incumbent’s cash balance at the beginning of period \( t \) is given by

\[
(4) \quad b_t \equiv \sum_{s=1}^{t} m_s - \sum_{s=1}^{t-1} e_s,
\]

where we assume that \( e_t \leq b_t \) for all \( t \) (no debt), and that \( b_{T+1} = 0 \).

Each incumbent is endowed with an ideal policy \( \theta \in \mathbb{R} \) and a career concerns parameter \( \omega \in \mathbb{R}_+ \). Given \((\theta, \omega)\), the incumbent’s problem is to choose \( y_t = (x_t, e_t) \in X \times E \) in periods \( t = 1, \ldots, T \) to maximize

\[
V_t = E \left[ \sum_{r=t}^{T} u(x_r; \theta) + \mu(y_r) \right]_{s_t, \mu_t} + \omega E \left[ U(p_{T+1}) \right]_{s_t, \mu_t}
\]

s.t. (3), (4), \( e_t \leq b_t \forall t \) and \( b_{T+1} = 0 \),

where \( \mu(y_t) \) is a state variable that is observed by the politician but not by the econometrician which is i.i.d. with pdf \( g(\cdot) \). In particular, we will assume \( u(x_t, \theta) = -(x_t - \theta)^2 \) and that the office rent payoff is given by \( U(p) = 0 \) for \( p < 1/2 \), \( U(p) = \omega \) for \( p \in [0.5, 0.6) \), and \( U(p) = \omega + \alpha \) if \( p > 0.6 \). In this formulation, \( \omega \) measures the benefit of winning by a small margin, and \( \omega + \alpha \) captures the payoff of winning by a large margin.

**Optimality.** The value function for the politician in period \( T \) (after the realization of the \( \mu \) innovations) is

\[
(5) \quad W_T(s_T, \mu_T) = \max_{x_T} \left\{ u(x_T, \theta) + \omega \sum_{k} U(p^k) q^p_k(z_T) + \mu(y_T) \right\}_{e_T=b_T}
\]

The solution to the politician’s problem in period \( T \) is a policy function \( x^*_T(\cdot) \), where \( x^*_T(s_T, \mu_T) \) solves (5) in state \((s_T, \mu_T)\). We can then define the ex ante value function

\[
(6) \quad \overline{W}_T(s_T) \equiv \int W_T(S_T, \mu_T) g(\mu_T) d\mu_T.
\]
Similarly, for each $t = T - 1, \ldots, 1$, define, recursively,

$$
W_t(s_t, \mu_t) = \max_{y_t} \left\{ u(x_t, \theta) + \sum_{k=1}^{K \times L} W_{t+1}(s^k \theta) q_k(z_t) + \mu(y_t) \right\},
$$

and

$$
\overline{W}_t(s_t) \equiv \int W_t(S_t, \mu_t) g(\mu_t) d\mu_t.
$$

The solution to the politician’s problem in period $t = 1, \ldots, T - 1$ is a policy function $y^*_t(\cdot)$, where $y^*_t(s_t, \mu_t)$ solves (7) in state $(s_t, \mu_t)$.

5. Estimation

Let $\rho \equiv \{\theta, \omega, \alpha, \sigma_\mu\}$ denote the individual-specific parameters, let $\beta$ denote the transition parameters, and let $q$ denote senators’ beliefs. As in Section 4, we let $s_i \equiv (p_t, b_t)$ denote the observable $t$-period state for senators $i = 1, \ldots, n$, $y_t = (x_t, e_t)$ denote the $t$ period control for senators $i = 1, \ldots, n$, and $z_t \equiv (y_t, s_t)$. With this notation, the likelihood is

$$
L = \prod_{t=1}^{T} Pr(z_t | z_{t-1}; \rho, q) = \prod_{t=1}^{T} Pr(y_t | s_t; \rho, q) \cdot Pr(s_t | z_{t-1}, \beta).
$$

Note that the state transition function does not depend on the individual-specific parameters $\rho$. Thus, a consistent estimate of $\beta$ can be obtained using information on the transitions alone. Because this significantly reduces the computational burden, we estimate the parameters of the model in two steps. In the first step, we estimate the transition parameters $\beta$, pooling information across individuals. In the second step, we estimate the individual-specific parameters $\rho$ (see Aguirregabiria and Mira (2010)).

