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The volatility of median and supermajoritarian pivots in the U.S. Congress and the effects of party polarization

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Abstract Krehbiel's (Pivotal politics, 1998) seminal work on pivotal politics in the US Congress emphasizes the importance of supermajoritarian rules and veto players in determining what bills can pass. We illustrate empirically that the volatility of the pivot points has increased markedly since the mid 1970s, and we link changes in pivot volatility to the degree of party polarization. In general, median and supermajority pivots shift considerably more than the overall mean and, when politics is polarized, the congressional median and supermajority pivots can change dramatically when a shift in control occurs. The relative volatility of median and supermajoritarian pivots varies with the degree of polarization and the extent to which there is continuity in party control. We develop a theoretical model to explain the nature of these relationships.

Keywords Pivotal politics · US Congress · Supermajoritarian · Party polarization · Conditional party government · Gridlock interval

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1 Introduction

The idea of pivotality is that a voter is *pivotal* or decisive if a change in her vote can transform a losing situation into a winning one, or a winning coalition into a losing one. Pivotality is a key theoretical concept in virtually every analysis of voting that has been influenced by decision theoretic and game theoretic reasoning. The idea of *power* reflected in the *Shapley–Shubik value*, the *Banzhaf index*, and other measures of power such as the *Shapley–Owen value* (see Owen 1995; Machover and Felsenthal 1998 for reviews) is based directly on *decisiveness/pivotality*.[1] Applications of the concept of pivotality in the unidimensional case allow for further specification, because we can then identify the pivot in terms of location on a (left–right) line (see, e.g., Downs 1957; Black 1958; Groseclose and Snyder 1996; Krehbiel 1998).[2]

We are interested in studying pivotal politics in the US Congress. We follow Krehbiel (1998) in focusing on the location of pivot points in the legislature as a whole, rather than looking at the pivotal member(s) within each party, as in party-centric models of legislative decision making (Cox and McCubbins 2005, 2007). However, the location of the party delegations and the overall median and other pivots necessarily are connected and we analyze that connection. We also follow Krehbiel (1998) in making central to our analysis the fact that, in the multicameral legislative setting in American politics, with presidential veto power and supermajoritarian rules of congressional veto override, and cloture in the Senate in the presence of a filibuster, different legislators can occupy the pivotal role, across different types of votes. Because of these institutional factors, the key pivotal locations in the US Congress are the median, and two supermajoritarian quantiles: two-thirds (in both chambers) and three-fifths (in the Senate).

We begin our study with an empirical examination of changes in the location of these various pivots for the 1940–2010 period. In the next section we consider the effects of replacement of members of Congress on the location of pivots. We offer a theoretical model that allows us to show how changes in party control, and the degree of partisan polarization affect the volatility of both the median and the supermajoritarian pivots—noting that the latter switch back and forth as power alternates in the presidency or Congress. Thus, we distinguish expectations about the volatility of different types of pivots during one-party control as opposed to when partisan control changes.

We are particularly interested in the effects of party polarization on pivots. In the next to the last section of the paper we consider the link between the location of party delegations and the location of pivots in terms of a simple four-variable analysis involving (1) change in party control, (2) change in seat share, (3) difference in mean locations of the party delegations, and (4) the interaction of variables 1 and 3.

[1] The standard assumption is that the preferences of those who are pivotal either decide outcomes or act to constrain the scope of feasible outcomes; thus, voters expected to be pivotal are more likely to be offered or to extract resources in the form of side payments from others who wish to influence their votes. Groseclose and Snyder (1996) provide a powerful antidote to this common wisdom by showing that sequential vote buying models in which two competitors seek to influence outcomes can lead to offers to those with locations beyond that of the pivotal (median) voter. Such supraminimal coalitions may minimize the potential for extracting resources from the vote buyer. In such cases, the pivotal voter may not be the voter who is expected to receive the largest payoff. Here, our focus is simply on identifying the location of pivotal voters rather than modeling their expected payoff.

[2] Any model in which voters are arrayed along some given dimension allows us to label voters according to where they are located on that dimension. Consider for example, the redistribution models of Meltzer and Richard (1978, 1981, 1983), or social insurance and special interest group models of welfare spending (Husted and Kenny 1997), where voters may be located according to income.

In our concluding discussion, we summarize our key results, briefly discuss some policy implications, and show how our results can be used to link the study of supermajoritarian pivots to the idea of *conditional party government* (Aldrich and Rohde 1998, 2000a, b). Because median pivots would play a more critical role in a legislative system without supermajoritarian requirements, contrasting the volatility of medians with that of supermajoritarian pivots sheds light on the effects of supermajoritarian rules on the dynamics of policy decisions.

2 Replacement effects, legislative polarization, and the locations of median and supermajoritarian pivot points

2.1 Replacement effects on mean and median pivots

In this section, using the first dimension of DW NOMINATE scores to represent legislator location, we examine empirical evidence about how pivot locations have changed during the period from 1940 to 2010, and we examine factors linked to these changes, such as replacement effects, legislative polarization,[3] and changes in party control. How do pivot locations change after an election? In a two-party situation, with voting along a unidimensional continuum, suppose that legislator A is replaced by legislator B, who is to her right. The *mean* ideological location of the legislature as a whole will always shift rightward, but the *median* shifts rightward only if legislators A and B were on opposite sides of the previous median.

Thus, we might expect the influence of elections on the location of the median legislator (median pivot point) to be minimal. In fact, one might think that the effect on the median might be less than that on the mean, because the median is thought of as a robust estimator of central tendency. But this latter argument misses the mark. The median is robust in the sense that it is little affected by extreme outliers, such as those several standard deviations from the mean of a unimodal distribution, but such outliers are empirically uncommon for DW NOMINATE scores. On the other hand, for a highly bimodal distribution, such as that for the currently polarized US Congress in which the distributions of the partisan delegations are completely separate—the overall median of the legislative body is decidedly more variable than that of the mean—as we will see in greater detail both empirically and analytically.[4]

2.2 Replacement effects on supermajoritarian pivots

Similarly, the location of a supermajoritarian quantile[5] changes only when a legislator on one side of the quantile is replaced by one on the other side. The quantiles related to

[3] *Legislative polariz*ation is defined here simply as the *difference* between the ideological location of the mean Democrat and the mean Republican.

[4] In fact, even for a normal distribution, the sample median is a less robust estimator than the sample mean (Mood et al. 1974, p. 257).

[5] A quantile is to a fraction as a percentile is to a percent. For example the 2/3rd quantile of the DW NOMINATE scores in the House is that value for which 2/3rds of the House members have lower (more liberal) values (i.e., the 2/3rd quantile is approximately the 67th percentile). The 3/5th quantile is the 60th percentile.

supermajoritarian pivots typically, however, are less likely than the median to be volatile when the legislature is polarized because in that case the median of the distribution of legislator locations is likely to lie in the thin portion of the distribution in the middle.

