Negative Voters?
Electoral Competition with Loss-Aversion

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Abstract: This paper studies how voter loss-aversion affects electoral competition. We show that there is both platform "rigidity" and reduced polarization of platforms relative to the standard case. In a dynamic extension of the model, we consider how parties strategically manipulate the status quo to their advantage: this further reduces polarization but also reduces rigidity. In the dynamic model, winning the election conveys no advantage on the incumbent, but an incumbency advantage of a particular kind does emerge via the voter reference point if preferences shift. Specifically, incumbents adjust less than challengers to shifts in voter preferences, and as a result, favorable (unfavorable) preference shifts, from the point of view of the incumbent, intensify (reduce) electoral competition. These two predictions are new, and we test them using elections to US state legislatures, where we find empirical support for them.
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1 Introduction

There is now considerable evidence that citizens place greater weight on negative news than on positive when evaluating candidates for office, or the track records of incumbents. In the psychology literature, this is known as negativity bias.[1] For example, several studies find that U.S. presidents are penalized electorally for negative economic performance but reap fewer electoral benefits from positive performance (Bloom and Price, 1975, Lau, 1985, Klein, 1991).

Similar asymmetries have also been identified in the UK and other countries. For example, for the UK, Soroka (2006) finds that citizen pessimism about the economy, as measured by a Gallup poll, is much more responsive to increases in unemployment than falls. Kappe (2013) uses similar data to explicitly estimate a threshold or reference point value below which news is "negative", and finds similar results. Nannestad and Paldam (1997) find, using individual-level data for Denmark, that support for the government is about three times more sensitive to a deterioration in the economy than to an improvement.[2]

In this paper, we study the impact of voter negativity bias on electoral competition in an otherwise quite standard Downsian setting. We model negativity bias in terms of loss-aversion. Our model is formally set up as one where voters suffer an additional loss if a party platform offers lower utility than the reference point; the additional ingredient of probabilistic voting means that when the platform is "negative" i.e. generates a utility below the reference point, it lowers the probability that the citizen votes for that party by more than a "positive" platform of the same distance from the reference point increases that probability.

This is one of the very few papers to incorporate loss-aversion into models of political choice. A recent and contemporaneous contribution by Alesina and Passarelli (2015), discussed in detail in Section 2 below, studies loss-aversion in a direct democracy setting. However, to our knowledge ours is the first paper to study the effect of loss-aversion in a representative democracy setting.[3].

In more detail, we study a simple model where voters care both about parties' policy choices and their competence in office (valence). Moreover, they have loss-aversion in the policy dimension. There are two parties which choose policy positions, and which care about both policy outcomes and holding office. Without loss-aversion, this setting is similar to the well-known one of Wittman (1983), where in equilibrium, parties set platforms by trading off the probability of winning the election against the benefits of being closer to their ideal points.[4]

[1] See for example, the survey on negativity bias by Baumeister et al. (2001).

[2] Soroka and McAdams (2015) argue that this negativity bias on the part of voters is an example of a more general bias whereby suggest that humans respond more to negative than to positive information, and they link this bias to loss-aversion.

[3] The first version of this paper, Lockwood and Rockey (2015), was finished in 2015

[4] Our model differs from Wittman's in that in his model, this trade-off is generated by party uncertainty about the position of the median voter, whereas in our model, it is generated by probabilistic voting. As

We assume that the reference point is the status quo policy. This assumption is widely made in the literature on loss-aversion applied to economic situations[5], and seems realistic, since benefits and costs of political reforms are normally assessed relative to existing policies.[6]

We first establish that loss-aversion affects the election probability of each party. Once the median voter's utility from a party's policy platform falls below utility from the reference policy, the re-election probability starts to fall more rapidly than without loss-aversion. Thus, there is a kink in the election probability for each party at this point. This kink has a number of implications for electoral competition.

First, there is *policy rigidity* ; for a range of values of the status quo (where the absolute value of the status quo lies in an interval $[x^-, x^+]$, $0 < x^- < x^+$) one party will choose a platform equal to the status quo, and the other will choose a platform equal to minus the status quo, regardless of other parameters. In this case, the outcome is insensitive to small changes in other parameters, such as the weight that political parties place on office. Second, there is a *reduced polarization* effect of loss-aversion; generally, equilibrium party platforms are both closer to the median voter's ideal point than in the absence of loss-aversion.

We also investigate who benefits from voter loss-aversion. It turns out that if political parties are risk-averse, both parties have higher equilibrium payoffs with voter loss-aversion than without, strictly so as long as the status quo is not too far from the median voter's ideal point. Moreover, the closer the status quo is to the ideal point, the better off are the parties. This is because parties dislike polarization, and with voter loss-aversion, polarization decreases, the closer the status quo is to the median voter's ideal point.

This suggests that it is important to study multi-period elections, as then parties have an incentive to strategically manipulate the status quo to reduce future polarization. To investigate this issue, we turn to a finitely repeated version of our model. We find that if the political parties are risk-averse, platform polarization, conditional on any reference point of the median voter, is smaller than in the static case. The reason is that starting at any policy platform that is short-run optimal for a party, a small move in the platform towards the ideal point of the median voter will, with some probability, reduce the next period's status quo in absolute value and thus polarization next period. Moreover, the less political parties discount the future, the less polarization there is. Finally, strategic incentives also reduce the the range of status quo values for which there is policy rigidity. Overall, this means that the median voter prefers political parties to be both risk-avese and forward-looking.

explained below, the latter is required for loss-aversion to have any bite.

[5]For example, see de Meza and Webb (2007) for a principal-agent problem, or Freund and Özden (2008) in the context of lobbying on trade policy.

[6]Extensions to the case of a forward-looking reference point as in Kőszegi and Rabin (2006) are discussed in the Appendix. There, it is shown that the political equilibrium exhibits policy moderation, as in the backward-looking case, but perhaps not surprisingly, due to the forward-looking reference point, there is no longer policy rigidity. There is also a continuum of equilibria.

A striking feature of the dynamic analysis is that, although the winning platform last period determines the reference point of the median voter this period, winning the election conveys no advantage on the incumbent; if, for example, the R party was the winner at $t-1$, he chooses the same platform at t, and wins with the same probability (i.e. one half) as if he did *not* win the previous election. The intuition for this is simply that the reference point is in utility space, not policy space.[7]

However, it turns out that a particular form of incumbency advantage *does* emerge in response to preferences shifts. We consider a scenario where one party has won the previous election and this party's platform is therefore the voter reference point. Starting from this position, without loss aversion, a shift in either direction (left or right) in the ideal points has the same effect on both incumbent and challenger - both move their equilibrium platforms in the direction of the preference shift by the same amount. But, with loss-aversion, there is asymmetric adjustment: regardless of the direction of the preference shift - i.e. left or right - the incumbent platform will adjust by less than the challenger's platform. In other words, loss-aversion generates a particular kind of asymmetry, which is testable; incumbents adjust less than challengers. The underlying force is that the status quo works to the advantage of the incumbent.

The second testable prediction of is the following. Say that a preference shift is favorable (unfavorable) for the incumbent if it is in the same direction as the incumbent's ideological bias i.e. a leftward (rightward) shift for the left (right) party. Then, following a "favorable" preference shift for the incumbent, the gap between platforms decreases, but following an "unfavorable" preference shift for the incumbent, the gap between platforms increases. That is, favorable (unfavorable) preference shifts intensify (reduce) electoral competition.

These predictions are both new, and we take them to data on elections to US state legislatures. We employ a new data-set introduced by Bonica (2014b) which contains time-varying estimates of the platforms of all candidates, winners and losers, in elections to state legislatures, based on the campaign donations they received. We combine these with detailed election results to identify shifts to the distribution of voter preferences and changes in party platforms at the state level over a 20 year period. These data have the important advantage of representing a large sample of institutionally and politically homogeneous elections. Using these data we find, as predicted by the theory, that incumbent parties are significantly less responsive to shifts. We also find, as predicted, that That is, favorable(unfavorable) preference shifts intensify (reduce) electoral competition.

The remainder of the paper is organized as follows. Section 2 reviews related literature, Section 3 lays out the model, and Section 4 has the main theoretical results. Section 5 studies the dynamic extension of the model, and Section 6 deals with

[7] Specifically, if the R party won with a platform of x last period, that has the same effect on the reference point as the L party winning with platform $-x$.

preference shifts. Section 7 discusses the US data we use to test our main hypotheses. Section 8 describes our empirical strategy and our empirical findings, and finally Section 9 concludes.

2 Related Literature

1. *Alesina and Passarelli (2015)*. This paper, henceforth AP, is the most closely related to what we do. In their paper, citizens vote directly on a one-dimensional policy describing the scale of a project, which generates both costs and benefits for the voter. In this setting, for loss-aversion to play a role, the benefits and costs of the project must be evaluated relative to separate reference points. This is because if loss-aversion applies to the net benefit from the project, the status quo cannot affect the ideal point of any voter. We do not need this construction, because in our setting, the voters compare the utility from policy positions to party valences.

So, loss-aversion has "bite" in our model via a different mechanism to theirs - that is, via the voters' comparison of utility from policy and party valence, rather than via separate reference points for benefits and costs. Moreover, we make the often-used assumption that parties do not know how voters evaluate them in the non-policy dimension, which creates probabilistic voting and thus a non-trivial tradeoff between winning the election and the closeness of the platform to the party ideal point.

The implication of this is that the effect of loss-aversion on both direct and representative democracy in the AP model and ours are very different. If we introduce political parties and electoral competition into the AP model, then, absent any other changes, the classic Downsian result would emerge i.e. parties would converge to the median voter's ideal point. In other words, a switch from direct to representative democracy would have no effect on the policy outcome in their setting. But, in the AP model, loss-aversion does generally affect most preferred policy of the median voter.

In our model, the situation is reverse. Loss-aversion affects the outcome with representative democracy, but does not affect the ideal policy position of the median voter, and thus does not affect the outcome with direct democracy.

As explained in more detail below, several of our results are similar in spirit to theirs, although the details differ substantially.[8] Furthermore, the dynamic behavior of our model is quite different to theirs; for example, we have a strategic choice of the reference point by political parties in equilibrium. Finally, our main empirical prediction, that incumbents adjust less than challengers to voter preference shifts, has no counterpart in their analysis.

2. *Electoral competition with behavioral and cognitive biases.*

A small number of papers study electoral competition with voter behavioral biases. Callander (2006) and Callander and Wilson (2008) introduce a theory of context-

[8]The relationship between our notions of platform rigidity and platform moderation and theirs is discussed in more detail below.

dependent voting, where for example, for a left wing voter, the attractiveness of a left wing candidate is greater the more right wing is the opposing candidate, and apply it to the puzzle of why candidates are so frequently ambiguous in their policy.

More recently, Razin and Levy (2015) study a model of electoral competition in which the source of the polarization in voters' opinions is "correlation neglect", that is, voters neglect the correlation in their information sources. Their main finding is that polarization in opinions does not necessarily translate into platform polarization by political parties compared with rational electorates. This contrasts with our result that loss-aversion always reduces platform polarization.

Matějka and Tabellini (2015) studies how voters optimally allocate costly attention in a model of probabilistic voting. Voters are more attentive when their stakes are higher, when their cost of information is lower and prior uncertainty is higher; in equilibrium, extremist voters are more influential and public goods are under-provided, and policy divergence is possible, even when parties have no policy preferences.

Finally, Bisin et al. (2015) consider Downsian competition between two candidates in a setting where voters have self-control problems and attempt to commit using illiquid assets. In equilibrium, government accumulates debt to respond to individuals' desire to undo their commitments, which leads individuals to rebalance their portfolio, in turn feeding into a demand for further debt accumulation.[9]

There are also a number of recent papers that consider the effects of voter biases in non-Downsian settings, either where party positions are fixed, or where policy can be set ex post e.g. political agency settings. However, these papers are clearly less closely related to what we do.[10]

3. *Multi-period electoral competition*. This paper shows how loss-aversion may create dynamic linkages between successive election outcomes. There is now a substantial literature on repeated elections; the closest strand of this literature are those contributions in a Downsian setting where parties can make ex ante policy commitments. In an influential paper, Duggan (2000) studied a model where individual citizens have policy preferences and also care about office, and can pre-commit to policy positions before elections. Every period the incumbent faces a challenger in an election, where the latter is randomly selected from the population.[11] The dynamic

[9] Passarelli and Tabellini (2013) is also somewhat related; there, citizens belonging to a particular interest group protest if government policy provides them with utility that is below a reference point that is deemed fair for that interest group. In equilibrium, policy is distorted to favor interest groups who are more likely to protest or who do more him when they riot. However, in their setting, there is no voting, so the main shared feature between that paper and ours is that we both consider the role of reference points in social choice.

[10] For example, Ashworth and Bueno De Mesquita (2014) and Lockwood (2015) consider deviations from the full rationality of the voter in a political agency setting. Ortoleva and Snowberg (2013), show theoretically that the cognitive bias of correlation neglect can explain both voter overconfidence and ideological polarization. Levy and Razin (2015), find that the cognitive bias of correlation neglect can improve outcomes for voters. Grillo (2016) studies the effect of voter loss-aversion on communication from politicians to voters about valence.

[11] This model has since been extended in various directions. to allow for term limits (Bernhardt et al., 2004), multi-dimensional policy spaces (Banks and Duggan, 2008), for political parties who can choose

model of Section 5 is rather different to the Duggan model; in our setting, the winning platform is a state variable that affects party preferences over platforms in the next period, and thus provides incentives for strategic manipulation.

4. *Related empirical work.* Our empirical work is related to that of Adams et al. (2004) and Fowler (2005). In particular, both study party platform responses to changes in the position of the median voter. (Adams et al., 2004) is a purely empirical study, which pools national election results for political parties in eight West European countries over the period 1976-1998, to relate parties' manifesto positions to the preferences of the median voter. On the basis of this analysis they argue that parties only respond to disadvantageous moves in the median voter.

Fowler (2005) considers elections to the US Senate over the period 1936-2010. His theoretical model shows that parties learn about voter preferences from election results, and consequently predicts that Republican (Democratic) victories in past elections yield candidates who are more (less) conservative in subsequent elections, and the effect is proportional to the margin of victory. This is a rather different hypothesis to the one we test, which concerns the effects of shifts in voter preferences before elections.

3 The Model

3.1 The Environment

There are two parties L and R, and a finite set of voters N. The two parties, L and R, choose platforms x_L, x_R in the policy space $X = [-1, 1]$. They are assumed to be able to commit to implement these platforms. Thus, the basic framework is Downsian competition.

Each voter $i \in N$ has preferences over policy and also party valences. Voter i has an ideal point x_i in the policy space $X = [-1, 1]$. We assume that the number of voters, n, is odd. Voters are ranked by their ideal points; i.e. $-1 < x_1 < x_2 < \cdots < x_n < 1$. To ensure existence of symmetric equilibrium, we assume that the median voter $m = \frac{n+1}{2}$ has an ideal point $x_m = 0$, equidistant between the two party ideal points. All voters also care in the same way about party valences, which are $\varepsilon_L, \varepsilon_R \in \Re$. Valence has the usual interpretation of candidate competence in office, but could also represent charisma etc.

The order of events is as follows. First, parties L, R simultaneously choose their platforms. Then, $\varepsilon_L, \varepsilon_R$ are drawn from distributions that are common knowledge. For voting behavior, all that matters is the difference $\varepsilon = \varepsilon_L - \varepsilon_R$, and we denote the distribution of ε by F. Finally, all voters vote simultaneously for one party or the other. We will assume that voters do not play weakly dominated strategies; with only two

candidates, (Bernhardt et al., 2009), and to the case where candidates also differ in valence (Bernhardt et al., 2011).

alternatives, this implies that they vote sincerely.

This timing of course implies that there is some aspect of valence that is not known to the parties at the point when platforms are chosen. This is quite plausible; parties may not fully know their competence in office before they win power, and as an assumption, has been made before in the literature e.g. Ansolabehere et al. (2012). The purpose of this timing assumption a standard one; it makes the outcome of the election uncertain for the two political parties, thus preventing complete convergence in equilibrium to the median voter's ideal policy point.