**First Step: Transition Parameters.** In the first step, we need to estimate the parameters of the conditional distribution $Pr(s_{t+1} | z_t, \beta)$ describing the stochastic relationship between the choices $(x_t, e_t)$ and state $(p_t, b_t)$ in period $t$ and the realization of the state
s_{t+1} = (p_{t+1}, b_{t+1}) in period \( t+1 \). To do this, we use the empirical model we specified in (1), adapted to the finite grid assumed in the structural model. Note that given \( \varepsilon^v_{i,t} \sim \mathcal{N}(0, \sigma^2_v) \), when \( p_{i,t+1} \) and \( b_{i,t+1} \) can take continuous values then \( \hat{v}_{i,t+1} | z_t \sim \mathcal{N}(m_v(z_t), \sigma^2_v(z_t)) \) for \( v = p, m \), where \( m_v(z_t) \) and \( \sigma^2_v(z_t) \) are computed directly from our estimates in Section 3.1. To adapt this stochastic framework for a finite set of states, we construct a partition \( \{a^v_0, a^v_1, \ldots, a^v_K(v)\} \) of the feasible set of values \( A^v \), and let \( v_t = v^k \) if \( v_t \in [a^v_{k-1}, a^v_k] \). Since \( \hat{v}_{i,t+1} | z_t \sim \mathcal{N}(m_v(z_t), \sigma^2_v(z_t)) \), then senators beliefs given the \( t \) period state \( s_t \) and control \( y_t \) are given by

\[
q^v_k(z_t) = \Phi \left( \frac{a^v_k - m_v(z_t)}{\sigma_v(z_t)} \right) - \Phi \left( \frac{a^v_{k-1} - m_v(z_t)}{\sigma_v(z_t)} \right) \quad \text{for } k = 1, \ldots, K(v)
\]

Second-Stage Estimates. Having estimated the parameters of the transition function, along with senators’ beliefs \( q(z_t) \), we turn to estimate the structural parameters \( \rho \equiv \{\theta, \omega, \sigma_\mu\} \). Note that unless we incorporate additional assumptions to link senators’ preference parameters across some observable trait, the log-likelihood function

\[
\ell = \sum_{i=1}^n \left[ \sum_{t=1}^T \log Pr(y^i_t | s^i_t; \rho_i, q) \right]
\]

is separable across \( i \). Thus, if we are to allow full heterogeneity in senators’ structural parameters, as is our goal, there is no gain in pooling the information of different senators. The difficulty in estimating \( \rho_i \) given (10) is that \( Pr(y^i_t | s^i_t; \rho_i, q) \) is not a known function of \( \rho_i \), but rather reflects optimal decision-making for the politician with characteristics \( \rho_i \) in each state \( (s^i_t, \mu^i_t) \), as given by the policy function \( y^i_*(s^i_t, \mu^i_t) \) that solves (7) in each state. This difficulty, however, doesn’t constitute a challenge from an econometric perspective, as the problem falls within the general class of single-agent dynamic problems that have been studied in the literature.

We estimate the structural parameters with a version of Rust’s nested fixed point algorithm. In this approach, we first solve the dynamic problem of each senator for every trial value of the parameters, and then search for the values that maximize the likelihood.
equation (10) using a stochastic global optimizer introduced by Mullen et al. (2011). Uncertainty on the estimates of the structural parameters can then be directly computed using the analytical gradient derived below evaluated at the MLE.