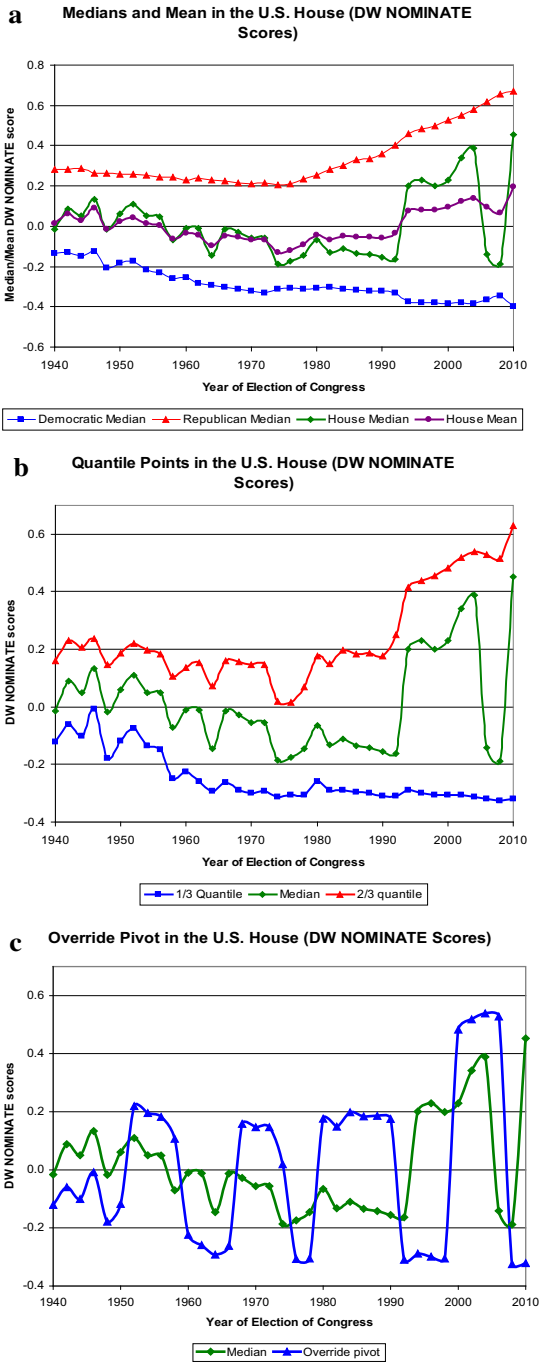


Fig. 1 Means, medians, and other pivotal points in the House: 1940–2010. **a** Comparison of House medians and means, **b** quantile points in the House, and **c** override pivot in the House

Thus, replacement of legislators by other members of the same party is not expected to have a systematic effect on the partisan distributions in the legislature (and, hence, on the quantiles of the distribution) unless new representatives are systematically more (or less) likely to be more extreme than those they replace. On the other hand, replacement of, say, a Democratic legislator by a Republican legislator typically moves both the overall legislative mean and median to the right.

In many cases, such replacements occur when—for example—one party, say the Republican, "picks off" a relatively moderate member of the opposite party. Such a change typically moves the overall mean (and often the median) to the right, while moving the mean and median of the Democratic Party to the left. The reverse would occur when the Democrats pick up a seat from a moderate Republican. However, in recent decades "moderate" Republicans are scarcer and so the effect of electoral tides on within-party ideological distributions has been very different for Republicans than for Democrats (see Brunell et al. 2014). For Republicans, electoral tides in either direction now do little to change the ideological center of the Republican Party.

Although turnover is not rampant in Congress, recent research indicates that, nevertheless, replacement can result in significant ideological movement. Bafumi and Herron (2010) document what they call leapfrog representation under which relatively extreme members of Congress are replaced by relatively extreme members from the other party. More recently McCarty et al. (2015) demonstrate, furthermore, that ideologically heterogeneous districts in the Congress and state legislatures often are represented by more ideologically extreme members. These districts are among the most competitive in the sense that either party has a chance at controlling the seat.

3 Empirical evidence about the location of median and supermajoritarian pivot points

3.1 Historical evidence on the volatility of the median and supermajority quantiles in the House

Figure 1a plots the empirical House medians and House means of (the first dimension of) DW NOMINATE scores,[6] along with the separate partisan medians, for the last 36 US Congresses (the 77th through the 112th Congress, i.e., those elected from 1940 through 2010). Although the separate Democratic and Republican medians change gradually, although not by much between any one Congress and the next, the overall House median can change dramatically, especially when a shift in control of the House occurs. This latter effect is especially marked under conditions of legislative polarization. The dramatic change in the location of the overall median in the US House of Representatives in 1994, after a change in party control has been noted previously (see, e.g., Grofman et al. 2001). Here we see a similar change in 2006 in the other direction.

Thus, we observe that the changes in the median are much more pronounced than those of the mean. The mean absolute change (from Congress to Congress) of the House medians

[6] DW NOMINATE scores were obtained from the Voteview website http://voteview.com/dw-nominate_textfile.htm (see Carroll et al. 2009). In House districts listing two occupants in a particular Congress (typically owing to the resignation or death of the first), only one occupant (the first one listed) is included in our dataset to avoid distorting the median and other quantiles. Similarly, when three or more Senators are listed for one state in a Congress, low roll call tallies are used to indicate incomplete terms, with the second listed low-tally Senator omitted. In questionable cases, biographical information was consulted.

over 1940–2010 is 0.094, almost three times the corresponding statistic for the House means, which is 0.034. Also, changes in the median increase strikingly over time, particularly from about 1978 on, and have accelerated as polarization increases.

Figure 1b plots the locations of supermajoritarian quantiles in the House over the same period. These quantiles changed much less from election to election than the median, although over time the 2/3rd quantile moves substantially to the right in the early 1990s as the Republican delegation both enlarged and became more conservative.[7] It is particularly notable that, in the presence of polarization in recent years, when control changed to the Democrats in 2006, both of these non-median quantiles barely budged while the median switched sharply from Republican to Democratic territory. This occurs because, under conditions of polarization, the 2/3rd and 1/3rd quantiles typically fall within the distribution of one of the parties regardless of which party is in power and hence are unlikely to change greatly unless one party has two-thirds of the seats in the House—which happens very rarely. The Democrats had two-thirds or more of the seats in the 74th–77th Congresses (1935–1943), as well as the 89th Congress (1965–1966). The median, on the other hand, is quite sensitive to which party holds a majority of seats.

3.2 Historical evidence about volatility of pivots in the House

The dynamics of supermajoritarian pivots are, however, not dependent on the movement of a single quantile. The location of the 2/3rd pivot required for override of a presidential veto, for example, switches back and forth between the 1/3rd and 2/3rd quantiles, depending on whether the president is a Democrat or a Republican.

Assuming that members of the House are voting ideologically, when the president is a Democrat, overriding a veto requires amassing votes starting from the ideological right. Because our scale counts from left to right, this defines the veto override pivot as the 1/3rd quantile. On the other hand, given a Republican president, override requires two-thirds of the members starting from the left, so that, again given our scale, the override pivot is the 2/3rd quantile. Figure 1c depicts the gyrations of this veto override pivot over the 1940–2010 period, in comparison with the median. Because of the switches in the override pivot between the 1/3rd quantile and the 2/3rd quantile each time the presidential party changes, the override pivot is highly volatile, even more so than the median (mean absolute change for the override pivot is 0.143, while that for the median is 0.094). In particular, the override pivot was volatile even during the long period of almost continuous Democratic hegemony in the House from 1940 until the election of 1994, because the party of the president switched back and forth.

3.3 Historical evidence about the volatility of quantiles and pivots in the Senate

Figure 2a, b provide quantile plots for the Senate. As in the House, the median is substantially more variable than the mean. The median is also much more variable than the 2/3rd and 1/3rd quantiles. Because 60 % of the Senate is needed to obtain cloture, the 60th

[7] In the House, the average absolute change from Congress to Congress for the quantiles Q(1/3), median, and Q(2/3) is 0.029, 0.094, and 0.043, respectively; the corresponding value for the mean is 0.034. Using the root mean square of a quadratic regression of quantile on year as the measure of volatility yields similar results. We prefer to use absolute change in a quantile as it is conceptually simpler.