3.2 Voter Payoffs

We begin with payoffs over policy. Following Osborne (1995), we assume that "ordinary" or intrinsic utility over alternatives $x \in X$ for voter i is given by $u_i(x) = -|x - x_i|$. Following Kőszegi and Rabin (2006, 2007, 2009), we specify the gain-loss utility over policy for voter i as;

$$v_i(x;r) = \begin{cases} (u_i(x) - u_i(r)), & u_i(x) \geq u_i(r) \\ \lambda(u_i(x) - u_i(r)), & u_i(x) < u_i(r) \end{cases} \tag{1}$$

The parameter $\lambda > 1$ measures the degree of loss-aversion, and $r \in X$ is a reference point, defined below. The empirical evidence gives a value for λ of around 2 (see, Abdellaoui et al., 2007). The assumption that λ is the same for all voters is made just for convenience, and could be relaxed. Note finally that that if $\lambda = 1$, the policy-related payoff is, up to a constant, just $u_i(x)$, so our specification of policy preferences nests the standard model with absolute-value preferences as a special case.

As already noted, voters also care about party valences. So, if party p offers platform x_p, the overall payoff of voter i from voting for party p is

$$v_i(x_p;r) + \varepsilon_p \tag{2}$$

Note from (2) that the two dimensions of utility are additively separable and the voter does not (fully) integrate gains and losses across dimensions. That is, preferences satisfy, in the language of Tversky and Kahneman, decomposability. This implies that the relative trade-off between the two dimensions changes discontinuously if the outcome in the policy dimension passes the reference point. This creates the relative change in the tradeoff which is responsible for all the interesting results.

Finally, similar to Alesina and Passarelli (2015), we assume that voters are "backward looking" in that the reference point r is an initial policy outcome, the *status quo*, x_S. The case of a forward-looking reference point, as in Kőszegi and Rabin (2006, 2007, 2009), is considered in Section B below in the not-for-publication Appendix. It turns out in this case, there are a continuum of equilibria, due to the simultaneous determination of the reference point and equilibrium party platforms.

3.3 Party Payoffs

Parties are assumed to have policy preferences, with the L party having an ideal point of $-1,$ and party R an ideal point of $1.$ Parties care about both the policy outcome, and winning office. The payoff to office is denoted $M.$ Payoffs of the L and R party members are $u_L(x) \equiv -l(|x+1|),\ u_R(x) \equiv -l(|x-1|)$ respectively, where l is twice differentiable, strictly increasing, symmetric and convex in $|x-x_i|$, and that $l(0)=l'(0)=0.$ This specification allows for parties to be risk-neutral ($l''=0$) or strictly risk-averse $(l''>0)$ over policy outcomes; some of our results will depend on the risk-aversion of party members, as discussed further below. Finally, we note that parties (or rather, their members) are assumed not to be loss-averse; party loss aversion raises a number of new issues which are not addressed in this paper.

So, expected payoffs for the parties are calculated in the usual way as the probability of winning, times the policy payoff plus $M,$ plus the probability of losing, times the resulting policy payoff. For parties R, L respectively, this gives

$$\begin{aligned} \pi_R &= p(u_R(x_R)+M)+(1-p)u_R(x_L) \\ \pi_L &= (1-p)(u_L(x_L)+M)+pu_L(x_R) \end{aligned} \tag{3}$$

where p is the probability that party R wins the election and is defined below. As we shall see, p depends not only on the platforms x_L, x_R, but also on the voter reference point x_S.

3.4 Win Probabilities

Here, we characterize the probability p that party R wins the election.We have assumed that all voters voters do not use weakly dominated strategies, implying that they vote sincerely. So, from (2), given $\varepsilon=\varepsilon_L-\varepsilon_R,$ any voter i will vote for party $R,$ given platforms $x_L,x_R,$ if and only if

$$v_i(x_R;r) \geq \varepsilon + v_i(x_L;r) \tag{4}$$

Our preferred interpretation, following , is that the shock ε is interpreted as the difference between the valences of the two parties.

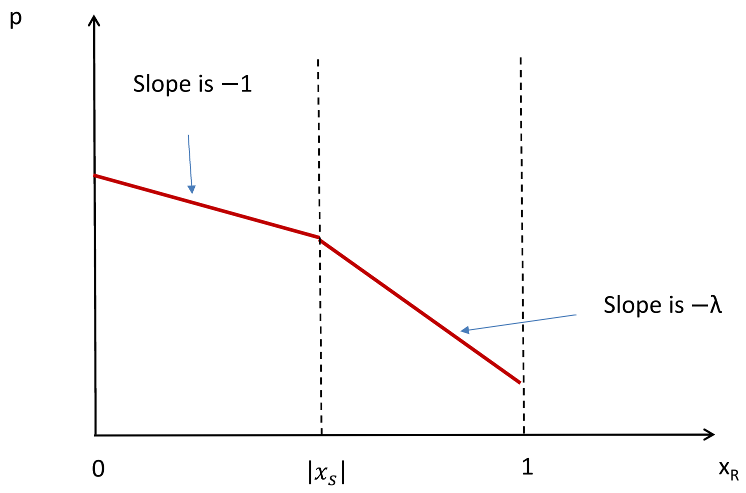
This implies that given a status quo $x_S,$ and platforms $x_L,x_R,$ the probability that party R wins the election is the probability that the median voter votes for $R.$ In turn, from (4), this is

$$p(x_L,x_R;x_S)=F\left(v_m(x_R;x_S)-v_m(x_L;x_S)\right) \tag{5}$$

To establish this, note from (4) that for the median voter, there is a critical value of $\varepsilon,$ $\varepsilon_m,$ such that m is indifferent between voting for L and R i.e.

$$v_m(x_R;r)-v_m(x_L;r)=\varepsilon_m \tag{6}$$

Figure 1: The Win Probability



Then, the crucial observation is that *even with loss-aversion, the payoffs* $v_i(x; r)$ *are single-peaked in* x *for a fixed* r. So, assuming $x_R > x_L$, single-peakedness implies immediately that (i) $\varepsilon < \varepsilon_m$, all $i > m$ will vote for R; (ii) if $\varepsilon > \varepsilon_m$, all $i < m$ will will vote for L. So, when $\varepsilon < \varepsilon_m$, a majority vote for party R, and when $\varepsilon > \varepsilon_m$, a majority vote for party L. So, the probability that party R wins is $\Pr(\varepsilon < \varepsilon_m)$, which gives (5).

From now on, we can drop the "m" subscripts without loss of generality; in particular, write $u(x) \equiv u_m(x) = -|x|$ and $v(x; r) \equiv v_m(x; r)$. Then, given (5), we can explicitly calculate;

$$p(x_L, x_R; x_S) = \begin{cases} F\left(u(x_R) - u(x_L)\right) & u(x_L), u(x_R) \geq u(x_S) \\ F\left(u(x_R) - \lambda u(x_L) + (\lambda - 1)u(x_S)\right) & u(x_R) \geq u(x_S) > u(x_L) \\ F\left(\lambda u(x_R) - u(x_L) - (\lambda - 1)u(x_S)\right) & u(x_L) \geq u(x_S) > u(x_R) \\ F\left(\lambda u(x_R) - \lambda u(x_L)\right) & u(x_L), u(x_R) < u(x_S) \end{cases} \tag{7}$$

So, p is continuous and differentiable in x_L, x_R except at the points $|x_R| = |x_S|$, $|x_L| = |x_S|$. Figure 1 shows the win probability for party R as x_R rises from 0 to 1, for a fixed x_L; for clarity, we assume in the Figure that F is uniform on $\left[\frac{1}{2}, \frac{1}{2}\right]$. It is clear from (7) that there is a kink at the point where $x_R = |x_S|$. Specifically, to the left of this point, a small increase Δ in x_R decreases p by Δ, and to the right, a small increase in x_R decreases p by $\Delta\lambda > \Delta$.

This kink in the win probability function drives all of our results. It is also broadly consistent with the empirical findings about asymmetric voter responses to macroeconomic shifts; in our model, where an economic policy platform yields the voter a lower utility than the status quo, he responds by "punishing" that party.

Note finally, from (7) or Figure 1, that loss-aversion affects the election probability of each party, even though the policy space is one-dimensional and there is a single reference point x_S. As already remarked, this is in sharp contrast to AP, where for loss-aversion to play a role, the benefits and costs of a project of variable scale are evaluated separately relative to different reference points. We do not need this construction because loss-aversion changes the rate at which voters trade off changes in policy positions against valence.

3.5 Assumptions

We will characterize equilibrium by first-order conditions for the choice of x_L, x_R by the parties. For this to be valid, we require that the expected party payoffs π_L, π_R defined below in (3) are strictly concave in x_L, x_R respectively. It is shown in the Appendix that given our other assumptions, a sufficient condition for concavity is that $f(\varepsilon)$, the density of ε, be non-increasing. Also, our focus will be a symmetric equilibrium, where parties offer platforms are symmetric around zero. For such an equilibrium to exist, ε must be symmetrically distributed around zero.

For both these conditions to hold, $f(\varepsilon)$ must be constant in ε i.e. ε must be uniformly distributed. So, to ensure both concavity and symmetry, we assume:

A1. *ε is uniformly distributed on* $\left[-\frac{1}{2\rho}, \frac{1}{2\rho}\right]$.

Note that here, $f(\varepsilon) = \rho$, and so ρ measures the *responsiveness* of the median voter to changes in the payoffs from policies of the two parties, and thus measures the importance of policy positions relative to other factors, such as random party valence, or candidate charisma. For convenience, we assume ρ is small enough that p is strictly between 0 and 1 for all $x_R, -x_L \in [0,1],\ x_S \in [-1,1]$. This requires $p(0,1;0) > 0$, or $1 > 2\lambda\rho$.

Secondly, we require, for non-trivial results, that the return to office, M, is not so large that parties compete to full convergence of platforms. The following assumption ensures this.

A2. $0.5u_R'(0) = -0.5u_L'(0) = 0.5l'(1) > \lambda\rho M.$

This says that at $x = 0$, each party prefers to move x slightly in the direction of their ideal point (with expected benefit of e.g. $0.5u_R'(0)$ for party R), even at the cost of reducing the probability of victory slightly, and thus foregoing some office-related rent (measured by the term M). Another way to interpret A2 is to say that voter responsiveness to policy utility, ρ, must not be so large as to induce complete platform convergence in equilibrium.

Finally, without loss of generality, given the other assumptions, we restrict x_R to be non-negative, and x_L to be non-positive.[12]

[12]In particular, A2 ensures that party R (resp. L) will not wish to set $x_R < 0$ (resp. $x_L > 0$).

4 Results

4.1 Baseline Results

We are interested in characterizing the symmetric Nash equilibria of the game with payoffs (3), and actions $x_L \in [-1, 0]$, $x_R \in [0, 1]$. We begin with the following intermediate result.

***Lemma* 1.** *Given A1,A2, there exist unique solutions x^+, x^- , $x^+ > x^- > 0$ to the equations*

$$f(x;1) \equiv 0.5u_R'(x^+) - \rho\left(u_R(x^+) - u_R(-x^+) + M\right) = 0 \tag{8}$$

$$f(x;\lambda) \equiv 0.5u_R'(x^-) - \lambda\rho\left(u_R(x^-) - u_R(-x^-) + M\right) = 0 \tag{9}$$

It is easily checked that these solutions x^+, x^- describe the symmetric Nash equilibria in the games where party R's re-election probability is $p = F\left((u(x_R) - u(x_L)\right)$ and $p = F\left(\lambda(u(x_R) - u(x_L))\right)$ respectively. For example, $-x^+, x^+$ is the Nash equilibrium in the first case, which is the benchmark case without loss-aversion. To see this, note that $0.5u_R'(x) > 0$ is the utility gain for party R from moving away from the moderates' ideal point, 0. In equilibrium, this is offset by the lower win probability i.e. the term in ρ. Note that $x^+ > x^- > 0$, as there is a stronger incentive to converge to 0 when $\lambda > 1$.

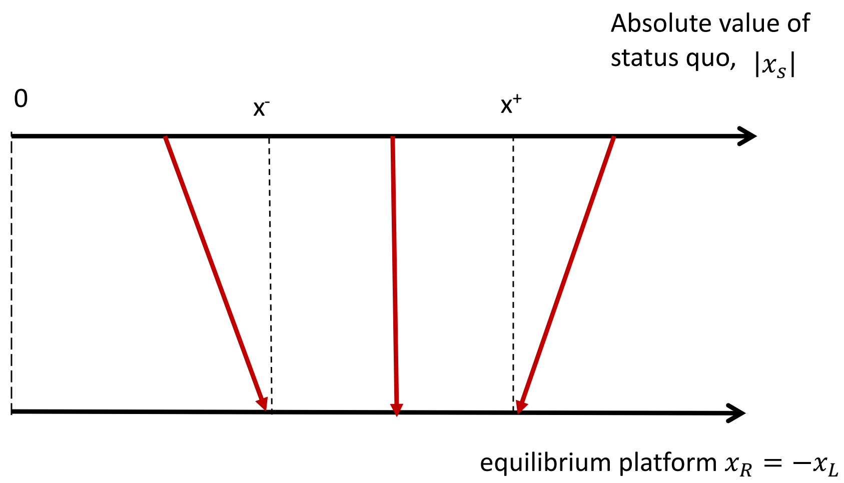
We are now in a position to characterize the equilibrium in the overall game.

***Proposition* 1.** *If $x^+ < |x_S|$, then $x_R = -x_L = x^+$ is the unique symmetric equilibrium. If $x^- > |x_S|$, then $x_R = -x_L = x^-$ is the unique symmetric equilibrium. If $x^+ \geq |x_S| \geq x^-$, then $x_R = -x_L = |x_S|$ is the unique symmetric equilibrium. The the value x^- is decreasing in λ, so the interval $[x^-, x^+]$ is increasing in voter loss-aversion, λ.*

This baseline result is best understood graphically. Figure 2 below shows how the initial status quo maps into the equilibrium platforms. For convenience of exposition, the figure shows how the *absolute value* of the status quo, which is also minus the median voter's utility from the status quo, maps into the absolute value of the equilibrium policy platforms. The latter is of course, the actual equilibrium platform of the R party and minus the actual equilibrium platform of the L party.

Note that in the absence of loss-aversion, from Proposition 1 and Lemma 1, the equilibrium platforms are simply $x_R = -x_L = x^+$. So, bearing this in mind, Proposition 1 shows that there are several important impacts of loss-aversion. First, there is *platform rigidity*; for a range of values of the status quo in the interval $[x^-, x^+]$, the outcome is insensitive to changes in other parameters, such as the weight M that political parties place on office, or the responsiveness of the median votre to policy, ρ.

Figure 2: The Baseline Result



This platform rigidity is similar in spirit to the entrenchment effect found the by AP.[13]

Second, there is a *reduced polarization effect* of loss-aversion; the equilibrium platforms are both closer to the median voter's ideal point than in the absence of loss-aversion. This is related the moderation effect of loss-aversion in AP (their Proposition 3), although there, the details are rather different; an increase in loss-aversion compresses the distribution of ideal points of the voters, and in particular, increases the number of voters who prefer the status quo.

Finally, note that in our setting, there is a key difference between representative and direct democracy; voter loss-aversion affects outcomes under the former arrangement but not the latter. To see this, suppose that there were no political parties, and direct voting over policies $x \in [-1, 1]$. In this case, it is reasonable to suppose that ε, which represents the difference in party valence or some other characteristic, is absent i.e. $\varepsilon \equiv 0$. But then, as voter preferences $v_i(x; x_S)$ are single-peaked, the outcome will be the median voter's ideal point, $x_m = 0$, *independently* of the degree of voter loss-aversion λ.

The following example shows these effects more explicitly.

