# Supporting Information: On The Validity Of The Regression Discontinuity Design For Estimating Electoral Effects: New Evidence From Over 40,000 Close Races

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Abstract

This document contains the Supporting Information (SI) appendices A, B, and C.

# Supporting Information Appendix A: Data sources and definitions

## A. U.S. State Legislative Elections

The U.S. State Legislative Election data comes from ICPSR Study 34297 (`http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34297`). The data set provides election returns for all fifty states, 1967-2010. We exclude nonpartisan elections (most notably Nebraska's unicameral legislature) along with multi-member districts. We subset to outcomes from 1990-2010 in order to use only the most reliable information on off-cycle redistrictings. While state legislatures are nominally redistricted each decade in the year ending in '2', there have been a significant number of redistrictings in other years due to court cases and other extenuating circumstances. The data on redistricting from 1990 to present comes from Carl Klarner. This leaves us with 65,199 observations across 49 states.

## B. U.S. Mayoral Elections

The U.S. Mayoral data was originally collected for Ferreira and Gyourko (2009) and has been extended by those authors in subsequent work. The extended data set contains mayoral election results for the years 1945-2007 in 834 cities, which includes non-partisan elections and elections in which members of the same party faced each other. We restrict to races where a Democrat faced a Republican, which leaves 2,396 observations spanning 494 cities.

## C. Canadian House of Commons Elections

Data is provided by the Constituency-Level Elections Archive for elections to the House of Commons of Canada between 1867 and 2011.[1] The reference party is the Liberal Party of Canada. Members are elected in single member constituencies (ridings) by simple plurality. We exclude the few double-member ridings that existed in some provinces in the early periods. Redistricting is conducted by an independent commission every ten years. A riding is included in the analysis only when the riding boundary remains unchanged from the previous election. Data on historical boundary changes is provided by the Parliament of Canada, History of Federal Ridings Since 1867.

## D. British House of Commons Elections

Data is provided by the Constituency-Level Elections Archive for elections to the British House of Commons between 1918 and 1997. Data for the elections in 2001, 2005, and 2010 are provided by the Electoral Commission and compiled by Rallings and Thrasher at the LGC Elections Centre at the University of Plymouth. The reference party is the Conservative Party. Members are elected in single member constituencies by simple plurality. We exclude the few multi-member constituencies that existed prior to 1950. Redistricting is conducted by a boundary commission every 8-12 years. A constituency is included in the analysis only when

[1] Ken Kollman, Allen Hicken, Daniele Caramani, and David Backer. Constituency-Level Elections Archive (CLEA; www.electiondataarchive.org), December 17, 2012 [dataset]. Ann Arbor, MI: University of Michigan, Center for Political Studies [producer and distributor].

the constituency name remains unchanged from the previous election; we cleaned and checked constituency names for consistency across elections. In the data we find that there are 1,850 unique constituencies across the 25 elections. Most of them experienced redistricting at some point during the sample period. The median constituency remains unchanged for seven elections.

### *E. British Local Elections*

Data comes from the British Local Election Database published by Rallings, Thrasher, and Ware.[2] The reference party is the Conservatives. Analysis is based on single-member elections to county councils, district councils, and unitary authorities in England, Scotland, and Wales in the period 1945-2003. Wards are included in the analysis only when the ward boundary is the same as in the previous election.

### *F. German Bundestag Elections*

Data is provided by the Federal Returning Officer (*Bundeswahlleiter*). The reference party is the Christian Democratic Union of Germany (CDU) together with its Bavarian sister party the Christian Social Union of Bavaria (CSU). Germany has a mixed electoral system where, since 1953, voters have two votes. The first vote is for a direct candidate for the constituency and the candidate who receives a simple plurality of first votes gets the direct mandate to serve in the Bundstag (SMD tier). Each constituency returns a single member. The second vote is for a party list and determines the proportion of seats a party receives in the Bundestag (PR tier). Analysis is based on the SMD tier races for the 12 elections between 1953 to 2009. Periodic redistricting is conducted by an independent election commission. A race is included in the analysis only when the constituency area remains unchanged from the previous election. Data on constituency areas is obtained from various years of the German election law (*Änderung des Bundeswahlgesetzes* 1949, 1964, 1972, 1976, 1979, 1985, 1989, 1990, 1993, 1996, 2001, 2005, 2008). Periodic redistricting often involves only a small subset of constituencies. 84 constituencies remain constant for all 12 elections. The median constituency remains unchanged for four elections.

### *G. Bavarian Mayoral Elections*

Data has been collected, and provided to us, by Florian Ade and Ronny Freier and was originally used in Ade and Freier (2011). The data covers about 25 000 mayor elections in the state of Bavaria for the time period 1946-2009. A feature of these elections is important for the correct implementation of a correct analysis is the presence of a second (or run-off) ballot. If no candidate reaches the majority of 50% in the first round, a second round is held between the two leading candidates. If there is such a second round we use that in our analysis. We use the CSU as the reference party in our analysis. Also, we restrict the sample to contested elections with the top two candidates being from different parties. These restrictions leave us with a sample of a little bit less than 100 00 observations.

[2]Rallings, C.S., Thrasher, M.A.M. and Ware, L., British Local Election Database, 1889-2003 [computer file]. Colchester, Essex: UK Data Archive [distributor], June 2006. SN: 5319, `http://dx.doi.org/10.5255/UKDA-SN-5319-1`.