Because Rust’s algorithm requires that we fully solve the senator’s problem for each trial value of the structural parameters, this estimation method has the disadvantage of being computationally costly relative to other alternatives proposed in the literature. In our problem, however, these disadvantages are minor (especially after exploiting parallel computing in Princeton’s Tukey and Della clusters), and well compensated by the advantages of imposing no restrictions on the preferences – ideal points and career concerns – of individual senators.11

In what follows we drop the individual specific index $i$ for simplicity, with the understanding that we are working on independent problems for each senator. Recall from (7), that in a state $s_t$ in period $t$, the senator chooses $y_t$ to maximize $h(z_t) + \mu(y_t)$. Thus, the conditional choice probability $\Pr(y_t|s_t; \rho)$ is given by

$$\Pr(y_t = y'|s_t; \rho) = \Pr[h(s_t, y'; \rho) + \mu(y') \geq \max_{y \in Y} \{h(s_t, y; \rho) + \mu(y)\}]$$

Then

$$\Pr(y_t = y'|s_t; \rho) = \int_{\mu_t}^{(K \times L)-1} \prod_{k=1}^{L} G[h(s_t, y'; \rho) - h(s_t, y^k; \rho) + \mu(y')] g(\mu(y')) d\mu(y')$$

When $[\mu_t(y)]$ are iid type 1 extreme value random variables with scale parameter $\sigma_{\mu_t}$, (8) and (11) become

11To appreciate this later point, note that all variants of the Hotz-Miller approach pool data from various individual problems to estimate conditional choice probabilities at each state, which can then be used to recover value functions and structural parameters without explicitly solving the optimization problem for each parameter. In order to interpret the recovered conditional distributions over actions as equilibrium choice probabilities, however, we need to assume that pooled senators have the same ideal point and career concern parameter, or at least significantly restrict the possible differences in their preferences. While similar assumptions are not too restrictive in other contexts, they are a significant shortcoming for our purposes.
\[ W_t(s_t) = \sigma_{\mu} \ln \left( \sum_{y \in Y} \exp \left[ \frac{h(s_t, y)}{\sigma_{\mu}} \right] \right), \quad \Pr(y_t = y'|s_t; \rho) = \frac{\exp \left[ \frac{h(s_t, y'; \rho)}{\rho_{\mu}} \right]}{\sum_{y \in Y} \exp \left[ \frac{h(s_t, y; \rho)}{\rho_{\mu}} \right]} . \]

Thus our problem becomes to choose \( \rho \) to maximize

\[ \hat{\ell} = \sum_{t=1}^{T} \ln \left[ \frac{\exp \left[ \frac{h(s_t, y'; \rho)}{\rho_{\mu}} \right]}{\sum_{y \in Y} \exp \left[ \frac{h(s_t, y; \rho)}{\rho_{\mu}} \right]} \right] . \]

If \( h(s_t, y; \rho) \) were a linear function of the parameters \( \rho \), (13) would boil down to a multinomial logit model. Here however, \( h(s_t, y; \rho) \) is a complex nonlinear function of \( \rho \) which has to be computed from the Bellman equation in (12).

We obtain the MLE of \( \rho \) combining a gradient search method (i.e., “Newton-Raphson”) with a dynamic programming problem for each “trial” value of \( \rho \) as in Rust (1987). We obtain the gradient \( \frac{\partial \hat{\ell}(\rho)}{\partial \rho} \) analytically and exploit the “information equality” to approximate the Hessian with \(- \left( \sum_{i=1}^{n} \frac{\partial \hat{\ell}(\rho)}{\partial \rho} \right) \). As the model has finite horizon, we can solve for the value function \( W_{t+1}(s_t) \), its gradient \( \frac{\partial W_{t}(s_t)}{\partial \rho} \), and choice probabilities \( \Pr(y_{it} = y'|s_{it}; \rho) \) in the inner loop.

6. Results

We begin by describing the estimates for senators’ ideal points, and relating our findings with the conventional wisdom regarding elite and voters’ policy preferences. We then discuss our results regarding senators’ responsiveness to the electorate.