Example. Assume that $l(z) = z$, i.e. political parties have absolute value preferences. Then, $u_L = -|x + 1| = -(1 + x)$, $u_R = -|x - 1| = -(1 - x)$. Moreover, from A1, we have, from (5);

$$p = \frac{1}{2} + \rho\left(v(x_R; x_S) - v(x_L; x_S)\right)$$

Then, it is easily verified that (8),(9) become;

$$\begin{aligned} 0.5 - \rho(-(1 - x^+) + 1 + x^+ + M) &= 0 \\ 0.5 - \lambda\rho(-(1 - x^-) + 1 + x^- + M) &= 0 \end{aligned}$$

[13] The rigidity of policy with respect to shifts in the mean preference of the moderates is studied separately below.

These solve to give $x^+ = \frac{1}{4\rho} - \frac{M}{2}$, $x^- = \frac{1}{4\lambda\rho} - \frac{M}{2}$. By assumption A2, $x^- = \frac{1}{4\lambda\rho} - \frac{M}{2} > 0$. So, for $|x_S| \in \left[\frac{1}{4\lambda\rho} - \frac{M}{2}, \frac{1}{4\rho} - \frac{M}{2}\right]$, there is platform rigidity i.e. $x^* = |x_S|$. Note that as claimed in Proposition 1, the length of the interval $\left[\frac{1}{4\lambda\rho} - \frac{M}{2}, \frac{1}{4\rho} - \frac{M}{2}\right]$ is increasing in λ.□

Finally, we can ask: who benefits from loss-aversion? Other recent studies in behavioral politics have shown that voters can actually be made better off as a result of their behavioral biases (Ashworth and Bueno De Mesquita (2014), Levy and Razin (2015), Lockwood (2015)). This kind of result is not so clear-cut here, as the bias we are studying (loss-aversion) actually affects the utility function, and so the behavioral bias cannot be varied independently of the payoff. But, we can show that *political parties* benefit from voter loss-aversion under certain conditions.

Note that from 3, the expected payoff of (say) party R at symmetric equilibrium $(x, -x)$ is

$$\pi_R(x) = 0.5(u_R(x) + u_R(-x)) + 0.5M \tag{10}$$

Note that if parties are risk-neutral, i.e. $l'' = 0$, $\pi_R(x)$ is independent of x, but if parties are risk-averse, $l'' = 0$, $\pi_R(x)$ is strictly decreasing in x. That is, when parties are risk-averse, they prefer x to be as small as possible. In other words, parties do not like platform polarization.

Then, we have the following result:

Proposition 2. *Assume political parties are strictly risk-averse i.e. $l'' < 0$. Then if $x^+ > |x_S|$, both political parties are strictly better off in equilibrium if the voters have loss-aversion i.e. $\lambda > 1$ than if they do not i.e. $\lambda = 1$. Moreover, the smaller is $|x_S|$, the better-off are the two parties.*

The proof of this is very simple and intuitive. From Proposition 1, voter loss-aversion strictly reduces polarization from x^+ to $|x_S|$ whenever $x^+ > |x_S|$. Also, as just established, risk-averse parties strictly dislike polarization in equilibrium. Finally, note that Proposition 2 implies that in repeated elections, parties have an incentive to *strategically manipulate* the current platform to reduce future polarization, as the current platform may be the winning platform, and thus be the next period's status quo. We explore this in more detail in the next section.

5 Dynamics of Electoral Competition

To study inter-temporal incentives of parties, we will consider a finite-horizon version of the electoral competition game above[14], where the parties compete in periods $t = 1, 2, ..T$, with an initial status quo x_0. The reason for focussing on the finite horizon is that the symmetric equilibrium can be shown to be unique, and we can establish some key properties of the continuation payoffs of the two parties by backward induction.

[14]Some of our results also hold for the infinite-horizon game, as explained below.

Voters are assumed to be myopic or only live for one period, so their behavior is captured by (7). Note that in the dynamic setting, the status quo at t will be the platform of the winning party at date $t = 1$, say x_{t-1}. So, from (7), we see that the state variable in the model i.e. the variable that links current payoffs to the past history of the game is simply the utility of median voter from the previous period's electoral outcome. It is helpful to express this as a positive variable, so we define a state variable $s_t = \left|x^w_{t-1}\right|$, where x^w_{t-1} is the winning platform at time $t-1$.

We now introduce an additional refinement, *imperfect memory*. Specifically, we suppose that in period t, the median voter does not remember the position of the winning platform at $t-1$ exactly, but makes some error in recall. This is quite plausible, given that in practice, there is a large amount of evidence that voters pay limited attention to politics, and their recall about past political events, including their own past voting behavior, is often inaccurate (Carpini and Keeter (1996), Van Elsas et al. (2013)).

Specifically, we assume that the median voter recalls x^w_tas $\theta_t x^w_t$, where θ_t is a random variable drawn from an absolutely continuous distribution $F(\theta)$ with support $[0,\infty)$ and mean of unity. A mean of unity means on average, the median voter recalls last period's winning platform correctly. Imperfect memory also plays a technical role in the analysis, because it "smooths" the parties' continuation payoffs, making them differentiable functions of the state variable.[15]

So, the absolute value of the median voter's reference point in period t is $\left|\theta_t x^w_{t-1}\right| = \theta_t s_t$. We assume that the two parties know $\theta_t s_t$ at the beginning of period t. Let $(x_{L,t}, x_{R,t})$ be platforms at time t. Then,$p_t \equiv p(x_{L,t}, x_{R,t}; \theta_t s_t)$ is the win probability for party R in period t, given status quo utility $\theta_t s_t$ and platforms $x_{L,t}, x_{R,t}$, where p is defined as in (7), setting $u(x^s) = -\theta_t s_t$.

In period t, the parties have per period payoffs

$$\begin{aligned}\pi_R(x_{R,t}, x_{L,t}; s_t\theta_t) &\equiv p_t(u_R(x_{R,t}) + M) + (1-p_t)u_R(x_{L,t}) \\ \pi_L(x_{L,t}, x_{R,t}; s_t\theta_t) &\equiv (1-p_t)(u_L(x_{L,t}) + M) + p_t u_L(x_{R,t})\end{aligned} \tag{11}$$

We assume that parties are long-lived, and that they discount future payoffs by factor δ.

As in the static case, we focus on symmetric equilibria. Let $V^k_t(s_t)$ be the continuation payoff for party $k = L, R$ in any symmetric equilibrium from t onwards, given a value of s_t. It is possible to show that in stationary symmetric equilibrium, $V^R_t \equiv V^L_t \equiv V_t$. In fact, we have the following characterization of symmetric equilibrium:

[15]Without this smoothing, the analysis even in the finite horizon case quickly becomes intractable as the non-differentiability in p, the probability of election, induces kinks in the value function V defined below. A characterization of equilibrium in the case of two or three periods is possible - although difficult - and it is available on request: the results are qualitatively similar to the ones proved below.

***Proposition* 3.** *In period t, any symmetric equilibrium $(x_t(\theta_t s_t), -x_t(\theta_t s_t))$ is characterized by the following two conditions:*

$$x_t(\theta_t s_t) = \arg\max_{x_R} \{\pi_R(x_R, -x_t(\theta_t s_t); \theta_t s_t) + \delta(pV_{t+1}(x_R) + (1-p)V_{t+1}(x_t(\theta_t s_t))\} \quad (12)$$

where $V_t(.)$ satisfies the recursive equation

$$V_t(s_t) \equiv E_{\theta_t}[\pi_R(x_t(\theta_t s_t), -x_t(\theta_t s_t); \theta_t s_t) + \delta V_{t+1}(x_t(\theta_t s_t))] \quad (13)$$

This is proved in the Appendix. Due to symmetry, both parties have the same value function V_t, and as a result, we only need to consider the $R-$party's optimal response to party $L's$ equilibrium platform to describe the equilibrium, not the reverse.[16]

We start with the simplest case where *political parties are risk-neutral i.e.* $l'' \equiv 0$. Here, for any x :

$$u_R(-x) + u_R(x) = -(1+x) - (1-x) \equiv -2 \quad (14)$$

So, from (13), (14), the continuation payoff for both parties is just $V_t(s_t) = 0.5M - 1$ and thus is independent of s_t. So, the only stationary symmetric equilibrium must be the one described in Proposition 1. Intuitively, with risk-neutrality, parties do not care about next period's status quo and so there is thus no incentive to manipulate next period's status quo via platform choice in the current period. We can summarize as follows:

***Proposition* 4.** *If political parties are risk-neutral i.e. $l'' \equiv 0$, then there is a unique symmetric equilibrium where*

$$x_t(\theta_t s_t) = \begin{cases} x^+, & \theta_t s_t > x^+ \\ \theta_t s_t, & x^- \leq \theta_t s_t \leq x^+ \\ x^-, & \theta_t s_t < x^- \end{cases}, \; t = 1, ..T \quad (15)$$

So, we see that a *necessary precondition* for strategic effects is party risk-aversion. This is not surprising, given the discussion above that establishes that risk-averse parties dislike platform polarization in equilibrium. In particular, from Proposition 2, shifting the median voter's reference point closer to zero reduces polarization, so each party as prefers to move the status quo in the next period closer to the independent voter's ideal point in order to reduce future polarization.

To proceed, we will assume $l''' < 0$, which will ensure that $V_t(.)$ is strictly concave.[17] We can then establish:

[16]Note that also, by definition, in the next period, the state variable is the absolute value of $x(\theta s)$ or $-x(\theta s)$ i.e. $x(\theta s)$.

[17]If for example, $l(x) = \frac{x^{\alpha+1}}{\alpha+1}$, then $l'' > 0, l''' < 0$ are both satisfied if $0 < \alpha < 1$.

Proposition 5. *(a) If political parties are strictly averse i.e. $l'' > 0$, and $l''' < 0$, then there is a symmetric stationary equilibrium where*

$$x_t(\theta_t s_t) = \begin{cases} z_t^+, & \theta_t s_t > z_t^+ \\ \theta_t s_t, & z_t^- \leq \theta_t s_t \leq z_t^+ \\ z_t^-, & \theta_t s_t < z_t^- \end{cases} \tag{16}$$

(b) Except in the last period T, $z_t^- < x^-$, $z_t^+ < x^+$, so both the largest and smallest level of polarization are smaller than in the static equilibrium. Also, z_t^-, z_t^+ are both strictly decreasing in δ, so the more forward-looking the two parties, the less polarization there is in equilibrium. As a result, the median voter is better off, the more forward-looking are political parties.
(c) Except in the last period T, there is less policy rigidity than in the static case i.e. $z_t^+ - z_t^- < x^+ - x^-$.

So, we see that in equilibrium, there is both less polarization *and* less policy rigidity than in the static case. These both result from the strategic incentive of parties to move platforms to the center to reduce future polarization. Specifically, z_t^-, z_t^+ are the unique solutions to the first-order conditions

$$f(z_t^-; \lambda) + \delta V'_{t+1}(z_t^-) = 0, \; f(z_t^+; 1) + \delta V'_{t+1}(z_t^+) = 0 \tag{17}$$

where $f(z;\lambda)$ is defined in Lemma 9. Moreover, it is shown in the proof that V_t is twice continuously differentiable, strictly decreasing, and strictly concave in s_t. So, (17) says the R party weights the static incentive of an increase in $x_{R,t}$ against the dynamic incentive, captured by $\delta V'_{t+1}$, to reduce $x_{R,t}$.

As an application of this result, we can think of an overlapping generations model where party members live for two periods and do not discount the future. Then, δ can be interpreted as the bargaining power of the "young" party members relative to the "old". Our result then says that the median voter prefers political parties where young members have greater bargaining power.

6 Incumbency Advantage

A striking feature of the dynamic analysis is that, although the winning platform last period determines the reference point of the median voter this period, winning the election conveys no advantage on the incumbent; if (for example, the R party was the winner at $t-1$, he chooses the same platform at t, and wins with the same probability (i.e. one half) as if he did *not* win the previous election.

In this Section, we show that incumbency advantage of a particular form emerges when preferences of both parties and the median voter shift. Specifically, with loss-aversion, there is asymmetric adjustment: regardless of the direction of the preference shift - i.e. left or right - the incumbent platform will adjust by less than the challenger's platform. In other words, loss-aversion generates a particular kind of asymmetry, which is testable; incumbents adjust less than challengers.

Assume absolute value preferences for the political parties for convenience. Also, suppose that initially, the platforms are at their steady-state values, so the status quo is $x_S \in [x^-, x^+]$ if party R won the election, whereas if party L won the last election it is $-x_S,\ x_S \in [x^-, x^+]$.

Now consider a rightward shift in the distribution of preferences, so the ideal points of both party members *and* the independents shift rightward by $\Delta\mu$. That is, the independents shift from $-|x|$ to $-|x - \Delta\mu|$, and the L and R party preferences shift from $-|x+1|,\ -|x-1|$ to $-|x+1-\Delta\mu|,\ -|x-1-\Delta\mu|$, respectively. Our focus on a rightward shift is without loss of generality, because due to the symmetry of the model and the equilibrium described in Proposition 1, the $L(R)$ party will react to a left shift by $\Delta\mu$ in voter preferences in exactly the same way as the $R(L)$ party reacts to a right shift. The reason for allowing the ideal points of all voters to shift, not just the moderates, is twofold. First, this ties in with our empirical approach, where we construct the preferences of the median voter from the preferences of candidates for office (see Section 7.2 below). Second, this assumption gives us cleaner results than the more general case where the preferences of moderates and party members shift by different amounts.

Then, without loss-aversion, it is easy to check that adjustment to the shift is symmetric i.e. the equilibrium platform of the R party moves from x^+ to $x^+ + \Delta\mu$, and the platform of the L party moves from $-x^+$ to $-x^+ + \Delta\mu$. But what happens with loss-aversion?

The key to understanding this is to observe that with a reference point, the effect of a *rightward shift in all ideal points on the equilibrium must be mathematically equivalent to the effect of a leftward shift in the reference point by the same amount (because the reference point is given and unaffected by the preference shift), followed by a rightward move in all variables by* $\Delta\mu$.

For example, suppose that party R is the incumbent, so that the reference point is $x_S > 0$, and the reference point shifts left from x_S to $x_S - \Delta\mu$. Suppose that this shift is small i.e. $x_S - \Delta\mu > x^-$. Then, by Proposition 1, the equilibrium platforms first move from $x_R = x_S, x_L = -x_S$ to $x'_R = x_S - \Delta\mu,\ x'_L = -(x_S - \Delta\mu)$. Then, both platforms are moved to the right by $\Delta\mu$, which gives new platforms

$$x''_R = x'_R + \Delta\mu = x_S,\ x''_L = x'_L + \Delta\mu = -x_S + 2\Delta\mu \tag{18}$$

Thus, from (18), we have the striking result that the incumbent platform does not move at all, but that the non-incumbent party platform moves by twice the amount of the shift in voter preferences.

Now assume party L is the incumbent, so that the reference point is $-x_S < 0$, and the reference point shifts left from $-x_S$ to $-x_S - \Delta\mu$. Suppose again that this shift is small i.e. $-x_S - \Delta\mu > -x^+$. Then, by Proposition 1, the equilibrium platforms first move from $x_R = x_S,\ x_L = -x_S$ to $x'_R = x_S + \Delta\mu,\ x'_L = -(x_S + \Delta\mu)$. Then, both platforms are moved to the right by $\Delta\mu$, which gives new platforms

$$x''_R = x'_R + \Delta\mu = x_S + 2\Delta\mu,\ x''_L = x'_L + \Delta\mu = -x_S \tag{19}$$

Thus, from (19), we again see that that the incumbent platform does not move at all, but that the non-incumbent party platform moves by twice the amount of the shift in voter preferences. In the same way, we can compute what happens to equilibrium platforms for all shifts, not just small ones, which leads to the following characterization of the effects.