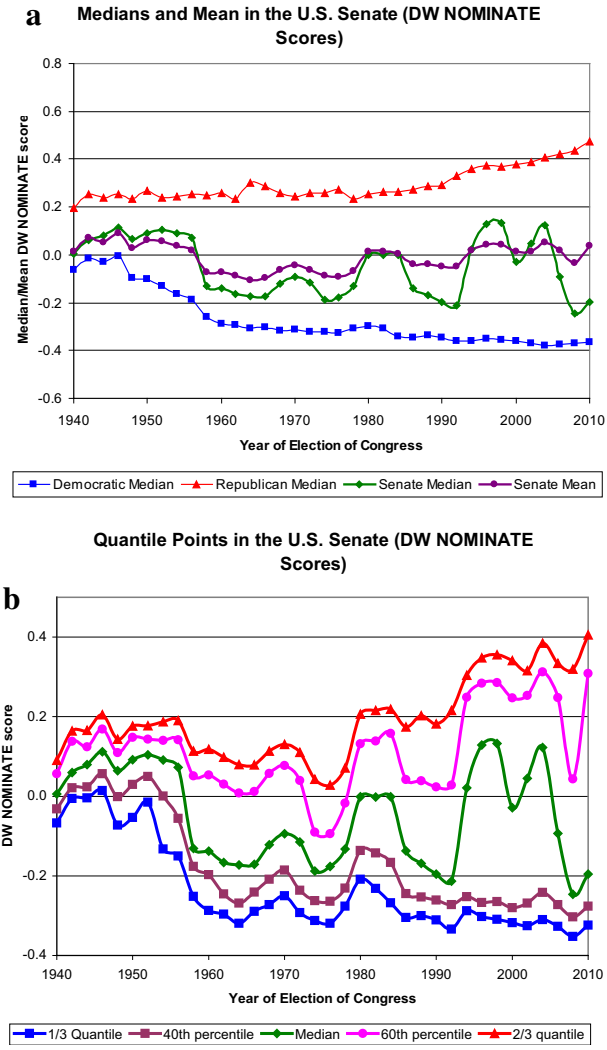


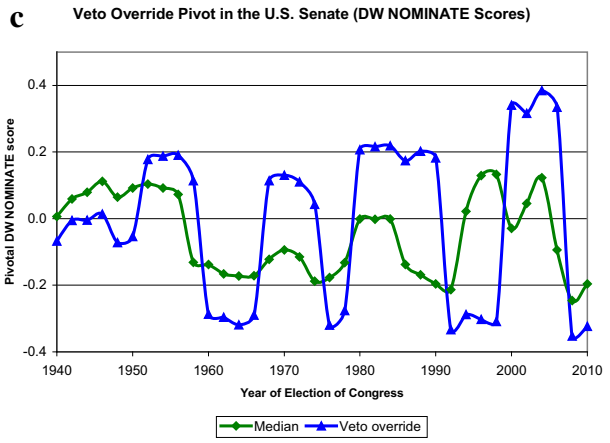
Fig. 2 Means, medians, and other pivotal points in the US Senate, 1940–2010. **a** Comparison of Senate medians and means, **b** quantile points in the US Senate, **c** veto override pivot in the US Senate, and **d** cloture pivot in the US Senate

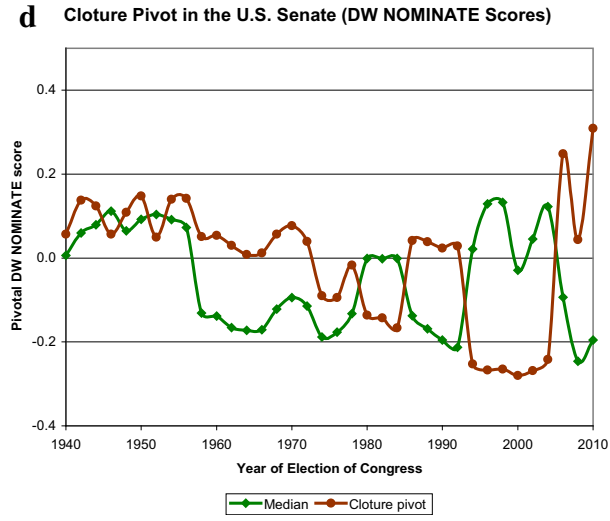
and 40th percentiles also are relevant to determining pivots. We note first that the median is much more volatile than the 40th percentile and slightly more than the 60th percentile.[8]

Veto override in the Senate is similar to the House, and the plot for veto override exhibits a pattern similar to that for the House (see Fig. 2c). Cloture pivots depend on which party controls the Senate. When the Democrats hold a majority in the Senate, the cloture pivot is the 60th percentile; when the Republicans have the majority, however, the cloture pivot is the 40th percentile. The plot for the cloture pivot is in Fig. 2d. We note that the override pivot in the Senate is substantially more volatile than the median, whereas the

[8] In the Senate, the average absolute change in the five quantiles, Q(1/3), Q(2/5), median, Q(3/5), and Q(2/3) is 0.031, 0.032, 0.061, 0.055 and 0.035, respectively; the corresponding value for the mean is 0.028.

Fig. 2 continued





cloture pivot exhibits only slightly more volatility then the median.[9] The reduced volatility of the cloture pivot (relative to that of the override pivot) occurs because during most of the period of greatest median volatility, Republicans have held a majority in the Senate, so that the cloture pivot remained at the 40th percentile, which was relatively stable.

As was pointed out by one of the anonymous reviewers, during 17 of the 36 Congresses in our study period, government was unified. There were, however, also many years in which it was divided. Although presidents frequently had support of at least one House in Congress (particularly prior to 1978), having even one chamber in control of the opposition is generally enough to stop a majority party from exerting its will unchecked. Moreover, truly unified government requires a cohesive majority in the House and—to muster

[9] The mean absolute change statistics for the override pivot, cloture pivot, and the median, respectively, are 0.130, 0.074 and 0.061.

cloture—a 3/5 majority in the Senate (2/3 before 1975). This form of truly unified government is rare, being achieved in only four out of 36 Congresses in our study period.[10]

Although vetoes, and especially veto overrides and full-throttled filibusters are not always exercised, the mere existence of those tools, in particular the threat the filibuster, affects the shape of legislation and actions by legislators themselves. Veto and filibuster threats are both very real and extremely powerful tools that are used all the time.

4 Modeling the dynamics of median and supermajoritarian pivot points

4.1 Modeling changes in the median and other pivot points

In this section, we investigate three questions concerning pivot volatility and the effects of polarization on that volatility: (1) Why is the median more volatile than the mean? (2) Why is the median most variable under conditions of extreme polarization? and (3) Why are quantiles other than those near the median considerably less volatile than the median during periods in which the party delegations are sharply separated?

To investigate the degree of sensitivity of the overall median (or a supermajoritarian quantile) to replacements, and to show how such sensitivity depends on the nature of polarization, let us suppose that the Democratic and Republican legislative delegations follow distributions specified by probability density functions f_D and f_R. Inspection of histograms of the distributions of DW NOMINATE scores of members of the US House of Representatives suggests that the scores of the delegations of each party fit roughly to normal distributions, especially recently.[11]

Accordingly, we suppose in our model that the ideological locations of the Democratic and Republican delegations are each normally distributed, with means μ_D and μ_R, and standard deviations σ_D and σ_R, respectively. Finally, suppose that π_D and π_R denote the proportion of the legislative seats held by the Democratic and Republican parties, respectively (we assume that $\pi_D + \pi_R = 1$). It follows that the overall legislature has a mixed normal distribution, with probability density given by $f(x) = \pi_D f_D(x) + \pi_R f_R(x)$.