6.1. Elite and Voters’ Preferences Revisited

Ideal points in our model are conceptually equivalent to the ideal points estimated in previous literature (e.g., Poole and Rosenthal (1985), Clinton et al. (2004)): all else equal, a senator prefers to vote for \( x \) over \( y \) if the latter is farther away from her ideal
position. However, our estimates differ from previous estimates. This is not because we employ a different method to estimate the same model (as is the case between IDEAL and DW-NOMINATE), but because our model integrates voting over policies with career concerns, which in turn allows us to separate preferences from pandering.

The key point to note here is that since different realizations of polls and budget change the payoff of using different actions, the likelihood of observing a particular policy choice \((x_t, e_t)\) will generally be a function of both the intrinsic characteristics of the senator (her ideal point and career concern) and the current state \((p_t, b_t, t)\).

To see this point clearly, consider Figure 6. The figure plots the optimal position-taking choices of a senator with ideal policy \(\theta = 0.71\) as a function of her advantage in the polls, two and four months away from the election. The blue curve represents optimal choices of a “poor” senator (budget in the lower 25% of the distribution), and the red curve the optimal choices of a “rich” senator (budget in the top 25% of the distribution). For a large advantage in the polls, this senator’s optimal response is to adopt a position close or at her ideal policy (dotted black line in the figures). As the election becomes more competitive, instead, the senator optimally moves towards the position that maximizes voter support, indicated by the green line. The extent and speed of adjustment towards
the voter depends on the time period and the senator’s war chest. Response is larger and faster when the senator is two months away from the election than when she is four months away from the election, and larger and faster when the senator has a small war chest than when she has a large war chest.

This example (and Figure 6 is only meant as that) illustrates that assuming a constant relationship between ideal policies and voting behavior is heavily restrictive. We expect senators’ voting positions to change in predictable ways with the state. Our model relaxes this assumption, recovering the ideal point and career concern parameters that would lead to choices observed in the data taking into account war chest, poll advantage and time to election.

Our ideal point estimates are presented in Figure 7. Senators Reed, Boxer and Schumer are among the most liberal senators, while senators Bunning, Coburn and Crapo are among the most strongly conservative senators. Democrats Carnahan and Feingold and Republicans Abraham and Snowe are among the most centrist senators. The most interesting finding, however, is that the distribution of senators’ ideal points is much more populated at the center than in the estimates from the spatial model. This is shown most clearly in Figure 8, which compares our ideal point estimates side by side with both the DW-Nominate and IDEAL estimates.

Since our estimates discount pandering, the senators who we find are centrist relative to DW-NOMINATE are *pandering out to voters*; voting more extreme than how they would want to vote because of office motivations. This finding contrasts with the view of the dominant work on polarization (McCarty et al. (2006)), which holds that standing legislators are generally more extreme than their constituents.

The relationship between the politicians and the direction of electoral pressure is shown in the top row of Figure 9, which plots the distribution of senators’ ideal points and the poll maximizing policy position in each race. As the figure shows, the distribution of the poll maximizing position is bimodal, with peaks at the side of the center. Thus,
consistent with the argument by Fiorina (1974), electoral pressures push this group of centrist senators to the extremes.

Importantly, the poll maximizing position is not the mean district ideology. In fact, the distribution of mean voter ideology, while still bimodal, is more heavily concentrated in the center of the political spectrum (bottom row of Figure 9). Note that differently to the mean district ideology, which we measure directly from the data, the poll maximizing position is a “free parameter”, which we estimated in the first stage, allowing the effect of position-taking on next period polls to differ both based on the party of the senator and on partisan preferences at the state level (see equation (1)). Thus, the comparison
between the average district ideology and the poll maximizing position is informative: if they were to coincide, then we could say that the electoral pull is from the average district ideology (as it is often assumed). But when they differ (and in fact they do, as we just saw), there is something else going on.\textsuperscript{12}

\textsuperscript{12}This is consistent with the findings of Clinton (2006), which shows (for congressmen and in one session) that representatives are not responsive to the mean voter, but that democrats and republicans are differently responding to voters of the same party and the opposition (for the 106th House, where republicans had the majority, Clinton (2006) finds Republicans are more responsive to the preferences of the same-party constituency, and Democrats more responsive to opposition constituents.)
Up to this point, we have focused on the group of truly moderate senators that go against the conventional wisdom. However, Figures 7-9 also show that alongside the centrist group negotiating the vote-maximizing pressure to be more extreme, there is another group of senators, who are negotiating a vote-maximizing pressure to moderate.