***Proposition* 6.** Assume that the status quo is x_S if R *is the incumbent, and that the status quo is* $-x_S$ *if* L *is the incumbent.Following a preference shift* $\Delta\mu > 0$, *the equilibrium outcome is the following.*

(a) If the shift is small, i.e. $\Delta\mu \leq \min\{x_S - x^-, x^+ - x_S\} \equiv \Delta\mu_{\min}$, *then if* R *is the incumbent, the equilibrium is* $x_R = x_S,\ x_L = -x_S + 2\Delta\mu$. *If* L *is the incumbent, then the outcome is* $x_R = x_S + 2\Delta\mu,\ x_L = -x_S$.

(b) If the shift is large i.e. $\Delta\mu > \max\{x_S - x^-, x^+ - x_S\} \equiv \Delta\mu_{\max}$, *then if* R *is the incumbent, the outcome is* $x_R = \Delta\mu + x^-,\ x_L = \Delta\mu - x^-$. *If* L *is the incumbent, then the outcome is* $x_R = \Delta\mu + x^+,\ x_L = \Delta\mu - x^+$.

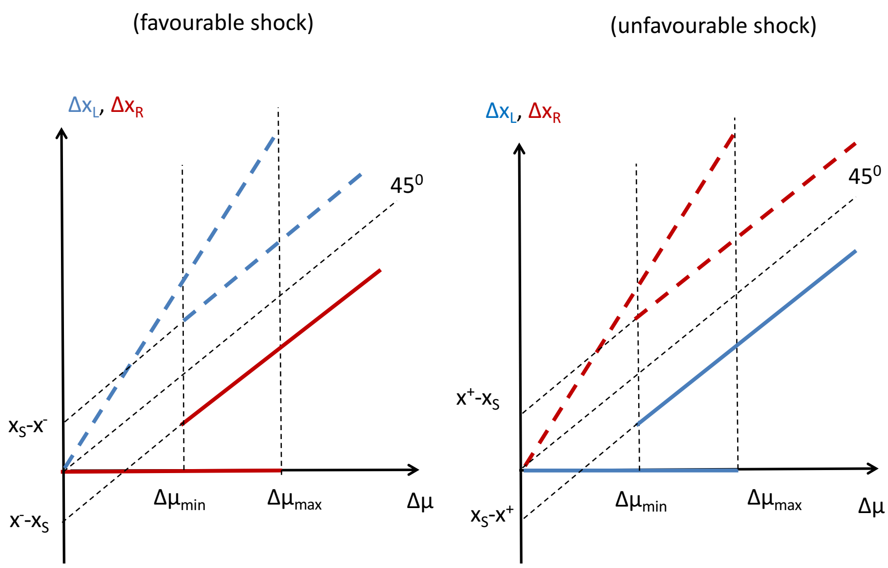
(c) If the shift is intermediate, with $x^+ - x_S < \Delta\mu \leq x_S - x^-$, *if* R *is the incumbent, the outcome is* $x_R = x_S,\ x_L = -x_S + 2\Delta\mu$, *and if* L *is the incumbent,* $x_R = \Delta\mu + x^+,\ x_L = \Delta\mu - x^+$.

(d) If the shift is intermediate, with $x_S - x^- < \Delta\mu \leq x^+ - x_S$, *if* R *is the incumbent, the outcome is* $x_R = \Delta\mu + x^-,\ x_L = \Delta\mu - x^-$, *and if* L *is the incumbent, the outcome is* $x_R = x_S + 2\Delta\mu,\ x_L = -x_S$.

To give an easier interpretation to these results, consider the *amount of adjustment* in platforms x_L, x_R made by either party as $\Delta\mu$ varies i.e. the change in equilibrium platforms form their initial values $x_L = -x_S,\ x_R = x_S$. The adjustment is $\Delta x_R = x_R - x_S,\ \Delta x_L = x_L - (-x_S) = x_L + x_S$ for parties $R,\ L$respectively. Then, from Proposition 6, it is possible to graph $\Delta x_R,\ \Delta x_L$ against $\Delta\mu$.These reactions are shown on the two panels of Figure 3 below. The first (second) panel shows the case where R (L) is the incumbent, and the reactions of incumbent and challenger platforms to the shift are denoted by solid and dotted lines respectively. Colors are chosen for US readers; in Figure 2, red and blue lines denote party R and party L respectively.

Note that when $\Delta\mu_{\min} \leq \Delta\mu \leq \Delta\mu_{\max}$, the adjustment of both the incumbent and challenger can take on two values, depending on the exact value of x_S; both are shown on the Figure. For example, if R is the incumbent, when $\Delta\mu_{\min} \leq \Delta\mu \leq \Delta\mu_{\max}$, from

Figure 3: Overview of Responses to a Preference Shock



Proposition 6, then the L party either does not adjust at all (case (c) of the Proposition) or adjusts by $\Delta\mu + x^{-} - x_S$ (case (d)).

It is easily verified from Proposition 6 that in the case where R is the incumbent, party R's adjustment, shown by the solid red line, must be less than party L's adjustment, shown by the dotted blue line, in the left panel. Looking at the right panel, the reverse must be true. Note also that if the shift were a leftward relative to the mean voter i.e. $\Delta\mu < 0$, Figure 2 would continue to apply with the L and R indices reversed. So, we have shown:

Proposition 7. *(Asymmetric Adjustment.) With loss-aversion, the incumbent party always has a smaller platform adjustment to the shift than the challenger. Moreover, the adjustment to the shift is non-linear for both the incumbent and challenger.*

This result, combined with our observation that there is symmetric adjustment to the shift without loss-aversion, shows that loss-aversion generates a particular kind of asymmetry, which is testable; incumbents adjust less than challengers. The underlying force is that the status quo works to the advantage of the incumbent.[18]

We now turn to consider how a shift affects the equilibrium gap between the platforms i.e. $\Delta_{RL} = x_R - x_L$. the initial gap is of course, $x_S - (-x_S) = 2x_S$. So, the gap between the platforms increases (decreases) iff $x_R - x_L > 2x_S$ ($x_R - x_L < 2x_S$). Say that a preference shift is favorable (unfavorable) for the incumbent if it is in the same direction as the incumbent's ideological bias e.g. $\Delta\mu > 0$ is favorable for R, and unfavorable for L.

Then, we can show;

[18]The result that the adjustment is non-linear is also found by AP, who show that if there is a shock to the median voter, this only has an effect on the outcome if the shock is sufficiently large. (AP, Proposition 4).

***Proposition* 8.** *(Changes in Party Polarization) Following a "favorable" preference shift for the incumbent, the gap between platforms, $\Delta_{RL} = x_R - x_L$ decreases. Following an "unfavorable" preference shift for the incumbent, the gap between platforms, $\Delta_{RL} = x_R - x_L$ increases.*

A formal proof is in the Appendix, but the result is also clear looking at Figure 2 above. In the first panel, a favorable shift for R is shown, and clearly R adjusts less than L, meaning that the difference between their platforms must become smaller. In the second panel, an unfavorable shift for L is shown, and clearly R adjusts more than L, meaning that the difference between their platforms must become larger. This is a second testable prediction.

7 Data and Measurement

The previous section makes two robust theoretical predictions; incumbents adjust less than challengers to changes in voter preferences, and parties become less (more) polarized following a "favorable" ("unfavorable") preference shift for the incumbent. In the remainder of the paper, we take these predictions to US data on elections to the lower houses of state legislatures over the period 1990-2012. As noted by Besley and Case (2003), the US states are a natural laboratory for empirical exercises of this kind, for a number of reasons.

First, at the state level, consistent with the theory, there are effectively only two parties, Democratic and Republican; we do not study the ideological positions of independent candidates, who in any case, attract very few votes.[19] Second, compared to the European elections studied by e.g. Adams et al. (2004), and the US Congress, studied by Fowler (2005), this is a large, homogeneous, sample. Moreover, the states have common electoral rules; each state holds general elections every two years.[20] Finally, we consider elections to the lower chamber, where tenure is comparatively short and a number of states have term limits reducing concern about incumbency advantage.

We begin by arguing that the theoretical results obtained above apply to this setting, as long as we assume party discipline i.e. that in each electoral district, the candidates of a given party stand on the same platform. To see this, suppose that there are an odd number of districts $d = 1, ..D$ of equal size. We suppose that each of the parties R, L field candidates in all districts. Moreover, following Callander (2005) and Ansolabehere et al. (2012), who also study multi-district elections, we assume that there is party control over candidate positions in the sense that each of

[19]Where information is available, we do include the ideological positions of independent candidates in the calculation of the median voter's ideology, but their positions have a very small effect on the calculation, as these candidates attract very few votes.

[20]Most electoral districts are single-member, but some states have multi-member electoral districts, and we exclude these states in our baseline specification; see below.

the candidates for a each district of a given party $p = R, L$ stands on the same platform x_p. Let the median voter m in district d have ideal point x_m^d. Rank the districts so that $x_m^1 \le x_m^2 \le \cdots \le x_m^D$. Continue to assume that voter preferences are given by (2), and that there is a common shift to preferences ε, in *all* districts. Then, by an argument similar to Section 3.4, conditional on any realization of ε, the median voter in the median district $q = (D+1)/2$ is decisive and so both parties will compete for this voter. So, to make the model symmetric, we assume $x_m^q = 0$. Then, all the results above apply to this setting.

RELAX THIS So, in taking the theory to the data, the main assumption that we make is complete party control over candidate positions. A concern here is that in the U.S., state parties are relatively weak in that candidates are chosen through primaries rather than by party members. On the other hand, we can note that there is some evidence of party cohesion for US state legislatures. For example, Cox et al. (2010) and Jenkins and Monroe (2016) argue that in US state legislatures, parties do in fact act cohesively, as revealed by the rarity of a majority party losing a vote. Also, Shor and McCarty (2011), who use roll call voting data for all state legislatures from the mid-1990s onward, finds that '[state] party medians correlate strongly with the preferences of moderates' and also as predicted that 'ideal points of state legislators correlate highly with presidential vote [shares] in their districts'.[21]

7.1 Data Description

Our data are for elections to the lower chamber of all state legislatures for the period 1990–2012.[22] Data describing the number of voters for each candidate in each district for every election are taken from Klarner et al. (2013).

These are then matched by candidate, district, and election to the DIME database (Bonica, 2014a), collected by Bonica (2014b) which contains information on candidates' platforms. These new data allow us to estimate separately the distribution of voter preferences in each electoral district in each state in each election. In particular, Bonica's data are based on a new method which recovers the platforms of all candidates, not just the winner, for election to state legislatures, based on the campaign donations they received. This is important as it means that we are not forced to make assumptions about the preferences of candidates who lost. These data are constructed using publicly available campaign finance information, collated by the National Institute on Money in State Politics and the Sunlight Foundation, and they are remarkable in that they provide time-varying estimates of the ideological position of almost every candidate in every election over the period we study.[23] Crucially, as

[21] Rodden (2010) provides an excellent review of the literature on multiple-district elections.

[22] This includes the single Nebraskan chamber, but excludes New England, Massachusetts, and Vermont.

[23] Bonica (2014b) uses a correspondence analysis procedure that exploits the fact that many politicians receive funds from multiple sources and many sources donate to multiple politicians to recover estimates for the positions of both politicians and donors. As this procedure is applied simultaneously at the federal

donors donate to losing candidates we observe the ideological position of *all* candidates. We then combine Bonica's data with election results at the district level to construct estimates of the preferences of the median voter in each district at each election as described below.

In this way, we can measure changes to the distribution of voters' preferences, and parties' responses to these changes for all state legislatures over a 20 year period. The details of this procedure are in Section 7.2 below. Using these data we find, as predicted by the theory, that incumbent parties are less responsive to shifts.

7.2 Measuring Voter Preferences and Party Platforms

To test our two hypotheses, we need a measure of each party's position and that of the median voter at a given election in a given state. Given a set of candidates $c = 1, \dots, C_d$ in each district $d = 1, \dots, D_s$ of state S, $Platform_{ct}$ is the platform of candidate c at election t, as measured by Bonica and $Votes_{ct}$ is the number of votes they received. The t variable is the set of even years $\{1990, \dots, 2012\}$, as elections are held in all states every even year. $Platform_{ct}$ is normalized such that -1 is the most left-wing position observed and 1 is the most right-wing observed in any election.

As a first step, we define the preference of the mean voter in each district d as the voter-weighted average position of the candidates;

$$\mu_{dt} = \sum_{c=1}^{C_d} \frac{Platform_{ct} \times Votes_{ct}}{\sum_C Votes_{ct}} \tag{20}$$

Our baseline estimate of the ideology of the median voter at the state level, μ_{st}, is then simply $\mu_{st} = \mu_{Mt}$, where districts are ordered by means μ_d and $M = \frac{D_s+1}{2}$. In other words, our estimate of the ideology of the median voter at the state level, μ_{st} is defined as the ideology of the mean voter in the median district at time t. Given that typically there are a large number of districts, this is likely to be close to the true median, even though within a district, without making distributional assumptions, we cannot identify the median voter and thus we work with the mean voter.[24] Formula (20) highlights why an estimate of the platform of both candidates is so important – it allows us to consistently estimate μ_{st} without recourse to additional assumptions or additional information (see, Kernell, 2009).

and state level, estimates for candidates in state-level elections are in a common space, and comparable over time and between states. We use the dynamic version of Bonica's data that allows politicians' ideologies to vary in an unrestricted way from one election to the next. The large number of candidates and donors also ensure that positions are measured precisely.

[24]Figure C.1 in the Appendix describes how the median voter of each state has varied over time. We can see that, as would be expected, voters in New York or Oregon are to the left of voters in Georgia or Oklahoma. We can also see that for some states, such as California or Texas, μ_{st} has varied less over time than others such as Arizona or Idaho.

Our variable measuring changes, or shifts, to voter preferences is then simply:

$$Shift_{st} \equiv \Delta\mu_{st} = \mu_{st} - \mu_{s,t-1} \tag{21}$$

This measure (21) has the advantage of corresponding directly to our theoretical definition of a preference shift. It does not necessarily use all of the available information, however. As a robustness test we will repeat our analysis using the state-wide *mean* voter position, μ'_{st}. We calculate the mean voter in state s in year t as

$$\mu'_{st} = \frac{1}{D_s}\sum_{d=1}^{D_s}\mu_{dt} \tag{22}$$

i.e. the average of the district mean ideologies. Inspection of Figure C.2 in the Appendix suggests that the choice between μ_{st} and μ'_{st} may not be that important as there is little empirical difference in the distributions across states in a given year of the mean and median voters.

The other main explanatory variable is a dummy Inc_{pst} recording whether the party p holds a majority of seats in the legislature in state s in the period prior to election t. The dependent variable is a (state) party's position, $Position_{pst}$. We define this as the median of the positions of all candidates of that party in the election at t including both incumbent and challengers i.e. the median of all the values of $Platform_{ct}$, for all candidates belonging to party p in state s.[25] The decision to treat incumbents and challengers equally is made for both statistical and substantive reasons.

Firstly, the substantive reason is that it is well known (see, Poole, 2007, Poole and Rosenthal, 2006) that individual politicians' positions are relatively stable over time and that most of the change in the views of representatives is due to electoral turnover. Thus, the response of incumbents to an electoral shift is likely to be relatively small. The second, statistical, reason relates to this. If we were to focus only on those who were elected we would introduce a substantial composition effect – for a given shift those still in office are those more isolated from changes in the median voter. Thus, a leftward move in the median voter, might mean the average Republican incumbent moves rightward. In the context of our model the dynamic implications of this would create a substantial econometric problem. By considering both incumbents and challengers we not only avoid the composition effect, but also observe better a party's response to changes in the distribution of voters.

In Appendix E, as an example, we introduce the data for California for 2004 and

[25] Our measure $Position_{pst}$ is a party's median representative rather than the mean as this corresponds both better to standard theory, and is less likely to be distorted by the preferences of extreme representatives. It is possible however that in the presence of a large number of uncompetitive seats, perhaps due to gerrymandering, a party's median representative will not have changed position despite large changes in its platform in competitive districts. However, as shown in the Appendix, all of our results are robust to using the mean representative instead.