Histograms for the 87th (elected in 1960), 103rd (elected in 1992), and 109th Congress (elected in 2004) are presented in Fig. 3. The distributions of these three Congresses suggest three possible forms that a mixed normal distribution may take. These hypothetical forms are depicted in Fig. 4: Scenario 1 (extensive overlap), Scenario 2 (slight overlap), and Scenario 3 (no significant overlap of partisan delegations).[12] As is visually apparent by comparing Figs. 3 and 4, the three actual Congresses shown in Fig. 3, respectively, closely approximate the conditions of our hypothetical distributions in Fig. 4.

In Scenario 1, the party means are placed at $-1/3$ and $+1/3$ (on the scale from -1 to $+1$ used by DW NOMINATE scores) and the intraparty standard deviations are each 1/3. In Scenario 2, the party means diverge to $-1/2$ and $+1/2$ and the intraparty standard

[10] Filibuster-proof, unified governments were achieved in those elected in 1940, 1962, 1964 and 1976. Had only a 3/5 majority been required for cloture before 1975, three more governments would have been filibuster-proof (1942, 1960 and 1966).

[11] See plots in Fig. 8 in the Appendix. The Shapiro–Wilk test of goodness of fit for the three Congresses plotted in Fig. 8 does not reject the normal distribution for the 103rd and 109th Congresses, provided that the extreme outlying score for one member, Ron Paul, is omitted for the 109th. However, normality is rejected for each of the party delegations for the 87th Congress, because each party delegation has a long tail to the right.

[12] In each scenario, for simplicity, π_D and π_R are each initially set at 0.5.

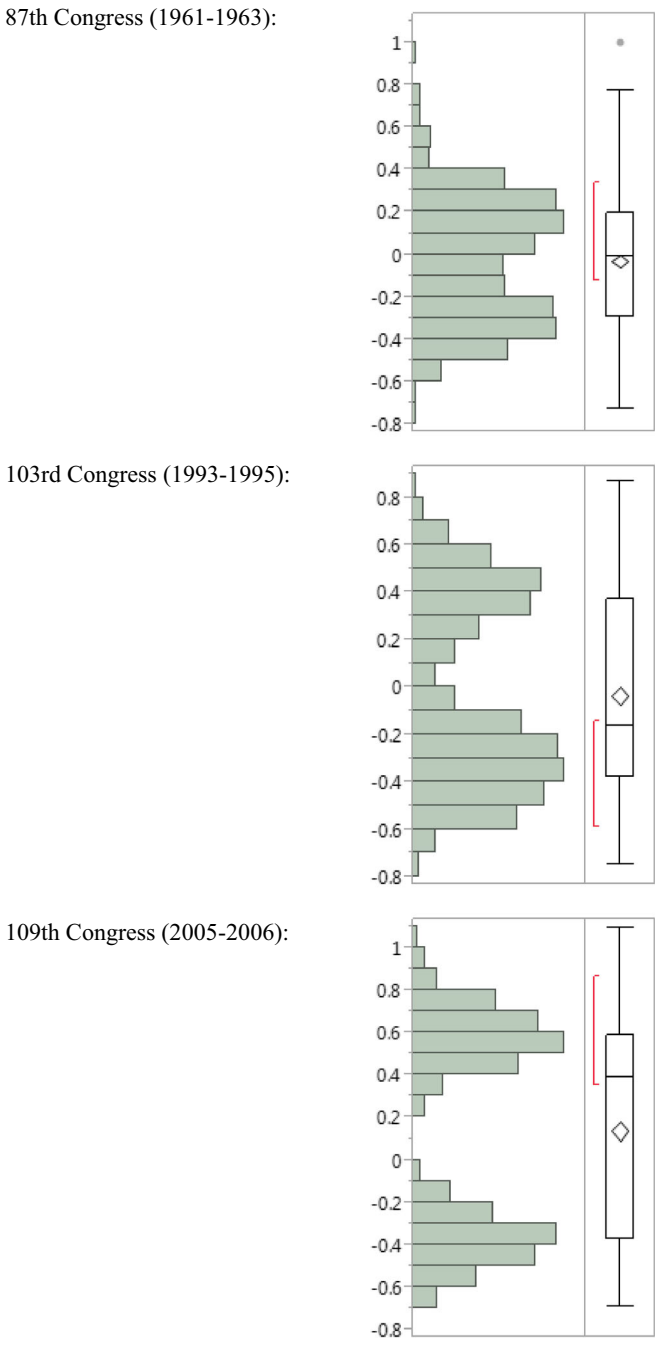


Fig. 3 Distributions of DW NOMINATE scores in the US House for selected Congresses. 87th Congress (1961–1963), 103rd Congress (1993–1995), and 109th Congress (2005–2006)

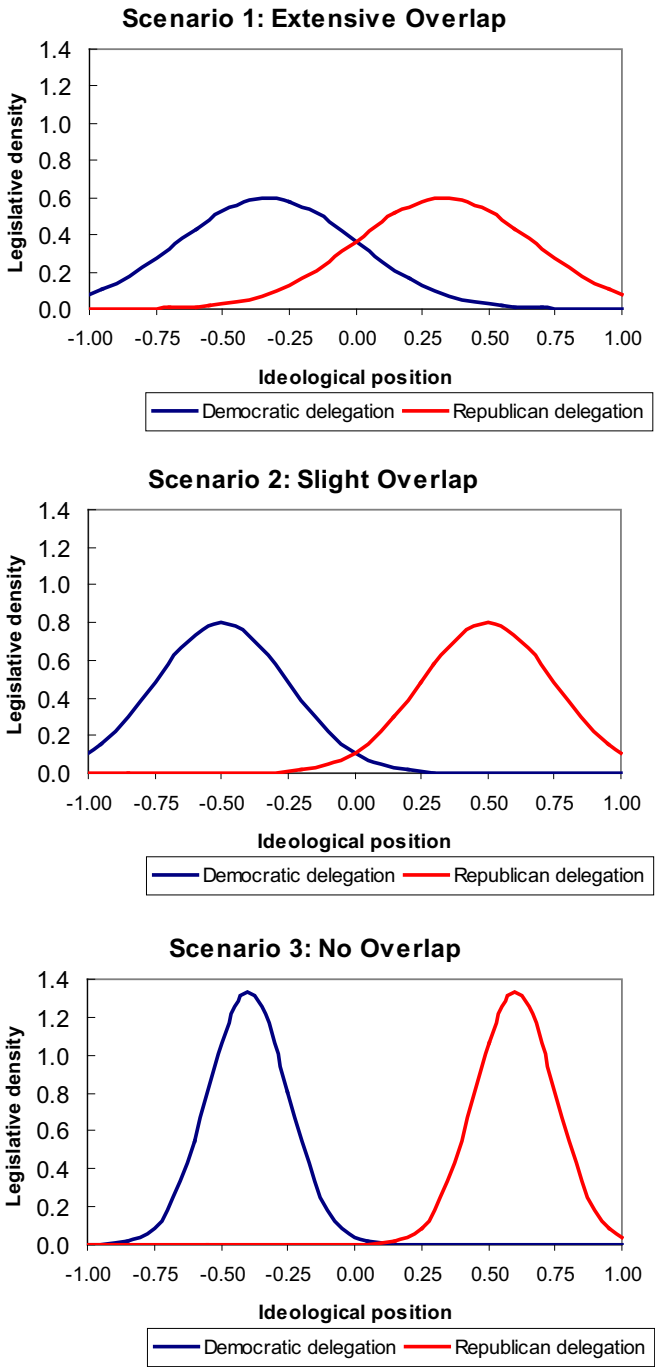


Fig. 4 Hypothetical legislative distributions by party

deviations are reduced to 1/4; the overlap is small. Finally, Scenario 3 is patterned on data from the past decade, in which the Democratic and Republican means have been on the order of -0.4 and $+0.6$ and the intraparty standard deviation roughly 0.15; in this last scenario, there is no significant partisan overlap.