6.2. Senator Responsiveness

The analysis in the previous section shows that senators’ ideal point estimates differ from those of the spatial voting model due to pandering. Another way to put this is that senators are being somewhat responsive to the preferences of the electorate. In this
section we analyze how and under what conditions are senators responsive. We do this without imposing a priori a particular pattern of behavior, both in terms of under what conditions senators would be responsive (if when challenged or not, if early in the cycle or late) or how (if towards the center or the extreme). Instead, we recover the predicted behavior for each senator in each time period, budget level and poll level from optimal play given the estimated structural parameters.

**Figure 10.** Top: Voinovich (R-OH) \( (\theta = 0.33, \omega = 54.1, \alpha = 100.6, \sigma_p = 0.3) \), middle row: Lautenberg (D-NJ) \( (\theta = -0.88, \omega = 72.6, \alpha = 4.0, \sigma_p = 0.4) \); bottom: Grassley (R-IA) 14226-111 \( (\theta = 1.43, \omega = 188.23, \alpha = 80.0, \sigma_p = 2.67) \)
Allowing this flexibility is important because optimal behavior in this model doesn’t fit in a straightforward manner with the relatively broad patterns examined in the previous literature. Consider Figure 10, which plots the policy functions for three senators at their estimated parameters. The plots in the top row (Voinovich (R-OH)) conform nicely with the patterns of the case depicted in Figure 6: for a large advantage in the polls, the senator adopts a position close to her ideal policy, but as election becomes competitive, she moves towards the position that maximizes voter support, especially in later periods. The optimal policy position of Senators Lautenberg (D-NJ) and Grassley (R-IA) with a low war chest, however, is non-monotonic in poll advantage. In this case, the senators adopt a position close to their ideal point both when winning by a landslide and when losing, and go towards the position maximizing voter support only when they enjoy a moderate advantage in the polls.

In spite of this heterogeneity, some general lessons emerge. First, senators that are office motivated will indeed depart radically from their ideal policies when the conditions dictate that there is sufficient return to this form of sacrifice. In fact, the extent of pandering or responsiveness to voters will be monotonic in electoral strength when the senator gives a relatively large value to both getting reelected ($\omega$) and, conditional on getting reelected, to getting reelected by a large margin ($\alpha$). Instead, the adjustment to voters can be non-monotonic in electoral strength when senators care about getting reelected but do not care about the size of support conditional on being reelected. Second, the degree of responsiveness to voters varies with time to election. This is not to say that senators will necessarily moderate as the election approaches, but that their response to changes in polls and war chest levels will be more intense as the election approaches. Third, since expenditures in TV ads and policy concessions tend to be substitutes at relatively high levels of voter support, senators with a high war chest will move away from their ideal point less than senators with a low war chest. At low levels of voter support, however, pandering and TV-ad expenditures can be complements, as one instrument might be insufficient to attain reelection. In these cases, it is only senators with a large war chest who will optimally pander to voters.
Finally, we can relate our results with the debates around the marginality hypothesis. There are two questions here. One is: when senators adjust their position, who do they pander to? We addressed the first question in Section 6.1. To recap, we find that senators generally do not pander to the mean district ideology. Moreover, we find that a large fraction of senators pander out to voters that have more extreme preferences than they do. Second, are senators in competitive races more responsive to voters? In order to answer this question, something like a summary statistic or small number of hypothesis tests are needed. In some sense the parameters $\alpha_i$ answers this challenge. In our specification we estimate the value of winning, $\omega_i$, as well as the value of winning by a landslide $\alpha_i$. If Senator $i$ is only responsive when she is worried about winning (or in a marginal seat) then one would expect large $\omega_i$ and small $\alpha_i$. But one version of the model in which responsiveness is driven by electoral pressures even when the race is not close would involve large $\alpha_i$ and large $\omega_i$. Our estimates of $\alpha_i$’s tend to be large, too large for us to conclude that incumbents are not responsive, once the correct source of control is identified.