2006, that illustrates the construction of these variables and how they relate to one another. Table 1 contains summary statistics for the key variables $Position_{pst}$, $Shift_{st}$ for all US states, by party. We also show $\Delta Position_{pst}$, the change in $Position_{pst}$ for party p in state s between elections at t and the previous election $t-1$. The Table shows, as expected, that $Position_{pst}$ for the republicans is to the right of that for Democrats. Note however, that the difference between the Democrat and Republican mean values on the $[-1, 1]$ scale are small – only 0.142 – as the endpoints of this scale are determined by the most ideologically extreme candidates in the sample.

Table 1: Summary Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max	P1	P10	P50	P90	P99
				Republicans						
$Position_{pst}$	214	.137	.043	.041	.215	.052	.073	.148	.187	.202
$\Delta Position_{pst}$	214	.004	.014	−.053	.064	−.03	−.01	.003	.022	.04
$Shift_{st}$	214	.001	.012	−.044	.04	−.025	−.012	0	.018	.034
				Democrats						
$Position_{pst}$	214	−.05	.064	−.173	.11	−.167	−.128	−.066	.051	.096
$\Delta Position_{pst}$	214	−.005	.012	−.063	.036	−.046	−.019	−.004	.008	.019
$Shift_{st}$	214	.001	.012	−.044	.04	−.025	−.012	0	.018	.034

Table 2: Cross-correlation table

Variables	$\Delta Position_{pst}$	$Shift_{st}$	$Inc_{pst} \times Shift_{st}$
$\Delta Position_{pst}$	1		
$Shift_{st}$	0.37	1	
$Inc_{pst} \times Shift_{st}$	0.01	0.70	1

Looking now at the values for $\Delta Position_{pst}$ over the sample period, we see, not surprisingly, that there has been polarization; the Republicans have moved to the right, and the Democrats to the left. Reflecting this, there are also relatively few large party moves with the $90th$ percentile of $\Delta Position_{pst}$ also being 0.02 for the Republican party. Comparison of the 1^{st} and 99^{th} percentiles suggests shifts are symmetrically distributed.

We can also see that, consistent with the literature (see, Erikson et al., 1993), that voter preferences are relatively stable – for example, for voter preferences in districts contested by the Republicans, the $90th$ percentile of the $Shift_{st}$ distribution is 0.018 compared to a theoretical maximum move of 2.

A final issue is the following. Using the same underlying ideology data to measure both party and voter positions is important because it ensures that both $Shift_{st}$ and $\Delta Position_{pst}$ are defined on the same space and thus directly comparable. However, a possible concern is that they might be mechanically positively correlated. In fact, it can be shown that because because $Shift_{st}$ and $Position_{pst}$ derive from different parts of the state distribution of representatives' preferences, any mechanical relationship is always small and converges to zero as the number of state representatives grows large. We provide a formal statement of this in Appendix F.[26]

8 Empirical Strategy and Results

8.1 Asymmetric Adjustment

8.1.1 Empirical Strategy

Proposition 7 suggests that parties that lost the previous election will respond more to any change in voters' preferences than the winner. We take this prediction to the data by relating the change in the position of party p in state s and year t, to whether the party won the previous election and what changes there have been in voters' preferences. In other words we estimate an equation of the form:

$$\Delta Position_{pst} = \lambda Shift_{st} + \gamma Inc_{pst} + \beta_1 Inc_{pst} \times Shift_{st} + \\ \beta_2 Inc_{pst} \times Shift_{st}^2 + \varepsilon_{pst} \tag{23}$$

Our key prediction from Proposition 7 is that β_1 is negative, while $\lambda > 0$. Note that the term in β_2 allows for a non-linear impact on the effect of incumbency on the response to the shift.

Give the data at hand, a key challenge in estimating (23) is to adequately control for any common factor, captured by ε_{pst}, that may be jointly driving changes in parties' platforms and changes in voters' preferences. These are likely myriad and will include both local political and economic factors in the districts of individual representatives (see, Healy and Lenz, 2014), the spillover effects of other elections (see, Campbell, 1986), the characteristics of the representatives themselves (see, Buttice and Stone, 2012, Kam and Kinder, 2012), or media-bias (see, Chiang and Knight, 2011). As well as endogeneity due to external events, there is also the possibility of simultaneity due to the persuasive or campaigning efforts of state-parties or individual politicians.

Our identification strategy is simple. Given our data are indexed by state, party, and year we include fixed effects for each of the pair wise combinations of the three. Our preferred model includes $state \times party$ (henceforth, SP), $state \times year$ (SY), and

[26] The key intuition is as follows. Consider an individual district; in (20) we estimate the mean ideology of this district as the vote weighted average of the candidates' positions. Yet, if candidates change their positions, in the absence of a change in the preferences of voters, then the vote shares for the parties might plausibly change in an offsetting way such that μ_{st} may not change much. For example, suppose both parties were initially located either side of the median voter, and both parties move to the right. Given that the distribution of voter preferences is single-peaked, then support for the Republicans will fall, and that for the Democrats will rise. As shown in Table 2, something like this seems to be the case; the correlation between $Shift_{st}$ and $\Delta Position_{pst}$, while positive as should be expected, is in fact quite small at 0.37.

$party \times year$ (PY) fixed effects. In other words, we assume

$$\varepsilon_{pst} = \xi_{sp} + \phi_{st} + \delta_{pt} + \zeta_{pst} \tag{24}$$

where $\xi_{sp}, \phi_{st}, \delta_{pt}$ are SP, SY, and PY fixed effects, and the error term ζ_{pst} is assumed to be $\zeta_{pst} \sim N(0, \Sigma)$ where we allow for Σ to be clustered by both SP and SY. This is because one can imagine that as well as errors being correlated within an individual state party, that state parties' behavior may be correlated across states within an election. For example, because Republican voters behavior may be nationally affected by the Republican nominee for US President.

So, we have partialled out all variation associated with particular, states, parties, and years. Importantly, as well as addressing short-term variation this strategy also controls for secular trends in U.S. politics over the period we study, such as changes in the degree of voter polarization.[27] We assume that, conditional on the fixed effects, the covariates in (23) are orthogonal to the error ζ_{pst}. This implies three substantive claims, that conditional on the fixed effects; the change in the median voter is random; which party is incumbent does not alter voters' votes given their preferences; and conditioning on this incumbency that the change in the median voter is still random. It is hard to think of processes which, given these fixed effects, would give rise to some unaccounted for systematic bias in our results.[28]

Of course, that such processes are hard to conceive of, does not rule them out. Thus, for the avoidance of doubt, we also present instrumental variable estimates for which these assumptions are relaxed. Here, our identification strategy relies on the premise that nearby states are likely to be subject to similar social forces and economic shifts, but that these shifts in other states should not depend on the incumbency or position of the parties in the state in question. Thus, we instrument $Shift_{st}$ and $Inc_{pst} \times Shift_{st}$ with the average shift in that state's census division, excluding state s, $Shift_{-s,t}$, and its interaction with incumbency $Shift_{-s,t} \times Inc_{pst}$.[29] As is standard, identification now requires $E[Shift_{-s,t}Shift_{st}] \neq 0$ and $E[Shift_{-s,t}\zeta_{pst}] = 0$. As well as addressing any endogeneity bias, a further advantage of this specification is that by construction there

[27] Ansolabehere et al. (2006) provide evidence that, contrary to popular perception, the key trend has been increased centrism in the U.S. electorate and that the differences between states are smaller than commonly supposed.

[28] To be precise, here, our identification assumptions are:

$$E[Shift_{st}\zeta_{pst}] = E[(Inc_{pst}\zeta_{pst})] = E[(Inc_{pst} \times Shift_{st})\zeta_{pst}] = 0$$

[29] US Census Divisions are as follows: **New England Division:** Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. **Middle Atlantic Division:** New Jersey, New York and Pennsylvania. **East North Central Division:** Illinois, Indiana, Michigan, Ohio and Wisconsin. **West North Central Division:** Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota. **South Atlantic Division:** Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia. **East South Central Division:** Alabama, Kentucky, Mississippi and Tennessee. **West South Central Division:** Arkansas, Louisiana, Oklahoma and Texas. **Mountain Division:** Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming. **Pacific** Division: Alaska, California, Hawaii, Oregon and Washington.

can no longer be any concerns about a mechanical relationship between $Shift_{st}$ and $Position_{pst}$. Of course, if as we argue, concerns about endogeneity are satisfactorily addressed by our fixed-effects strategy then our OLS estimates are to be preferred. In fact, it turns out that the results in both cases are similar.

A final concern is that there may be alternative explanations for asymmetric platform adjustment. Given our fixed effects, this requires that there is something systematically different about non-incumbent parties that is specific to a given state-election pair. We discuss these below, and show that controlling for these differences does not affect our estimates. In particular, one may be concerned that our results reflect incumbency advantage. The recent literature has focused on three key sources of incumbency advantage – that incumbents receive more campaign contributions which improve their chances of re-election; that high quality challengers avoid contesting elections against incumbents meaning incumbents run against relatively poor challengers on average; or that incumbents are themselves higher quality politicians.[30] It is possible that any of these three advantages could cause, in equilibrium, the incumbent to adjust less in response to a voter preference shift; however, there are to our knowledge, no theoretical predictions to this effect in the literature.

Our response to this is as follows. Firstly, we note that the vast majority of the empirical literature has identified incumbency advantage at the *individual* level, whereas our analysis is at the *party* level, and so we are concerned with the average advantage across individuals in a given party. Our fixed effects will control for this if this unless it is specific to a particular party at a particular election.[31]

One remaining way in which parties may differ at a given election is in terms of the number of incumbent legislators. If individual legislators accrue personal incumbency advantages, and this shields them from having to adjust their platform in response to shifts in the median voter. Assuming that winning parties are more likely to have more incumbent legislators, and these are less likely to have to adjust their positions then incumbent parties may be expected to move less other things equal. A related but separate hypothesis, is that parties with more incumbent legislators will be less likely to shift position since, as Bonica (2014a) shows, state legislators' preferred policies

[30] Uppal (2010) applies the approach of Lee (2008) to provide evidence for state legislatures. He finds that incumbency is associated with an average electoral advantage of around 5.3%, similarly Fowler and Hall (2014) find it to be 7.8%. The results of Fouirnaies and Hall (2014) suggests a substantial portion of this advantage is due to the additional campaign funding received by incumbents. Ban et al. (2016) using term-limits as an instruments suggests that the choice of high quality opponents to avoid competing against incumbents accounts for around 40% of incumbents' advantage. While, Hall and Snyder (2015) using an RDD approach finds much smaller effect of around 5%.

[31] For example, suppose it is the case that in a state, one party's representatives are on average is wealthier than the other's. Then, it is quite plausible, that following a shock to preferences, that party may seek to persuade the voters by increased advertising, rather than changing its platform, and so may respond less to the shock. Assuming that this differential does not change much over time, it will be picked up by the state-year fixed effect. Alternatively, to the extent that wealth differences between parties are at the national level, but vary over time, they will be picked up by the party-year fixed effect, and so on.

vary little over time. Thus, non incumbent parties are expected to move more, other things equal, purely because they have more new candidates.

We address these two alternative explanations using two additional controls. The first, $NewRep_{pst}$ measures the number of first-term legislators. The second, $AggTerms_{pst}$ is the sum of the number of previous terms in office across all party representatives at each election. Thus, the first captures the idea that the greater responsiveness of parties out of office may simply reflect the impact of more new representatives, while the other accounts for any effects of incumbency advantage.

A final concern is the so-called Partisan Incumbency Advantage discussed by Fowler and Hall (2014), which describes the beneficial effect to individual candidates of belonging to the party currently in office, over and above any individual incumbency advantage. If such an advantage exists, it will be a component of Inc_{pst}. This, however, is of limited concern for two reasons. First, Fowler and Hall (2014) shows that this effect is in practice close to zero. Second, even it is present, it should not bias the estimation of the parameter of interest β_1.

8.1.2 Results

We now report estimates of (23). As a first step, column 1 of Table 3 reports results from a simplified version of (23) where $\beta_2 = 0$, and in which there are only SP and PY fixed effects. We see that, as expected, parties react to movements in the median voter, with the coefficient on $Shift_{st}$ positive and significant. We also find, as the theory suggests, that parties with a majority react less. This coefficient is negative and significant and around 80% as large as for $Shift_{st}$. However, a more meaningful comparison is obtained by calculating standardized coefficients, which are 0.56 and -0.33 for $Shift_{st}$ and $Inc_{pst} \times Shift_{st}$ respectively, revealing that the magnitude of the former is nearly twice that of the latter. Thus, a one standard deviation move rightwards would move the incumbent party only 0.23 standard deviations rightwards, but a party not in power 0.56 standard deviations to the right. This is clearly as predicted by the theory as it shows that the party that lost (won) the previous election tend to make large (small) policy changes in the pursuit of future power. Given that we include $Inc_{pst} \times Shift_{st}$, γ gives the effect of Inc_{pst} given no shift. Perhaps unsurprisingly, given the shift will almost always be non-zero, the estimated effect, is small although positive and significant at the 1% level.

Column 2 maintains the restriction that $\beta_2 = 0$ but now includes the full battery of fixed-effects. Now λ is not identified but the addition of the SY fixed-effects simplifies the interpretation of the β_1 coefficient, given a shift, it is now the difference in the response of parties in power from those that are not. Importantly, β_1 remains of the same magnitude and significance.

This effect may not be linear however, parties may respond disproportionately to smaller or larger shifts. In columns 3 and 4 we therefore relax the constraint that

$\beta_2 = 0$. Column 3 reports results omitting the SY fixed-effects while column 4 includes them. With and without the SY fixed-effects, we find that β_2 is imprecisely measured and not significant at any conventional level, suggesting we can reject a non-linear effect of larger shifts.

Column 5 reports results augmenting the specification with the number of first term legislators ($NewReps_{pst}$) and aggregate incumbency ($AggTerms_{pst}$). The estimated coefficients on both variables are small, although we do find that *AggTerms* is significant. Importantly, the other coefficients are largely unchanged suggesting our empirical results cannot be understood as a consequence of the ideological inflexibility of incumbents.

We now move on to show that we obtain similar, indeed stronger, results using our IV estimator. These results are reported in columns 6-10 of Table 3. Column 6 reports a simple IV specification without fixed-effects. We can see that again we find that both parties respond to a shift, but that the incumbent party moves less. Columns 7 and 8 additionally include the fixed-effects used in columns 1-5 to progressively weaken the identification assumptions of our estimator from $E[Shift_{-s,t}\zeta_{pst}] = 0$ to $E[Shift_{-s,t}\zeta_{pst}|SY, PY, SP] = 0$. Column 7 includes only SP fixed-effects, and we can see that the magnitudes of λ and β_1 are slightly lower but that the main difference from column 5 is that the coefficient on incumbency γ is now significant. Column 8 includes the full-set of fixed-effects and now, as before, λ is not identified but we again find that β_1 is negative and significant.

Taken together these results provide strong evidence for the effects of loss-aversion predicted by the theory.One might be concerned that shifts to the identity of the median voter maybe only weakly correlated with those in neighboring states. If this were the case then the relevance assumption, $E[Shift_{-s,t}Shift_{st}] \neq 0$, maybe questionable. This is of particular concern given that our fixed-effects are designed to capture state and national trends. To allay such concerns we report the generalized LM test of under-identification test proposed Kleibergen and Paap (2006). Inspection of the associated p-values shows that we can reject under-identification and thus the violation of the relevance assumption in all cases. But, if $E[Shift_{-s,t}Shift_{st}] \approx 0$ then our estimates may still be substantially biased. Thus, we also report the associated Wald test of Weak-identification and we are able to reject this at all levels in all specifications.