We now investigate the sensitivity of quantile points (overall median, supermajoritarian quantiles) to statistical variability and to the nature of the mixed distributions described above. We may think of a particular legislature as a random sample of size N taken from the parent distribution, where N denotes the number of members in the legislature.[13] If the overall distribution is purely normal, with standard deviation σ (for instance if the two partisan distributions were coincident), then the standard deviation of the means of random samples of size N from that distribution (i.e., the standard error of the mean) is given by $\sigma_{mean} = \sigma/\sqrt{\mathrm{N}}$, whereas the standard deviation of medians of such random samples is given by $\sigma_{median} = (\sqrt{\pi/2}) * \sigma/\sqrt{N} \cong 1.25\sigma/\sqrt{N}$.[14]

Thus, in this (unrealistic) base case scenario of a normal overall distribution for the legislature, the median can be expected to be more variable over time than the mean.[15] Similar considerations apply to other quantile points, such as the 3/5th quantile (applicable to cloture votes the US Senate) and the 2/3rd quantile (which applies to each House of Congress in an attempt to override a presidential veto). The standard errors of the 3/5th and 2/3rd quantiles are $1.268\sigma/\sqrt{\mathrm{N}}$ and $1.296\sigma/\sqrt{\mathrm{N}}$, respectively, almost identical to those for the median.[16]

4.2 Effects of polarization

We are most interested in examining the effects of polarization on the locations of the median and other potential pivot points, caused either by the ideological spread between the parties, by intraparty variation, or by both. By looking at how interparty spread and intraparty dispersion affect the volatility of pivot points we can investigate the linkage between pivotal politics ideas *a la* Krehbiel and the work on conditional party government of Aldrich, Rohde and colleagues (Aldrich 1995; Aldrich and Rohde 1998; Rohde 1991). We maintain a temporary assumption that the two parties have delegations of equal size (i.e., $\pi_D = \pi_R = 0.5$), and assume that the intraparty variances, σ_D and σ_R, are equal.

[13] Of course, successive Congresses or legislatures are not independent, in particular because many incumbents are retained. So we do not expect the legislatures to vary as much as independent random samples. However, over a period of time, variation can be expected. Furthermore, the *relative* amount of variation as parameters (such as divergence between parties, intraparty variance, and so on) are varied is still meaningful.

[14] See Mood et al. (1974, p. 257). For this theoretical section, we use standard deviation as a measure of volatility of quantiles because it is analytically more tractable than mean absolute change, which we have used for the empirical analysis. Because of the non-linear, secular trends in some of the empirical quantiles, standard deviation would be misleading there, whereas root mean square error from a quadratic regression would be more meaningful (see note 7 above).

[15] Note that, although the sample median—when considered with regard to sensitivity to extreme outliers—is a more robust estimator of the population median than the sample mean is as an estimator of the population mean, for many distributions the sample median is a less precise estimator of its population counterpart, i.e., is likely to be more variable over time due to statistical variation. This is particularly relevant to the analysis of scores such as DW NOMINATE scores that are bounded in principle and hence tend not to have extreme outliers.

[16] In general, for a normal distribution with standard deviation σ, the standard error for the qth quantile is $\sigma_q = \sqrt{q \times (1-q)} * \sigma/\phi[\Phi^{-1}(q)]/\sqrt{n}$, where ϕ and Φ are the standard normal density and cumulative distribution functions, respectively.

The standard deviations of both sample means and sample medians generally increase as the party means diverge and the standard error of the mean increases with intraparty variance.[17] As indicated in Table 1A, the standard error for the median also increases with divergence between the party means. However, although the standard error of the median declines as the intraparty variance falls for low values of divergence, it increases as the intraparty variance decreases for high values of divergence. Thus, when party means are separated widely and the party delegations are ideologically concentrated tightly, the standard error of the median can be very large, i.e., the median can be very volatile over Congresses.

In particular, this uncertainty about the location of the median is pronounced when the divergence between the party delegations is large relative to the intraparty variation, as in Scenario 3, in which there is little or no overlap between the parties. Thus, in a highly polarized legislature, replacement, say, of a Democrat by a Republican may have a large effect on the overall median, because the middle range of the overall distribution is likely to be thin. Estimated values for these standard errors for Scenarios 1–3 are reported in Table 1B. Note that, in general, the standard errors of sample medians is greater than that of sample means, and increasingly so as the party distributions become more separated.

While standard errors for the 3/5th and 2/3rd quantiles are similar to that of the median for a normal distribution, the standard errors for these two quantiles for mixed normal distributions are substantially smaller than those for the median, particularly when the component normals are widely separated. Estimates for these values, based on the formulas in Hogg and Tanis (2001, pp. 276–279), are provided in Table 1B.

The 3/5th quantile (60th percentile) is the pivot in the Senate for a Democratic majority to overcome a Republican filibuster and the 2/3rd quantile is the pivot in each House of Congress for Democrats to overcome a veto by a Republican president. Conversely, the 2/5th quantile (40th percentile) is the pivot in the Senate for a Republican majority to overcome a Democratic filibuster and the 1/3rd quantile is the pivot in each House of Congress for Republicans to overcome a veto by a Democratic president. Because of the symmetry of Scenarios 1 and 2, the variability of the 1/3rd quantile is the same as that reported in Table 1B for the 2/3rd quantile (and that for the 2/5th the same as that for the 3/5th); for Scenario 3, the values are changed only slightly.

Next we relax the symmetry assumptions about the distributions of the party delegations. If the standard deviations of the party delegations are unequal, then the overall median shifts in the direction of the more concentrated party. For example, if the standard deviation of the Republican delegation is reduced by a factor of one-third in each of the scenarios pictured in Fig. 3, the median is shifted to the right by 0.066, 0.100 and 0.200 units, respectively.

If instead, we permit the size of the delegations to be unequal (but return to equal variances), the median shifts in location, as expected, in the direction of the larger delegation. If, for example, one party holds 55 % of the seats, the median shifts by 0.047, 0.169

[17] For the mixed normal distribution, the standard deviation (standard error) of the mean is $0.5\sqrt{[4\sigma_D^2 + (\mu_R - \mu_D)^2]/n}$, where σ_D ($=\sigma_R$) is the common intraparty standard deviation and μ_R and μ_D are the respective means of the partisan delegations. Thus, the standard error of the mean increases with both divergence and intraparty variance. The standard deviation (standard error) of the median can be calculated from formulas for the distribution of the sample median, such as in Hogg and Tanis (2001, p. 276). (Note that the mean is the same as the median for each party distribution because each party distribution is assumed to be normal).