![Figure 11. Career Concerns Parameters](image-url)
7. Conclusion

In this paper we formulate a model that captures key elements of the incumbent’s problem, and then estimate the model using monthly data on voting, TV ads, polls, and contributions for 74 standing Senators over the years 2000-2010. Central to the model are two related tradeoffs (i) balancing voting behavior that maximizes reelection prospects and voting behavior that is true to the legislators preferences, (ii) allocation of reelection oriented behavior over the months leading up to election. By modeling how incumbents balance the first tradeoff over time and estimating the reelection maximizing and sincere preferences we can contribute to the literatures that study the distribution of legislative preferences and debates on how electoral concerns influence representation. Overall, we find a large group of legislators that are fairly moderate but pulled to the extremes when the value of pandering for the election is high. We also find a small group that is actually very extreme and finds itself pulled to the middle as the election nears. Our results paint a picture of a less polarized Senate that faces varied constituent specific pressure to sometimes pander.

In estimating how senators balance the pull of electoral pressure and sincere motivations we recover senator specific values to reelection as well as winning by a large margin, The latter has close connections with debates on the relevance of close elections for influencing representation. These parameters represent a promising direction for future work studying which types of legislators are most responsive. In addition to incumbent policy preferences we estimate reelection maximizing positions, and thus the estimates also allow subsequent work to answer the question, to whom are incumbents responsive when they are responsive.

Holding fixed this Senator specific parameters the model still predicts substantial variation in how responsive an incumbent is depending on current standing in the polls, their budget, and proximity to the election. At an aggregate level we find that money matters a lot, as high budget incumbents vote in a way that is substantially less responsive to electoral pressure; senators tend to look substantially different in the last 6 months before
an election than in the previous 5 and 1/2 years of their term and even then Senators
tend to believe that what they do at the very end is much more important than what they
do in the spring before an election.


Fiorina, Morris P, *Representatives, roll calls, and constituencies*, Lexington Books,
1974.


Lee, David S, Enrico Moretti, and Matthew J Butler, “Do voters affect or elect


8. Appendix

Table A.1. Summary Statistics: Continuous Variables in the Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Min</th>
<th>( \bar{x} )</th>
<th>( q_{1} )</th>
<th>( q_{3} )</th>
<th>Max</th>
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<tr>
<td>Poll Spread</td>
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<td>-18.5</td>
<td>17.9</td>
<td>8.8</td>
<td>17.5</td>
<td>26.6</td>
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<td>Contributions ($M)</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
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<td>Budget ($M)</td>
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<td>2.5</td>
<td>4.5</td>
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<td>Inc. TV Ad ($M)</td>
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<td>0.9</td>
<td>0.2</td>
<td>0.4</td>
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<td>Pro-Inc. Indep. Ad ($M)</td>
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<td>0.7</td>
<td>0.1</td>
<td>0.4</td>
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<td>Total Pro-Inc. Ad ($M)</td>
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<td>0.1</td>
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</tr>
<tr>
<td>Challenger TV Ad ($M)</td>
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Table A.2. Summary Statistics: Discrete Variables

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Figure A.1. Change in the poll lead for democrats (top) and republicans (bottom) in various electoral cycles; 10-50-90 percentiles.
Figure A.2. First Stage Estimates for Polls Transition ($p_{t+1}$). Thin (wide) lines denote 90% confidence intervals (interquartile range).
Figure A.3. First Stage Estimates for Contributions Transition ($m_{t+1}$). Thin (wide) lines denote 90% confidence intervals (interquartile range).