As discussed in Section 7.1 our preferred measure of shifts is the change in the median voter. However, whilst this represents a natural choice, not least because it is in line with the theory, we may be concerned that this measure, focusing on the median district, disregards important information. To verify that this is not the case columns 8 and 9 report results using the same specification as in columns 6 and 8 except now using $\Delta\mu'_{st}$, the change in location of the mean voter. The only difference is an increase in the estimated magnitude of the coefficients, all of the estimates remain statistically significant. We provide further evidence of the robustness of our results in Appendix D which shows that these results are not affected by including states with multimember districts or defining parties' positions as given by their mean representative.

8.2 Testing for Changes in Polarization

We now turn to our second empirical prediction, Proposition 8. This Proposition implies that at an election the gap between two parties $\Delta_{st} = Position_{Rst} - Position_{Dst}$ should be smaller if the shift was favorable for the incumbent. Recall that positive (negative) changes in $\Delta\mu_{st}$ measure rightward (leftward) shifts in voter preferences. So, our measure of favorable shifts for Republicans and Democrats respectively are:

$$F_{Rst} \equiv \max\{\Delta\mu_{st}, 0\}, \ F_{Dst} \equiv \max\{-\Delta\mu_{st}, 0\}.$$

We then estimate the following model:

$$\begin{aligned} \Delta_{st} = \alpha_R(Inc_{Rst} \times F_{Rst}) + \alpha_D(Inc_{Dst} \times F_{Dst}) + \\ \beta_R(Inc_{Rst} \times F_{Dst}) + \beta_D(Inc_{Dst} \times F_{Rst}) + \varepsilon_{pst} \end{aligned} \quad (25)$$

where now, as Δ_{st} is defined at the state–year level, we are unable to control for state–year fixed effects and thus $\varepsilon_{pst} = \xi_s + \delta_t + \zeta_{pst}$.

To interpret this, consider first the variable $Inc_{Rst} \times F_{Rst}$ which records the presence and size of the favorable shift when the Republican party is the incumbent. Given Proposition 8, we expect this to have a negative impact on the dependent variable i.e. $\alpha_R < 0$. By the same argument, we expect $\alpha_D < 0$. Next, the variable $Inc_{Rst} \times F_{Rst}$ which records the presence and size of an unfavorable shift when the incumbent is the Republican. Following Proposition 8, we expect this to have a positive impact on the dependent variable i.e. $\beta_R > 0$. By the same argument, we expect $\beta_D > 0$.

The results of estimating (25) are reported in columns 1 and 2 of Table 4. As a first step in column 1, to maximize power, we restrict that $\alpha_R = \alpha_D$ and likewise $\beta_R = \beta_D$. The results are as predicted: α is negative and β is positive and both are significant. β is larger in magnitude than α and more precisely measured. Column 2 estimates 25 without additional restrictions. We see that, as predicted, both $\alpha_R < 0$ and $\alpha_D < 0$ while $\beta_R > 0$ and $\beta_D > 0$. Whilst of the expected sign the estimates of α_D and α_R are not significant, but more importantly we are able to reject the joint hypothesis that $\alpha_R + \alpha_D = \beta_R + \beta_D$ at the 1% level. Columns 3 and 4 repeat these two analyses but now the model is estimated using IV with an analogous identification strategy to that in the previous section. We again instrument shifts to the identity of the median voter using shifts in nearby states. That is, we instrument F_{Rst} with $\max\{\Delta\mu_{Rs-t}, 0\}$ and so on. The results in column 3 again restrict $\alpha_R = \alpha_D$ and $\beta_R = \beta_D$, to preserve power. The coefficients are now larger in magnitude and as precise, and we can again reject $\alpha = \beta$ at all conventional levels. Column 4 reports the results of the unrestricted model and as in column 2 some estimates are no longer statistically significant, but are still of the expected sign. Crucially, however, we can still reject the hypothesis that $\alpha_R + \alpha_D = \beta_R + \beta_D$ at the 1% level. Taken together the results of all four specifications provide strong evidence for the theory – all suggest that loss aversion means that unfavorable shifts lead to platform divergence.

9 Conclusions

This paper studied how voter loss-aversion affects electoral competition in a Downsian setting. Assuming that voters' reference point is the status quo, we showed that loss-aversion has a number of effects. First, for some values of the status quo, there is policy rigidity both parties choose platforms equal to the status quo, regardless of other parameters. Second, there is a moderation effect when there is policy rigidity; the equilibrium policy outcome is closer to the median voter's ideal point than in the absence of loss-aversion. In a dynamic extension of the model, we established that parties strategically manipulate the status quo to their advantage, and we find that this decreases both polarization and policy rigidity. Finally, we made two empirical predictions. First, with loss-aversion, incumbents adjust less than challengers to changes in voter preferences. The underlying force is that the status quo works to the advantage of the incumbent. Second, we showed that following a "favorable" preference shift for the incumbent, the gap between platforms, decreases, whereas the reverse is true following an "unfavorable" preference shift.

We test both of these predictions using elections to US state legislatures. We find robust support for both. The results are as predicted: incumbent parties respond less to shifts in the preferences of the median voter. Also as predicted, "unfavorable" shifts lead to platform divergence.

Table 3: Asymmetric Adjustment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Shift_{st}$	0.78^{***}		0.78^{***}			0.65^{***}	0.58^{***}		0.72^{***}	
	(0.11)		(0.11)			(0.15)	(0.12)		(0.18)	
$Inc_{pst} \times Shift_{st}$	-0.65^{***}	-0.66^{***}	-0.65^{***}	-0.68^{***}	-0.65^{***}	-0.78^{***}	-0.65^{***}	-0.63^{***}	-0.94^{***}	-0.75^{***}
	(0.11)	(0.06)	(0.11)	(0.07)	(0.06)	(0.19)	(0.15)	(0.17)	(0.23)	(0.15)
Inc_{pst}	0.01^{***}	0.01^{***}	0.01^{***}	0.00^{***}	0.00^{***}	-0.00	0.00^{**}	0.01^{***}	-0.00	0.01^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Inc_{pst} \times Shift^2_{st}$			-1.29	5.10^{*}	6.55^{**}					
			(1.29)	(2.70)	(2.84)					
$NewReps_{pst}$					0.00					
					(0.00)					
$AggTerms_{pst}$					-0.00^{**}					
					(0.00)					
R^2	0.32	0.20	0.24	0.20	0.23	0.24	0.25	0.20	0.23	0.18
N	428	428	428	428	428	428	428	428	428	428
UnderID LM						26.83	28.00	3.52	23.25	4.00
P(UnderID)						0.00	0.00	0.06	0.00	0.14
WeakID Wald						32.71	50.89	24.38	22.81	20.41
Estimator	OLS	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
State × Party Fixed-Effects	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Party × Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes
State × Year Fixed-Effects	No	Yes	No	Yes	Yes	No	No	Yes	No	Yes
Shock Measure	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu_{st}$	$\Delta\mu'_{st}$	$\Delta\mu'_{st}$

All data are for elections to the lower-houses of state legislatures. The dependent variable is the change in a party's platform as measured by that of the median candidate. $Shift_{st}$ measures the change in the median voter's preferences as defined in Equation 21, except which employ the change in the position of the mean voter, $\Delta\mu'_{st}$. Inc_{pst} is a binary variable that is equal to 1 if a party won more than 50% of the seats at the previous election.NewReps$_{pst}$ is the number of non-incumbent candidates elected for each party at each election. AggTerms$_{pst}$ is the sum across all representatives of the number of terms served for each party at each election. All columns except 6 and 9 include $State \times Party$ and $Party \times Year$ fixed-effects. Columns 2,4,8, and 10 additionally include $State \times Year$ fixed effects. Standard errors are in parentheses and are clustered by both $State \times Party$ and $Party \times Year$ except in columns 6 and 9 where they are not clustered, and column 7 where they are clustered by $State \times Party$. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ UnderID LM refers to the generalized Under-identification test of Kleibergen and Paap (2006) and P(UnderID) the associated p-value. WeakID Wald refers to the Kleibergen and Paap (2006) generalized test of Weak-identification and we are able to reject this at all levels in all specifications.

Table 4: Platform Convergence

	(1)	(2)	(3)	(4)
$Inc_{Dst} \times F_{Dst} + Inc_{Rst} \times F_{Rst}$	-0.25*		-0.56**	
	(0.13)		(0.27)	
$Inc_{Rst} \times F_{Dst} + Inc_{Dst} \times F_{Rst}$	0.53***		0.53***	
	(0.10)		(0.20)	
$Inc_{Dst} \times F_{Dst}$		-0.24		-1.47*
		(0.17)		(0.76)
$Inc_{Rst} \times F_{Rst}$		-0.26		-0.20
		(0.21)		(0.24)
$Inc_{Rst} \times F_{Dst}$		0.44***		0.59**
		(0.13)		(0.24)
$Inc_{Dst} \times F_{Rst}$		0.68***		0.41
		(0.13)		(0.41)
Estimator	OLS	OLS	2SLS	2SLS
R^2	0.022	0.023		
$\chi^2(H_0)$	27.91	28.37	11.94	8.31
$Pr(H_0)$	0.00	0.00	0.00	0.00
N	636	636	636	636

The dependent variable is the absolute distance between the Republicans and the Democrats, $|Position_{Rst} - Position_{Dst}|$. Columns 1 and 2 report OLS estimates, and Columns 3 and 4 report 2SLS estimates. Inc_{Rst} (alternatively, Inc_{Dst}) is a binary variable that is equal to 1 if the Republican (Democratic) party won more than 50% of the seats at the previous election. F_{Rst} (alternatively, F_{Dst}) report the size of any favourable shock, taking a value of zero if the shock was unfavourable. All specifications include $State$ and $Year$ fixed effects. Standard errors are clustered by $State$. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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A Proofs of Propositions and Other Results.

Conditions for Concavity of π_L, π_R in x_L, x_R. W.l.o.g., we consider only π_R. First, from (3), at all points of differentiability

$$\frac{\partial \pi_R}{\partial x_R} = \frac{\partial p}{\partial x_R}(u_R(x_R) + M - u_R(x_L)) + p(x_L, x_R)u'_R(x_R) \tag{A.1}$$

So, differentiating (A.1), we get;

$$\frac{\partial^2 \pi_R}{\partial x_R^2} = 2\frac{\partial p}{\partial x_R}u'_R(x_R) + p(x_L, x_R)u''_R(x_R) + \frac{\partial^2 p}{\partial x_R^2}(u_R(x_R) + M - u_R(x_L)) \tag{A.2}$$

Now, by inspection of (7), plus $u(x) = -x$ when $x > 0$, we can write generally that

$$\frac{\partial p}{\partial x_R} = -\phi f(z) < 0$$

where $\phi = \lambda > 1$ or $\phi = 1$, depending on the values of x_R, x_S, and where $z = v(x_R; x_S) - v(x_L; x_S)$. So, from (A.2), as $u'_R(x_R) > 0$, and also $u''_R(x_R) \leq 0$ from A2, strict concavity follows as long as $\frac{\partial^2 p}{\partial x_R^2} \leq 0$. But differentiating again, and recalling again that $\frac{\partial z}{\partial x_R} = -\phi$, we have

$$\frac{\partial^2 p}{\partial x_R^2} = \phi^2 f'(z)$$

So, for concavity we just need $f'(z) \leq 0$. □

Proof of Lemma 1. (a) To prove uniqueness, let

$$g(x; \phi) = 0.5u'_R(x) - \phi\rho(u_R(x) + M - u_R(-x)) \tag{A.3}$$

where $\phi = \lambda > 1$ or $\phi = 1$, depending on the values of x_R, x_S. Then, suppose to the contrary that $g(x; \phi) = 0$ has two solutions, x^* and $x^{**} > x^*$. Then, as g is differentiable, by the fundamental theorem of calculus,

$$g(x^{**}; \phi) - g(x^*; \phi) = \int_{x^*}^{x^{**}} g_x(x; \phi)dx = 0. \tag{A.4}$$

But, by differentiation of (A.3):

$$g_x(x; \phi) = 0.5u''_R(x) - \phi\rho(u'_R(x) + u'_R(-x)) < 0, \ x \in [-1, 1] \tag{A.5}$$

So, $\int_{x^*}^{x^{**}} g_x(x; \phi)dx < 0$, which contradicts (A.4).

(b) To prove $x^+ > x^-$, note that from $g(x; \phi) = 0$,

$$\frac{dx}{d\lambda} = \frac{g_\lambda(x; \phi)}{-g_x(x; \phi)} = -\frac{\rho(u_R(x) + M - u_R(-x))}{-g_x(x; \phi)} < 0$$

So, as $g(x^-; \lambda) = 0, g(x^+; 1) = 0$, the result follows.

(c) to prove that $x^- > 0$, note that at $x \leq 0, u_R(x) - u_R(-x) \leq 0$, so

$$\begin{aligned} g(0;\lambda) &= 0.5u'_R(x) - \lambda\rho(u_R(x) + M - u_R(-x)) \\ &\geq 0.5u'_R(x) - \lambda\rho M \\ &\geq 0.5u'_R(0) - \lambda\rho M \\ &> 0 \end{aligned}$$

where the third inequality follows from concavity of $u_R(.)$, and the last by assumption A2. So, $g(x;\lambda)$ cannot have a negative or zero solution. □

Proof of Proposition 1. (a) Due to symmetry, it is sufficient to look at the choice of party R. Also, using the definition of $f(x;\lambda)$ from Lemma 8, it is easily checked that the derivative of π_R w.r.t. x at $(x,-x)$ is $f(x;1)$ if $x < |x_S|$ and $f(x;\lambda)$ if $x > |x_S|$; moreover, π_R has left-hand and right-hand derivatives $f(x;1)$, $f(x;\lambda)$ if $x = |x_S|$.

So, the symmetric equilibrium $(x,-x)$ is characterized by the first-order conditions

$$f(x;1) = 0,\ x < |x_S| \tag{A.6}$$

$$f(x;\lambda) = 0,\ x > |x_S| \tag{A.7}$$

$$f(x;\lambda) \leq 0 \leq f(x;1),\ x = |x_S| \tag{A.8}$$

The second-order conditions are satisfied as $f(x;\lambda)$ is decreasing in x, from the proof of Lemma 1. Also note from Lemma 1 that (A.6), (A.7) have unique solutions x^+, x^- respectively, and so (A.8) is satisfied as long as $u_S \in [x^-, x^+]$. It then follows that if $u_S > x^+$, if , $x = x^-$, and if $u_S \in [x^-, x^+]$, then $x = |x_S|$, as claimed. □

Proof of Proposition 3. (i) By definition, the symmetric equilibrium is a pair of mappings, in every period t, from the state variable $\theta_t s_t$ to platforms, $x_t(\theta_t s_t), -x_t(\theta_t s_t)$ characterized by two equations:

$$x_t(\theta_t s_t) = \arg\max_{x_R} \left\{\pi_R(x_R, -x_t(\theta_t s_t);\theta_t s_t) + \delta(p_t V^R(x_R) + (1-p_t)V^R_{t+1}(-x_t(\theta_t s_t))\right\} \tag{A.9}$$

$$-x_t(\theta_t s_t) = \arg\max_{x_L} \left\{\pi_L(x_L, x_t(\theta_t s_t);\theta_t s_t) + \delta((1-p_t)V^L(x_L) + p_t V^L_{t+1}(x_t(\theta_t s_t))\right\} \tag{A.10}$$

These equations say that in symmetric equilibrium, each party is choosing its platform optimally given the fixed platform of the other, and conditional on the state variable $\theta_t s_t$, to maximize the present value of payoffs.