Table 1 Standard errors for the median and other pivot points (simulated data)

(A) Standard errors of the median, by degree of interparty divergence and intraparty variance

Intraparty standard deviation	Difference between party means		
	0	0.5	1.0
0.15	0.019	0.065	0.276
0.25	0.035	0.052	0.163
1/3	0.044	0.055	0.119

(B) Standard errors for sample means, medians, and supermajority quantiles for mixed normal distributions

	Party locations	Party standard deviations	Standard errors			
			Mean	Median	60th percentile	2/3 quantile
Scenario 0	(0, 0)	(1/3, 1/3)	0.033	0.044	0.042	0.043
Scenario 1	(−1/3, 1/3)	(1/3, 1/3)	0.047	0.068	0.067	0.066
Scenario 2	(−0.5, 0.5)	(0.25, 0.25)	0.056	0.163	0.101	0.068
Scenario 3	(−0.4, 0.6)	(0.15, 0.15)	0.052	0.276	0.121	0.043

Panel A: N = 101 seats was assumed

Panel B: N = 101 seats was assumed and party seat proportions are (0.5, 0.5). Scenario 0 assumes that the two party distributions are coincident, and is included for comparison. Calculations of the standard error of the median used formulas for the distribution of the sample median in Hogg and Tanis (2001, p. 276). Of course, standard errors would be smaller if, say, N = 435, but their relative size over quantiles should be similar

Table 2 Regression of change in chamber median against other change variables for the period 1940–2010

	Estimate	s.e.	t	*P* value
(A) US House				
Intercept	−0.019	0.016	−1.18	0.2459
Change in control	−0.375	0.030	−12.40	<.0001
Change in seat share	1.043	0.091	11.50	<.0001
Polarization	0.030	0.024	1.22	0.2312
Polarization × ChControl	0.804	0.041	19.47	<.0001
(B) US Senate				
Intercept	−0.029	0.024	−1.22	0.2331
Change in control	−0.212	0.042	−5.10	<.0001
Change in seat share	1.260	0.142	8.85	<.0001
Polarization	0.036	0.041	0.86	0.3962
Polarization × ChControl	0.444	0.076	5.81	<.0001

Panel A: $R^2 = 0.98$, N = 36

Panel B: $R^2 = 0.86$, N = 36

Change in control +1 for a Republican takeover, −1 for a Democratic takeover, *seat share* Republican seat share, *Polarization* mean DW NOMINATE score of the Republican delegation minus the mean of the Democratic delegation

and 0.200 units toward the larger delegation in the three scenarios in Fig. 4, respectively. We note the rather large shifts that accompany marked polarization.

5 Empirical analysis

5.1 Multivariate analysis of volatility for the median and supermajority pivots

Returning to the empirical analysis, we run a multivariate regression, intended to explain the volatility of the chamber median, i.e., the *change* in the median from election to election (dependent variable) in terms of a small set of independent variables: (1) change in party control (+1 for a Republican takeover, −1 for a Democratic takeover, and 0 otherwise), (2) change in (Republican) seat share, (3) polarization, measured by the difference in mean locations of the party delegations (mean of Republican delegation minus mean of Democratic delegation), and (4) the interaction of change in party control with polarization. Because we expect that the chamber median will move to the right when the Republicans gain seat share, we expect change in seat share to have a positive coefficient. More significantly, we expect that polarization will enhance movements of the chamber median (rightward in a Republican takeover and leftward in a Democratic takeover), so that a positive coefficient is expected for the interaction term.

For the House data (see Table 2A), these expectations are borne out—change in seat share and the interaction of polarization with change in party control—are both significant at the 0.0001 level.[18] The R^2 value for the overall regression is also very strong, at 0.98. Thus, as expected, change in the median increases as party seat share changes. But most strikingly, shifts in the median following a change in party control are far larger when the party delegations are strongly separated ideologically.[19] Specifically, the significantly positive coefficient on the interaction term demonstrates that the effect of changing control of the House on change in the chamber median is enhanced when polarization is present.

Similar results are obtained for the Senate (see Table 2B), except that the R^2 is less, 0.86. Similar tests to explain changes in the supermajoritarian pivots yield similar results for both House and Senate, but the fit is not quite as good and the slope coefficients generally are smaller.

5.2 Over-time variation in the patterns of pivots and the gridlock interval

While the regression analysis in Sect. 5.1 models changes simply as a linear time trend, visual inspection of the data suggests that it is useful to think about there being two

[18] Note that in the regression model with interaction term, the effect of changing control of the chamber on change in the chamber median cannot be determined from the sign of the coefficient of change in control alone; that conclusion must involve the coefficient of the interaction term as well. (If the model is run without interaction term, the coefficients for change in control and change in seat share are both positive and significant, but polarization is not significant and the R-squared is only 0.66.) The full estimated regression equation for the House is given by $M = b_0 + b_1 ChControl + b_2 ChSeatShare + b_3$Polarization $+ b_4$Polarization $\times$ *ChControl*, so that if $ChControl = -1$, $M = (b_0 - b_1) + b_2 ChSeatShare + (b_3 - b_4)$Polarization $= 0.356 + 1.043 ChSeatShare - 0.774 Polarization$. If, instead, $ChControl = +1$, $M = (b_0 + b_1) + b_2 ChSeatShare + (b_3 + b_4)$Polarization $= -0.394 + 1.043 ChSeatShare + 0.834 Polarization$. Similar equations hold for the Senate.

[19] The standard deviations of the partisan delegations are not statistically significant when added to the model.

different eras, with rather different patterns in each, with respect to the location of pivot points and their volatility. The mean absolute change of the Senate *medians* for the period 1978–2010 is 0.086, more than twice the corresponding statistic for 1940–1976, which is 0.036. This effect occurs because with polarization, the two partisan distributions become separated with only a thin density in between if any at all, leading to instability of the median location.

For these two historical periods, Fig. 5a compares the mean absolute change in DW NOMINATE scores between Congresses for each of the quantile locations.[20] Clearly, the median is substantially more volatile than the other quantiles and than the mean, particularly in the more recent period.

Figure 5b portrays relative pivot volatility over the two periods. Clearly, for all pivots, volatility increases substantially between the two periods. Although the absolute change in the mean is about the same in the earlier and later periods, that for the median and the cloture pivot more than double from the earlier to the later period with the changes in the override pivot increasing about 50 %. Furthermore, override volatility is higher than cloture volatility, which is in turn greater than the corresponding measure for the median. This occurs because of the flip-flopping of the supermajoritarian pivots resulting from changes in partisan control and in addition the fact that the override pivot depends on changes in an office (the presidency) outside of the body (the Senate) in which the pivot occurs.

Perhaps the most significant aspect of the pivot positions and their volatility over time is the *gridlock interval* they specify. Krehbiel (1998, p. 38) defines the *gridlock interval*, given a Republican president, as consisting of potential left-of-center status quo points for which a moderate-to-conservative legislative majority is unable to pass a more conservative policy because it would be killed by a liberal filibuster, together with potential right-of-center status quo points for which a moderate-to-liberal majority is blocked from passing a more liberal policy because a veto would be sustained. An analogous definition holds, given a Democratic president. Thus, the gridlock interval can be thought of as that interval within which no proposal can surpass the hurdles of House, Senate, and president to become law.

Although Krehbiel's definition makes use of the idea of a status quo point, that is not really needed. Basically, under a Republican president, the gridlock interval runs from the cloture pivot $P(0.4)$ to the override pivot $P(2/3)$; under a Democratic president, the gridlock interval runs from the override pivot $P(1/3)$ to the cloture pivot $P(0.6)$. Strictly speaking, the override pivot requires two-thirds in both Senate and House. However, for simplicity, we track—in Fig. 6—the gridlock intervals accounting just for the president and Senate.