Note that the expected payoff from any symmetric equilibrium i.e. where platforms $x, -x$ occur with equal probability is the same for both parties i.e.

$$0.5(u_R(x) + u_R(-x) + M) = 0.5(u_L(-x) + u_L(x) + M) \equiv \hat{\pi}(x) \tag{A.11}$$

So, using (A.11), the description of the equilibrium is completed by noting that from (A.9),(A.10), on the equilibrium path, the valuation functions must satisfy:

$$V^R_t(\theta_t s_t) \equiv E_{\theta_t}[\hat{\pi}(x_t(\theta_t s_t)) + \delta V^R_{t+1}(x_t(\theta_t s_t))] \tag{A.12}$$

$$V^L_t(\theta_t s_t) \equiv E_{\theta_t}[\hat{\pi}(x_t(\theta_t s_t)) + \delta V^L_{t+1}(x_t(\theta_t s_t))] \tag{A.13}$$

(ii) We show that $V^R_t \equiv V^L_t \equiv V_t$ by backward induction. First, $V^k_T(s_T) = E_{\theta_T}[\hat{\pi}(x_T(\theta_T s_T))]$, so $V_T^R \equiv V_T^L \equiv V_T$. Next from (A.12), (A.13), we see that if $V_{t+1}^R \equiv V_{t+1}^L \equiv V_{t+1}$, the the same property holds at t.

(iii) Now from parts (i) and (ii), we see that one of (A.9), (A.10) is redundant. So, dropping (A.10), and using $V^R \equiv V^L \equiv V$ in (A.9), we get (12). □

Proof of Proposition 5. (i) The equilibrium at T is the static one. So, from (13), noting $V_{T+1} \equiv 0$, setting $s_T = s,\ \theta_T = \theta$, and calculating the expectation with respect to θ explicitly, we have:

$$V_T(s) \equiv F(x^-/s)\hat{\pi}(x^-) + (1 - F(z^+/s))\hat{\pi}(x^+) + \int_{x^-/s}^{x^+/s} \hat{\pi}(\theta s) f(\theta) d\theta \tag{A.14}$$

So, by direct calculation from (A.14), it can be seen that V_T is twice continuously differentiable in s, with

$$V_T' = \int_{x^-/s}^{x^+/s} \hat{\pi}'(\theta s)\theta f(\theta) d\theta = 0.5 \int_{x^-/s}^{x^+/s} (u_R'(\theta s) - u_R'(-\theta s))\theta f(\theta) d\theta < 0 \tag{A.15}$$

$$V_T'' = \int_{x^-/s}^{x^+/s} \hat{\pi}''(\theta s)\theta^2 f(\theta) d\theta = 0.5 \int_{x^-/s}^{x^+/s} (u_R''(\theta s) - u_R''(-\theta s))\theta^2 f(\theta) d\theta < 0 \tag{A.16}$$

The inequality (A.15) follows because u_R is strictly concave, and $\theta s > 0$, so $u_R'(\theta s) < u_R'(-\theta s)$. The inequality (A.16) follows from from Assumption A3, which implies $u_R''(\theta s) < u_R''(-\theta s)$.

(ii) Now assume that V_{t+1} is twice continuously differentiable in s_{t+1}, with $V_{t+1}', V_{t+1}'' < 0$. Then the maximand in (12) is strictly concave given the assumptions made, and it is also everywhere differentiable except at $x = \theta_t s_t$.

So, using the definition of $f(x;\lambda)$ in Lemma 1, the symmetric equilibrium at $t,\ x_t$, is characterized by the conditions

$$\begin{aligned} &f(x_t;1) + \delta V_{t+1}'(x_t) = 0,\ x_t < \theta_t s_t \\ &f(x_t;\lambda) + \delta V_{t+1}'(x_t) = 0,\ x_t > \theta_t s_t \\ &f(x_t;\lambda) + \delta V_{t+1}'(x_t) \le 0 \le f(x_t;1) + \delta V_{t+1}'(x_t),\ x_t = \theta_t s_t \end{aligned} \tag{A.17}$$

Following the logic of Proposition 1, and using (17), it is easily checked that the solution to (A.17) is (16) as claimed. Also, note that as $V_{t+1}' > 0$, $V_{t+1}'' < 0$, z_t^-, z_t^+ as defined in (17) are unique, and $z_t^- < x^-$, $z_t^+ < x^+$, as claimed.

(iii) To complete the induction argument, we need to verify that V_t is twice continuously differentiable, strictly increasing and concave, given these properties for V_{t+1}. So, from (13), setting $s_t = s,\ \theta_t = \theta$ to lighten notation, and calculating the expectation with respect to θ explicitly, using (16), we have:

$$\begin{aligned} V_t(s) \equiv\ & F(z_t^-/s)(\hat{\pi}(z^-) + \delta V(z_t^-)) + (1 - F(z^+/s))(\hat{\pi}(z_t^+) + \delta V_{t+1}(z_t^+)) \\ &+ \int_{z_t^-/s}^{z_t^+/s} (\hat{\pi}(\theta s) + \delta V_{t+1}(\theta s)) f(\theta) d\theta \end{aligned} \tag{A.18}$$

Then, assuming V_{t+1} on the RHS of (A.18) is twice continuously differentiable in s, it is clear by inspection that the entire RHS of (A.18) is twice continuously differentiable in s because $\hat{\pi}(\theta s)$ also has this property. So, V_t is also twice continuously differentiable in s.

We can prove $V_t',\ V_t'' < 0$ in the same way, using the fact that $\hat{\pi}'(x), \hat{\pi}''(\theta s) < 0$. For example, differentiating (A.18) and using (A.11):

$$V_t'(s) = \int_{z_t^-/s}^{z_t^+/s} (\hat{\pi}'(\theta s) + \delta V_{t+1}'(\theta s))\theta f(\theta) d\theta < 0 \tag{A.19}$$

As $V_{t+1}',\ \hat{\pi}'(\theta s) < 0$, so $V_t' < 0$ on the LHS also. Then, $V_t'' < 0$ is proved in exatly the same way.

(iv) We prove that $z_t^+ - z_t^- < x^+ - x^-$. To do this, note first that because $z_t^+ > z_t^-$, and V_{t+1}' is strictly decreasing, $\delta V_{t+1}(z_t^+) < \delta V_{t+1}(z_t^-) < 0$. So, from (17), we see that $f(z_t^+;1) > f(z_t^-;\lambda) > 0$. So, as $f(x^+;1) = f(x^-;\lambda) = 0$, and f is decreasing in x, we simply need show that $\Delta = f(x;1) - f(x;\lambda)$ is increasing in x. To see this, note that if this is the case, letting $f(z';1) = f(z_t^-;\lambda)$, then $z' - z_t^- < x^+ - x^-$. But, as f is decreasing in x, $f(z_t^+;1) > f(z';1)$ implies $z_t^+ < z'$, so $z_t^+ - z_t^- < x^+ - x^-$ as required. But then, using (8),(9), we get:

$$\Delta = f(x;1) - f(x;\lambda) = (\lambda - 1)\rho(u_R(x) - u_R(-x))$$

So, $\Delta' = (\lambda - 1)\rho(u_R'(x) + u_R(-x)) > 0$ as required.

(v) We prove that z^+ is decreasing in δ; the proof for z^- is identical. First, we show that the derivative $\frac{\partial V_t'(s)}{\partial \delta}$ exists and is non-positive. This is clearly the case if $t+1 = T$, as V_T is independent of δ. Next, assume that $\frac{\partial V_{t+1}'(s)}{\partial \delta}$ exists and is non-positive. Then, differentiating (A.19), we get

$$\frac{\partial V_t'(s)}{\partial \delta} = \int_{z_t^-/s}^{z_t^+/s} \left(V_{t+1}'(\theta s) + \delta \frac{\partial V_{t+1}'(s)}{\partial \delta} \right) \theta f(\theta) d\theta \tag{A.20}$$

So, from (A.20), as $V_{t+1}' < 0$, if $\frac{\partial V_{t+1}'(s)}{\partial \delta} \leq 0$, then $\frac{\partial V_t'(s)}{\partial \delta} \leq 0$ also. The proof then follows by induction.

Now, from (17), given that $\frac{\partial V_{t+1}'(z^+)}{\partial \delta}$ exists, we have

$$\frac{\partial z_t^+}{\partial \delta} = -\frac{V_{t+1}''(z^+) + \delta \frac{\partial V_{t+1}'(z^+)}{\partial \delta}}{f_x(z^+;1) + \delta V_{t+1}''(z^+)} \tag{A.21}$$

Now, $V_{t+1}''(z^+) < 0$,as already proved, and $f_x < 0$ from Lemma 1, so the denominator of (A.21) is negative. Thus, for $\frac{\partial z_t^+}{\partial \delta} < 0$, it suffices to show that the numerator is negative. But this follows as $\frac{\partial V_{t+1}'(z^+)}{\partial \delta} \leq 0$. □

Proof of Proposition 6. (a) Assume $\Delta\mu \leq \Delta\mu_{\min}$. Assume first that R is the incumbent, so that the status quo is x_S. Then, from Proposition 1, if $x_S \in [\Delta\mu + x^-, \Delta\mu + x^+]$, the equilibrium is $x_R = x_S,\ x_L = -x_S + 2\Delta\mu$. So, we require

$$x_S \in [\Delta\mu + x^-, \Delta\mu + x^+] \Leftrightarrow x_S - x^+ \leq \Delta\mu \leq x_S - x^- \tag{A.22}$$

But as x_S is an initial equilibrium, from Proposition 1, $x_S \leq x^+$ and so $x_S - x^+ \leq 0$, so $x_S - x^+ \leq \Delta\mu$ always holds. Thus, as $\Delta\mu \leq x_S - x^-$, (A.22) certainly holds.

Now assume that L is the incumbent, so that the status quo is $-x_S$. Then, from Proposition

1, if $-x_S \in [\Delta\mu - x^+,\ \Delta\mu - x^-]$, the equilibrium is $x_L = x_S,\ x_L = -x_S + 2\Delta\mu$. So, we require

$$x_S \in [\Delta\mu - x^+,\ \Delta\mu - x^-] \Leftrightarrow x^- - x_S \leq \Delta\mu \leq x^+ - x_S \tag{A.23}$$

But as $-x_S$ is an initial equilibrium, from Proposition 1, $x_S \geq x^+$ and so $x^- - x_S \leq 0$, so $x^- - x_S \leq \Delta\mu$ always holds. Thus, as $\Delta\mu \leq x_S - x^-$, (A.23) certainly holds.

(b) Now suppose that the shift is large i.e. $\Delta\mu > \Delta\mu_{\max}$. Then, if R won the election, so that the status quo is x_S, from Proposition 1, as $x_S < \Delta\mu + x^-$, the outcome is $x_R = \Delta\mu + x^-,\ x_L = \Delta\mu - x^-$. If L won the election, i.e. is the incumbent, so that the status quo is $-x_S$, then from Proposition 1, as $-x_S < \Delta\mu - x^+$, the outcome is $x_R = \Delta\mu + x^+,\ x_L = \Delta\mu - x^+$.

(c) Now suppose that the shift is intermediate, with $x^+ - x_S < \Delta\mu \leq x_S - x^-$. Then if R won the election, so that the status quo is x_S, by the argument in part (a) of the proof, the outcome is $x_R = x_R = x_S,\ x_L = -x_S + 2\Delta\mu$. On the other hand, if L won the election, so that the status quo is $-x_S$,then by the argument in part (b) of the proof, the outcome is $x_R = \Delta\mu + x^+,\ x_L = \Delta\mu - x^+$.

(d) Now suppose that the shift is intermediate, with $x_S - x^- < \Delta\mu \leq x^+ - x_S$. Then if R won the election, so that the status quo is x_S, by the argument in part (b) of the proof, the outcome is the outcome is $x_R = \Delta\mu + x^-,\ x_L = \Delta\mu - x^-$. On the other hand, if L won the election, so that the status quo is $-x_S$, then by the argument in part (a) of the proof, the outcome is $x_L = x_S,\ x_L = -x_S + 2\Delta\mu$. □

Proof of Proposition 8. From inspection of the results in Proposition (6), the following table can be constructed, where cases (c) and (d) refer to cases in the Proposition, and $I = R, L$ denotes the incumbent:

$\Delta\mu$	I	x_R	x_L	$x_R - x_L - 2x_S$
small	R	x_S	$-x_S + 2\Delta\mu$	$-2\Delta\mu$
small	L	$x_S + 2\Delta\mu$	$-x_S$	$2\Delta\mu$
large	R	$\Delta\mu + x^-$	$\Delta\mu - x^-$	$2(x^- - x_S)$
large	L	$\Delta\mu + x^+$	$\Delta\mu - x^+$	$2(x^+ - x_S)$
case (c)	R	x_S	$-x_S + 2\Delta\mu$	$-2\Delta\mu$
case (c)	L	$\Delta\mu + x^+$	$\Delta\mu - x^+$	$2(x^+ - x_S)$
case (d)	R	$\Delta\mu + x^-$	$\Delta\mu - x^-$	$2(x^- - x_S)$
case (d)	L	$x_S + 2\Delta\mu$	$-x_S$	$2\Delta\mu$

In the case of a small shift, we then see that if R is the incumbent, then $x_R - x_L < 2x_S$, but if R is the incumbent, then $x_R - x_L > 2x_S$. The same is clearly true if the shift is large, as $x^- \leq x_S \leq x^+$. In case (c), we require $-2\Delta\mu \leq 2(x^+ - x_S)$, or $\Delta\mu \geq x_S - x^+$, which is always true, as $x_S \leq x^+$. In case (d), we require $x^- - x_S \leq \Delta\mu$,which is always true, as $x_S \geq x^-$. □

B Equilibrium with a Köszegi-Rabin Reference Point

In our setting, from the point of view of the individual voter, the Köszegi-Rabin reference point is the *actual probability distribution* over party platforms generated by equilibrium voting behavior. That is, r is stochastic and $r \in \{x_L, x_R\}$ with probabilities $1-p$, p, where p is the equilibrium probability of a win for the R party. Given this definition of r, voter payoffs are given by (2) as before.

Then, given the reference point r, expected utilities for the median voter from voting for R, L respectively are:

$$\begin{aligned} Ev_R &= pv(x_R; x_R) + (1-p)v(x_R; x_L), \\ Ev_L &= pv(x_L; x_R) + (1-p)v(x_L; x_L) \end{aligned} \tag{B.1}$$

Thus, the median voter will vote for party R if $Eu_R - Eu_L \geq \varepsilon$. So, p is defined by the equality

$$p = F\left(Ev_R - Ev_L\right) \tag{B.2}$$

It is clear from (B.1), (B.2) that there is a "feedback effect"; a change in p changes the critical value of $\varepsilon,\ Ev_R - Ev_L$, and thus changes p on the left-hand side of (B.2).

The political parties then choose x_L, x_R to maximize π_R, π_L subject to p being defined as a function of x_R, x_L in (B.2). To analyze this equilibrium, we assume A1. Also, we assume the following variant of A2 above, which ensures that there is less than full convergence of equilibrium platforms:

A2′. $u_R(0) = -u_L(0) = l'(1) > \rho(1+\lambda)M.$

Given these assumptions, it turns out that there are a continuum of equilibria, as shown in the not-for-publication Appendix. Specifically, define the endpoint x^+ as in 8 and y^- by the equation;

$$0.5u_R'(y^-) - \rho\frac{1+\lambda}{2}\left(u_R(y^-) - u_R(-y^-) + M\right) = 0 \tag{B.3}$$

Following the argument in Lemma 1, given assumptions A1, A2′, it is easily established that there exists a unique solution $0 < y^-$ to (B.3). Also, comparing (B.3) to (9), we see that the coefficient on the gain from winning in (B.3) i.e. $\frac{1+\lambda}{2}$ is lower than the corresponding term in (9) of λ, implying that $y^- > x^-$. So, we have:

***Proposition* 9.** *Assume A1, A2′. With a rational expectations reference point, any pair* (x_R, x_L) *with* $x_R = -x_L \in [y^-, x^+]$ is a symmetric Nash equilibrium. So, all equilibria are weakly closer to the median voter's ideal point than the unique symmetric Nash equilibrium without loss-aversion.

So, the key difference between the baseline case with a backward-looking reference point and this case is that in the former, the pre-existing status quo pins down the equilibrium; here, we have a continuum of equilibria. Also, we see that as $y^- > x^+$, the simultaneous determination of p and the median voter's gain from voting for party R via (B.1) and (B.2) seems to generate less party convergence toward the median voter's ideal point. Finally, note that as in the baseline case, y^- is decreasing in λ, so the set of equilibria is increasing in voter loss-aversion.