For each Congress, the red line in Fig. 6 represents the pivot Democrats would need in order to pass legislation (i.e., the Republican "firewall") while the blue line represents the pivot Republicans would need to pass legislation (i.e., the Democratic "firewall"). For example, in 1992, there was a Democratic president and Democratic Senate. Hence the Democrats needed the 60th percentile in the Senate (0.028) to attain cloture and pass legislation, whereas the Republicans would have needed the 1/3rd quantile (−0.334) to override a veto and pass legislation. Congresses with unified government (i.e., president and Senate controlled by the same party are indicated by black dots).

The width of the gridlock interval has expanded rapidly from 1940 to 2010, particularly since the late 1970s. Typically in the neighborhood of 0.1–0.2 in the 1940s, the gridlock

[20] Patterns are similar if the mean absolute change is replaced by the standard deviation.

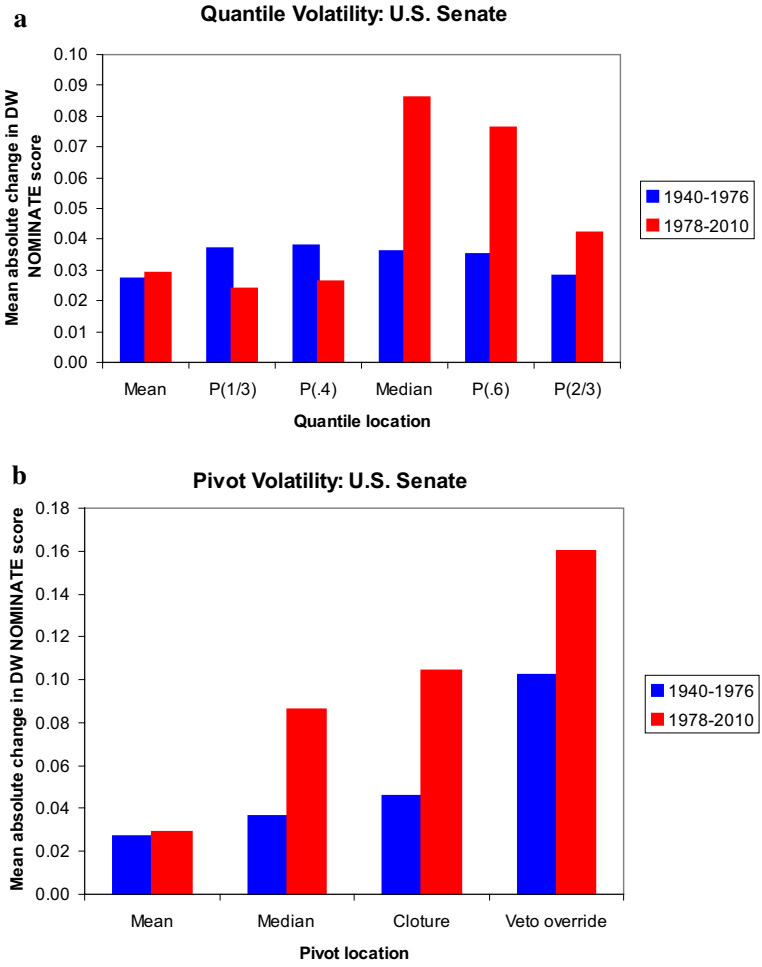


Fig. 5 **a** Quantile volatility in the Senate, and **b** pivot volatility in the US Senate

interval has hovered during the latest decade in the vicinity of 0.6, an overall three–sixfold increase.

6 Discussion

Absent change in partisan control of a chamber or the presidency, we have emphasized the difficulty of moving pivotal points, especially supermajoritarian pivots, through replacement effects. But we have also provided new insights into the relative volatility of median and supermajoritarian pivots as a function of party polarization. Although supermajority quantiles are less volatile than the median, supermajority pivots—because they switch back and forth when party control changes—are more volatile than the median. Most notably, the volatility of all pivots increases dramatically with polarization. And we have also

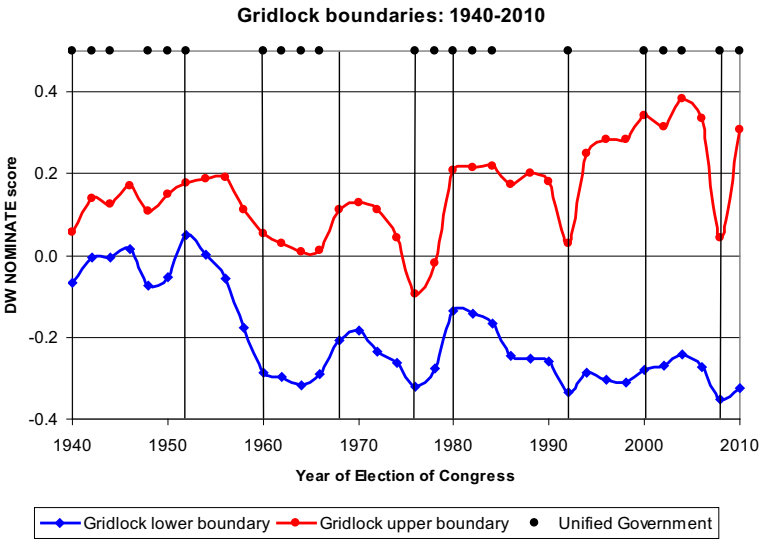


Fig. 6 Gridlock boundaries for president and Senate, 1940–2010. *Note* for simplicity, only the president and Senate are considered in this scenario. For each Congress, the *upper line* represents the pivot Democrats would need to pass legislation (i.e., the Republican firewall) while the *lower line* represents the pivot Republicans would need to pass legislation (i.e., the Democratic firewall). For example, after the election of 1992, there was a Democratic president and Democratic Senate. Hence the Democrats needed the 60th percentile in the Senate (0.028) to attain cloture and pass legislation, whereas the Republicans would have needed the 1/3rd quantile (−0.334) to override a veto and pass legislation. Congresses with unified government (i.e., president and Senate controlled by the same party are indicated by *black dots*). *Vertical lines* denote changes of presidential party

shown that the volatility of both median and supermajoritarian pivots has increased greatly since the 1970s, to the point where we can reasonably distinguish two different legislative eras: *before* the late 1970s and *after* the late 1970s.

Turning to the policy implications of our work, we first note that a change from divided to unified control must change the location of a supermajoritarian pivot from one side of the median to the other side in at least one branch of government, creating an alignment of pivots on a given side of the median. Nevertheless, one important implication of Krehbiel's (1998) work is that even unified party control does not guarantee that major policy change can take place—unless the majority party control is so overwhelming that it includes even the supermajoritarian cloture pivot.

On the other hand, the need to reach cross-chamber agreement and agreement between the Congress and the president insures that it will be even more difficult to make major policy shifts in periods of divided party government, since the needed pivots will be on both sides of the median. Insofar as the location of supermajoritarian pivots (rather than that of the median) determines the likelihood of gridlock, policy can be expected to be more stable during periods when neither the House, the Senate nor the president changes party hands, but more volatile after a change in party control in one of these branches.