Proof of Proposition 9. Consider a symmetric equilibrium where $x_R = -x_L = x^* > 0$. We consider a small deviation in the platform starting at this equilibrium. It is sufficient to study the behavior of one party, and we choose the R party. The effects on π_R of a small increase and decrease in x_R, starting at $x_R = -x_L = x^*$, $p = 0.5$, are, respectively:

$$0.5u'_R(x^*) + \left(\frac{dp}{dx_R}\right)^+ (u_R(x^*) - u_R(-x^*) + M) \tag{B.4}$$
$$0.5u'_R(x^*) + \left(\frac{dp}{dx_R}\right)^- (u_R(x^*) - u_R(-x^*) + M)$$

respectively, where $\left(\frac{dp}{dx_R}\right)^+$, $\left(\frac{dp}{dx_R}\right)^-$ are the right-hand and left-hand derivatives of p w.r.t. x_R at $x_R = -x_L = x^*$, $p = 0.5$.

To compute these derivatives, we combine (B.1),(B.2) to get

$$p = F\left(p(v(x_R; x_R) - v(x_L; x_R)) + (1-p)(v(x_R; x_L) - v(x_L; x_L))\right) \tag{B.5}$$

Now from (B.5), using the implicit function theorem, and using $v(x_R; x_R) = v(x_L; x_R)$, $v(x_R; x_L) = v(x_L; x_L)$ when $x_R = -x_L = x^*$ and also $p = 0.5$, we have, at any point of differentiability of p;

$$\frac{dp}{dx_R} = 0.5\rho\left(\frac{\partial v(x_R; x_R)}{\partial x_R} + \frac{\partial v(x_R; x_L)}{\partial x_R}\right) \tag{B.6}$$

Now, from (2), we have;

$$\frac{\partial v(x_R; x_R)}{\partial x_R} = -1, \quad \frac{\partial v(x_R; x_L)}{\partial x_R} = \begin{cases} -1, & u(x_L) \leq u(x_R) \\ -\lambda, & u(x_L) > u(x_R) \end{cases} \tag{B.7}$$

So, from (B.6), (B.7), using the fact that $u(x_L) > u(x_R)$ for the right-hand (+) derivative, and $u(x_L) < u(x_R)$ for the left-hand (-) derivative, we get

$$\left(\frac{dp}{dx_R}\right)^+ = -0.5\rho\left(1+\lambda\right), \quad \left(\frac{dp}{dx_R}\right)^- = -\rho \tag{B.8}$$

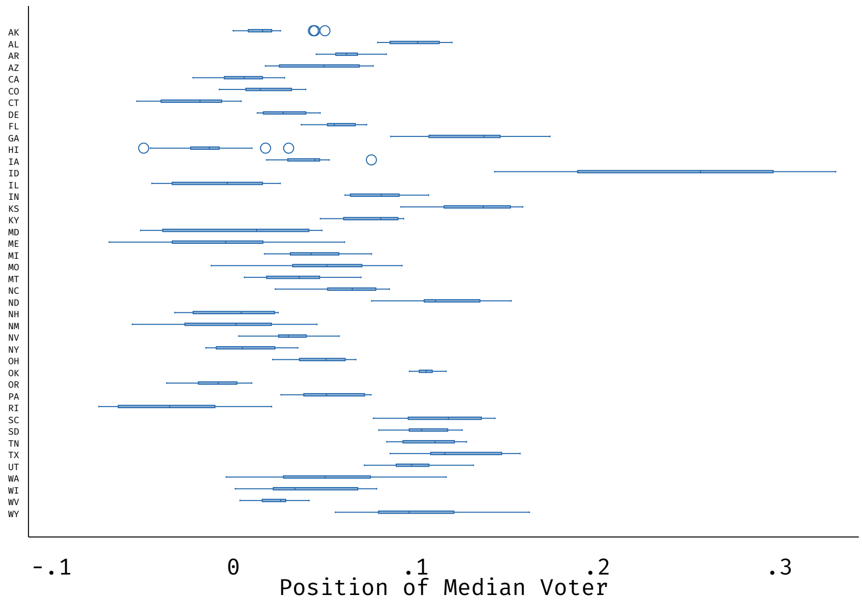
So, any symmetric equilibrium $x^* = x_R = -x_L$ must satisfy the condition that party R cannot gain from a small deviation, which requires from (B.4), (B.8) that

$$u'_R(x^*) - \rho\left(1+\lambda\right)\left(u_R(x^*) - u_R(-x^*) + M\right) \leq 0 \leq u'_R(x^*) - 2\rho\left(u_R(x^*) - u_R(-x^*) + M\right) \tag{B.9}$$

Then, clearly if x^+, x^- solve (B.3) then by construction, any pair (x_R, x_L) with $x_R = -x_L = x^* \in [x^-, x^+]$ satisfies (B.9) and thus is a Nash equilibrium. Moreover, following the argument in Lemma 1, given assumptions A1, A2', it is easily established that there exists a unique solution to (B.3) and that x^- is decreasing in λ. □

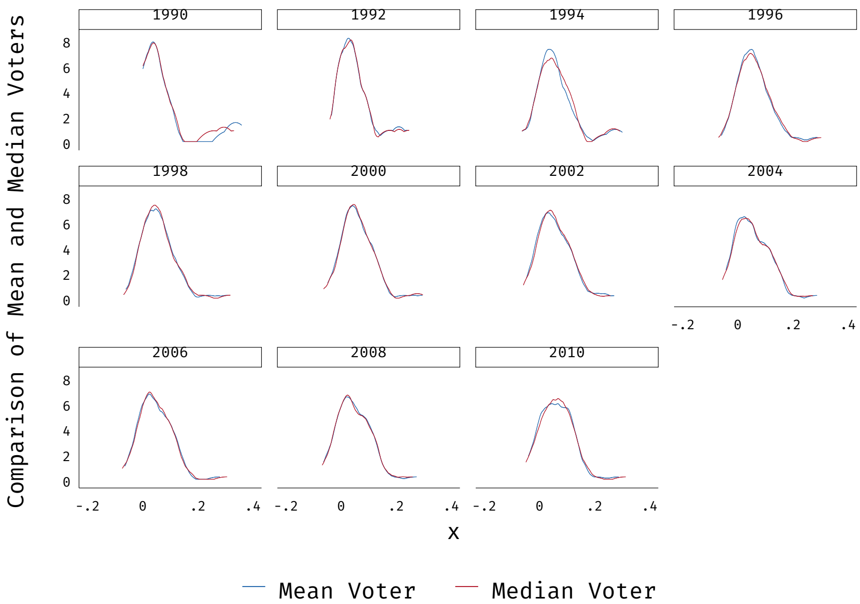
C Additional Figures

Figure C.1: Distribution of State Median Voters



Each state is represented by a box-plot. The more heavily shaded area represents the inter-quartile range. and the whiskers represent the upper and lower adjacent values. These are the values x_i such that $x_i > 1.5 * IQR + X_{75}$ and $x_i < 1.5 * IQR + X_{25}$ respectively. Where, x_{75} and x_{25} denote the 75^{th} and 25^{th} percentiles respectively and IQR is the Inter-Quartile Range, $x_{75} - x_{25}$ (see, Tukey, 1977).

Figure C.2: Comparison of Mean and Median Voters



D Robustness Tests

As discussed above, one important advantage of studying state legislative elections is that there is a large sample of elections in an institutionally homogeneous setting. Thus, our preferred sample excludes all elections with multi-member districts.[32] As well as making the states we study as similar as possible, a second advantage of restricting the sample is so that the setting we study empirically is as close as possible to that analyzed theoretically. However, it is nevertheless important to check that our results are not an artefact of this choice. Columns 1 4 of Table D.1 report fixed-effects and IV estimates. Columns 1 and 3 include only SP fixed-effects, while columns 2 and 4 also include SY, and PY effects. The coefficients are largely unchanged, and remain statistically significant suggesting that our results are not being driven by the choice of states.

Columns 5-8 of Table D.1 report results for our preferred sample, but now defining party positions on the basis of their mean, rather than median, representative. As in columns 1-4 the first two columns report OLS estimates and the latter two IV estimates. Also similarly, columns 5 and 7 report results only including SP effects, while 6 and 8 additionally include SY and PY effects. The coefficients are now in fact a little larger, and mostly precisely measured. However, the IV estimates in column 8 including the full-set of fixed-effects, while of the expected sign, are not significant at conventional levels. We interpret this as reflecting the demanding nature of the specification. In sum, we argue that tables D.1 provides further evidence that the empirical support for the predictions of the theory is robust to a wide range of alternative modelling assumptions.

[32]These are Arkansas, Arizona, Georgia, Idaho, Maryland, North Carolina, North Dakota, New Hampshire, South Dakota, Washington, and West Virginia.

Table D.1: Robustness Tests

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Shift_{st}$	0.46***	0.76***	0.51***		0.68***	0.96***	0.52***	
	(0.13)	(0.11)	(0.13)		(0.12)	(0.05)	(0.17)	
$Inc_{pst} \times Shift_{st}$	-0.38***	-0.67***	-0.62***	-0.65***	-0.53***	-0.52***	-0.53**	-0.24
	(0.15)	(0.06)	(0.17)	(0.13)	(0.16)	(0.10)	(0.21)	(0.19)
Inc_{pst}	0.00**	0.00***	0.00	0.00***	0.00**	0.01***	-0.00	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.18	0.15			0.20	0.16		
N	552	552	552	552	428	428	428	428
UnderID LM			48.06	4.51			26.83	3.52
P(UnderID)			0.00	0.03			0.00	0.06
WeakID Wald			40.16	24.70			32.71	24.38
Estimator	OLS	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS
Party Position	Median	Median	Median	Median	Mean	Mean	Mean	Mean
MultiMember	Yes	Yes	Yes	Yes	No	No	No	No

The dependent variable is the change in party position measured either by each party's median representative (columns 1-4) or alternatively its mean representative (columns 5-8). OLS estimates are reported in columns 1,2,5, and 6 and corresponding 2SLS estimates are reported in columns 3,4, 7, and 8. Columns 1-4 additionally include observations from states which have at least one multi-member district. All columns other than 3 and 6 include SP fixed effects. Columns 2,4,6, and 8 additionally include SY, and PY fixed effects. Columns 3 and 7 report robust standard errors, columns 1 5 report standard errors cluster by SP, columns 2,4,6, and 8 report standard errors clustered by SP and PY. UnderID LM refers to the generalized Under-identification test of Kleibergen and Paap (2006) and P(UnderID) the associated p-value. WeakID Wald refers to the Kleibergen and Paap (2006) generalized test of Weak-identification and we are able to reject this at all levels in all specifications. Other details as for Table 3.

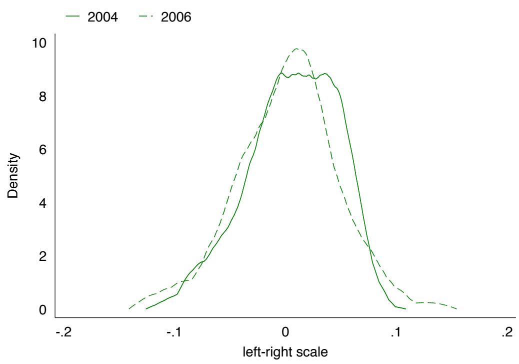
E The example of California

We take California as our example as it has a large population, and a relatively large state-legislature, in which neither party is overly dominant. Figure E.1 describes the results of the Californian State Legislature elections in 2004 and 2006. Panel E.1a plots kernel density estimates of voters' preferences in 2004 and 2006 i.e. the kernel of the distribution of μ_{dt}. We can see that the solid 2004 curve is to the right of the dashed 2006 curve. This represents a leftward move in the position of the average voter between the two elections. The prediction of the theory is that this move, given the Democrats had a majority in 2004 should have led the Republican party to move to the left.

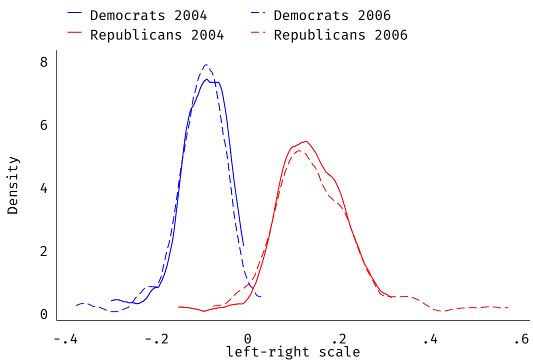
The kernel density estimates of representatives positions for each party in Panel E.1b show that this is precisely what happens. The distribution of Democrats changes little – there is a slight move to the left, particularly in the left-wing of the party – but as predicted the Republican party moves markedly to the left. The nature of this move is revealed by looking at the histograms in panels E.1c and E.1d. We can see again that there are no pronounced changes in the Democratic representatives. The Republican representatives, however, tend to move closer to the centre – there is now more overlap with the Democrats and the main body of the party can be seen to be more centrist.[33]

[33]Notably, however there are a small number of comparatively extreme representatives. This highlights that districts and their representatives are extremely heterogeneous – the variation in the positions of Republicans is much larger than the distance between the two party means. This is why we pay close attention to our measures of the average voter, and party position.

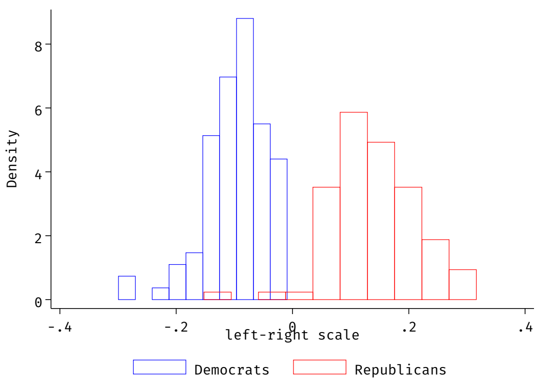
Figure E.1: Californian State Legislature Elections 2004 and 2006



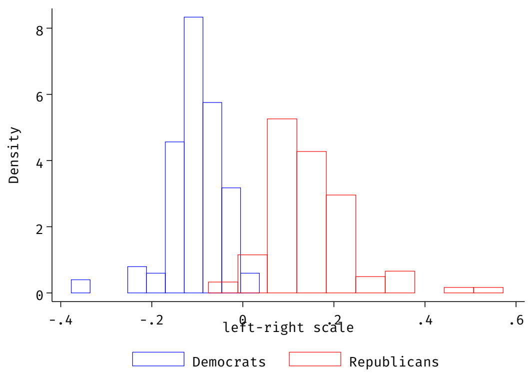
(a) Changes in Voter Positions



(b) Changes in Party Positions



(c) Representatives 2004



(d) Representatives 2006

F Party Shifts and Median Voter Shifts

One concern is that there may be a correlation between the position of the median representative and the mean voter in the median district solely due to both variables being derived from the same underlying data. In the following we show that whilst the covariance is necessarily always weakly positive, it grows small rapidly as the number of districts in a state grows and may be disregarded.

We consider a state, in which there are two parties L and R with $L + R = N$ districts: $i \in \{1, ..., L, L+1, ..., L+R\}$. Where L and R are both odd. Median Representative of L is the $(L+1)/2$ representative. And the Median Representative of R is the $L + (R+1)/2$ representative. The mean voter in the median district, because of the assumption that all districts are ranked in terms of their representatives is then then (a vote weighted) mean of L and $L+1$. Thus, assuming approximately equal vote shares the automatic correlation is given by the covariance between the $(L+1)/2$ order statistic and the L order statistic, or symmetrically, the $L+1$ order statistic and the $L + (R+1)/2$ order statistic.

Arnold et al. (2008) show that this covariance may be expressed approximately as series expansion in terms of powers of $\frac{1}{n+2}$, which thus converges to 0 as n grows large. Thus, we need not be concerned about any mechanical correlation.