When we examine the empirical record in the US Congress over the 1940–2010 period, the expectations from our analytic results are supported. We find that both the median and the supermajority pivots have become distinctly more volatile during the latter half of this period as partisan polarization increased. Volatility is particularly marked when party

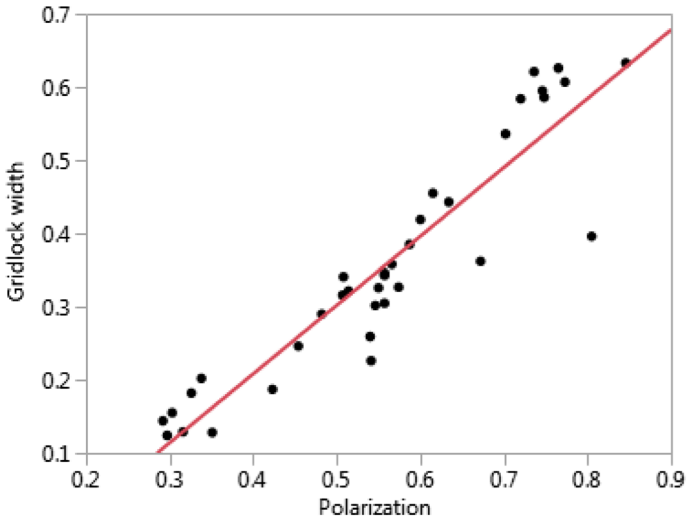


Fig. 7 Relation of width of gridlock interval to polarization, for president and Senate, 1940–2010. *Note* the coefficient of the variable *width of gridlock interval* is highly significant (at the 0.0001 level); $R^2 = 0.86$. *Polarization* is the mean DW NOMINATE score of the Republican Senate delegation minus the mean of the Democratic Senate delegation

control in the legislature changes hands in an era such as the present when the party delegations are highly ideologically separated. In such a case, the gridlock interval lengthens markedly as both the median and supermajority pivots swing dramatically. See Fig. 7.

Krehbiel (1998) argues that his evidence supports an ideological basis for congressional voting more than it does a purely party-centric model (e.g., Cox and McCubbins 2005, 2007), since (a) coalitions exceed the size of the majority party, and (b) it seems to be possible to change the votes of legislators near the 3/5ths or 2/3rds pivot location, despite the fact that, given polarization between the parties, these will almost certainly be of a different party than the majority of those supporting the bill. While we, like Krehbiel, find a *purely* party-centric model inappropriate on empirical grounds, unlike Krehbiel (1998, pp. 166–172) we see much to offer in the *conditional party governance* approach of John Aldrich, David Rohde and colleagues (Aldrich 1995; Aldrich and Rohde 1998, 2000a, b; Rohde 1991).

The key idea of *conditional party governance* is that the degree to which party, as opposed to ideology, matters will vary with the degree to which the parties are separated from each other, on the one hand, and the degree to which they are internally homogeneous, on the other. When parties are both widely separated and highly homogeneous internally, we can expect *strong party government*, in which each party tends to vote largely as a bloc because party cues and ideological cues are more or less the same. If we have strong party government, the parties are polarized.

Krehbiel (1998, pp. 166–172) suggests that the *conditional party governance* model is too imprecisely specified to say much about voting when the parties are not completely ideologically distinct. However, once we accept that not merely the median party locations and the location of the overall median are important but, following Krehbiel, so, too, are supermajoritarian pivot locations, then we can extend the *conditional party governance*

literature to take into account the location of supermajoritarian pivots. The degree to which parties are both ideologically cohesive and distinct are the two key facets of party governance called attention to by the *conditional party governance* model. We have seen that these two factors generally increase the volatility of both the median and the supermajoritarian pivots and affect the width of the gridlock interval because they affect the degree of legislative polarization. When linked to issues of pivot location and gridlock intervals in this way, the *conditional party governance model* helps us better make sense of the congressional gridlock we have seen in recent decades, continuing to the present (Mann and Ornstein 2012).

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Appendix

See Fig. 8.

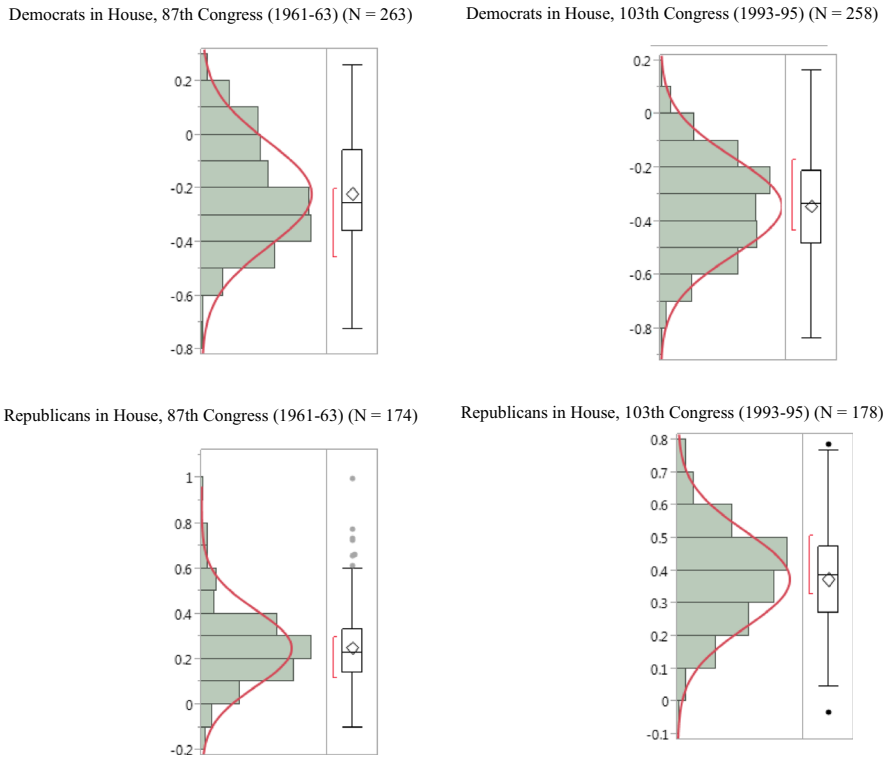

Fig. 8 *Histograms* for selected Congresses, by party delegation, with normal fits. Democrats in House, 87th Congress (1961–1963) (N = 263), Republicans in House, 87th Congress (1961–1963) (N = 174), Democrats in House, 103th Congress (1993–1995) (N = 258), Republicans in House, 103th Congress (1993–1995) (N = 178), Democrats in House, 109th Congress (2005–2007) (N = 202), and Republicans in House, 109th Congress (2005–2007) (N = 235)

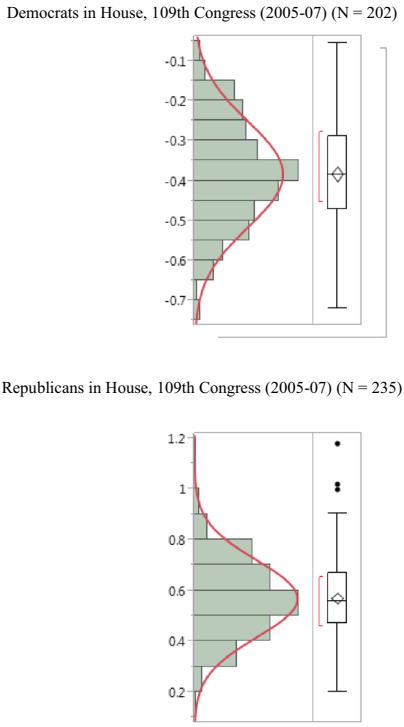

Fig. 8 continued

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