### *H. French National Assembly elections*

Data is provided by CDSP (Centre de Données Socio-politiques) of Sciences Po and CNRS. The reference party is the Socialists. From 1958 to 1981 the results are aggregated by party label, meaning that the vote totals are incorrect in cases where multiple candidates from the same party compete. Analysis of the data from 1988 to 2007 indicates that this happened so rarely as to not pose a serious problem: two candidates of the same party label appeared in the second round in only about .6% of cases. (In the first round, which is rarely decisive, the rate was about 3.5%.) The election of 1986 was conducted via party-list proportional representation and was followed by a major redistricting; we thus omit the 1986 election and treat the periods before and after separately. (Other episodes of minor redistricting are dealt with by dropping observations in which the lagged outcomes took place under different boundaries.)

Legislative elections in France take place in two-round contests: if no candidate wins a majority of votes in the first round, then a second round is held in which all candidates receiving less than a certain amount of support are eliminated. (This threshold is currently 12.5% of registered voters; between 1966 and 1976 it was 10% of registered voters and between 1958 and 1966 it was 5% of votes cast.) We define the running variable based on the decisive round – the round in which the winner was declared.

### *I. French municipal elections*

Data is provided by the Ministry of the Interior. Analysis is based on the 2008 election in cities with at least 3,500 inhabitants. The electoral system in this setting is not single-member plurality as it is in the other settings we study: municipal elections in France take place between lists of candidates rather than between individual candidates, and the electoral system is nominally proportional rather than plurality rule. Including these elections in the analysis makes sense, however, because the electoral system confers a large "winner's bonus" of 50% of the seats to the winning list (the remainder of seats are distributed proportionally among all of the lists), such that the winner of a close contest between two lists ends up with a large majority and can thus choose the mayor. If sorting is a problem in SMP elections, therefore, one would expect to find it here as well.

Due to the large number of parties and inconsistent labeling of parties across years, we use as the reference party the "Left", meaning lists labeled by the Ministry of the Interior in 2008 as Socialist, Communist, "miscellaneous Left", extreme Left, Green, or union of the Left; in 2001, the corresponding labels are Left, "miscellaneous Left", extreme Left, and Green.

As in legislative elections in France, municipal elections take place in two rounds. (At the municipal level, lists winning less than 10% of the vote are eliminated.) We take the same approach, basing the running variable on the decisive round.

### *J. Australian House of Representatives Elections*

Data on Australian House of Representatives Elections from 1987 to 2007 is from the Australian Electoral Commission as assembled and cleaned by Horiuchi and Leigh (2009). The reference party is the Australian Labor Party. Australia has essentially a two-party system with the Labor Party on the left and several other

parties typically forming a coalition on the right. Voting is by a preferential system (or instant runoff) where voters rank candidates, allowing for the calculation of a two-party preferred vote for the top two candidates. Our analysis focuses on the Labor Party's share of the two-party preferred vote.

Redistricting in Australia is conducted by an independent commission before every election, but the changes are typically small. Between the 1990 and 2010 elections (when redistricting data is available) 59 percent of districts were not changed at all before an upcoming elections, only 26 percent of districts were changed by 10% or more (meaning that 10% of the voters in that election were new to the district), 16 percent of districts were changed by 20% or more, 10 percent of districts were changed 30% or more, 6 percent of districts were changed by 40% or more, and only 3 percent of districts were changes by 50% or more. We cannot restrict our analysis based on the extent of redistricting in a particular electoral division or year, because the placebo outcomes may have potentially influenced the redistricting process. However, given the minimal extent of redistricting in each election, attenuation resulting from redistricting is likely to be minimal.

### *K. New Zealand House of Representatives*

Data is provided by the Constituency-Level Elections Archive for elections to the New Zealand House of Representatives between 1946 and 1987.[3] The reference party is the New Zealand National Party. Members are elected in single member districts by simple plurality. Redistricting is conducted by an independent commission every fifth year. A district remains in the analysis only if its name has not changed from the previous election, which we use to approximate large redistricting events.

### *L. Indian Lower House Elections*

Data is provided by the Election Commission of India for elections to the lower house of parliament (Lok Sabha) between 1977 and 2004. The reference party is the Indian National Congress (INC). Candidates are directly elected in single member constituencies by simple plurality. Constituency boundaries remain unchanged during this period (apart from a few changes in the state boundaries).

### *M. Brazilian Mayoral Elections*

Data is provided by the Supreme Electoral Tribunal (*Tribunal Superior Eleitoral*) for mayoral elections in 2000, 2004, and 2008. The reference party is the Brazilian Democratic Movement Party (*Partido do Movimento Democrático Brasileiro*). Mayors are elected by simple plurality in each municipality. The vast majority of municipalities only have one round, but large municipalities can have a run-off election and for those municipalities we use the results from the first round. There is no redistricting during this period. In a very small number of cases the municipality names change and these cases are excluded (following cleaning to identify unique names across election years).

[3]Ken Kollman, Allen Hicken, Daniele Caramani, and David Backer. Constituency-Level Elections Archive (CLEA; www.electiondataarchive.org), December 17, 2012 [dataset]. Ann Arbor, MI: University of Michigan, Center for Political Studies [producer and distributor].

### *N. Mexican Municipal Elections*

State-by-state municipal election data for Mexico was collected by Melissa Dell for Dell (2012) among other studies. The original data "are from Mexico Electoral-Banamex and electoral results published by the Electoral Tribunals of each state. For 11 states, data on the total number of eligible voters, required to calculate turnout, are not reported" (Dell 2012: 34). Elections are multi-party; we use PRI as the party of interest.

## Supporting Information Appendix B: Graphs

Figure B1: Testing for imbalance in lagged incumbent victory using the difference-in-means and the local linear regression estimator (All Races Pooled).

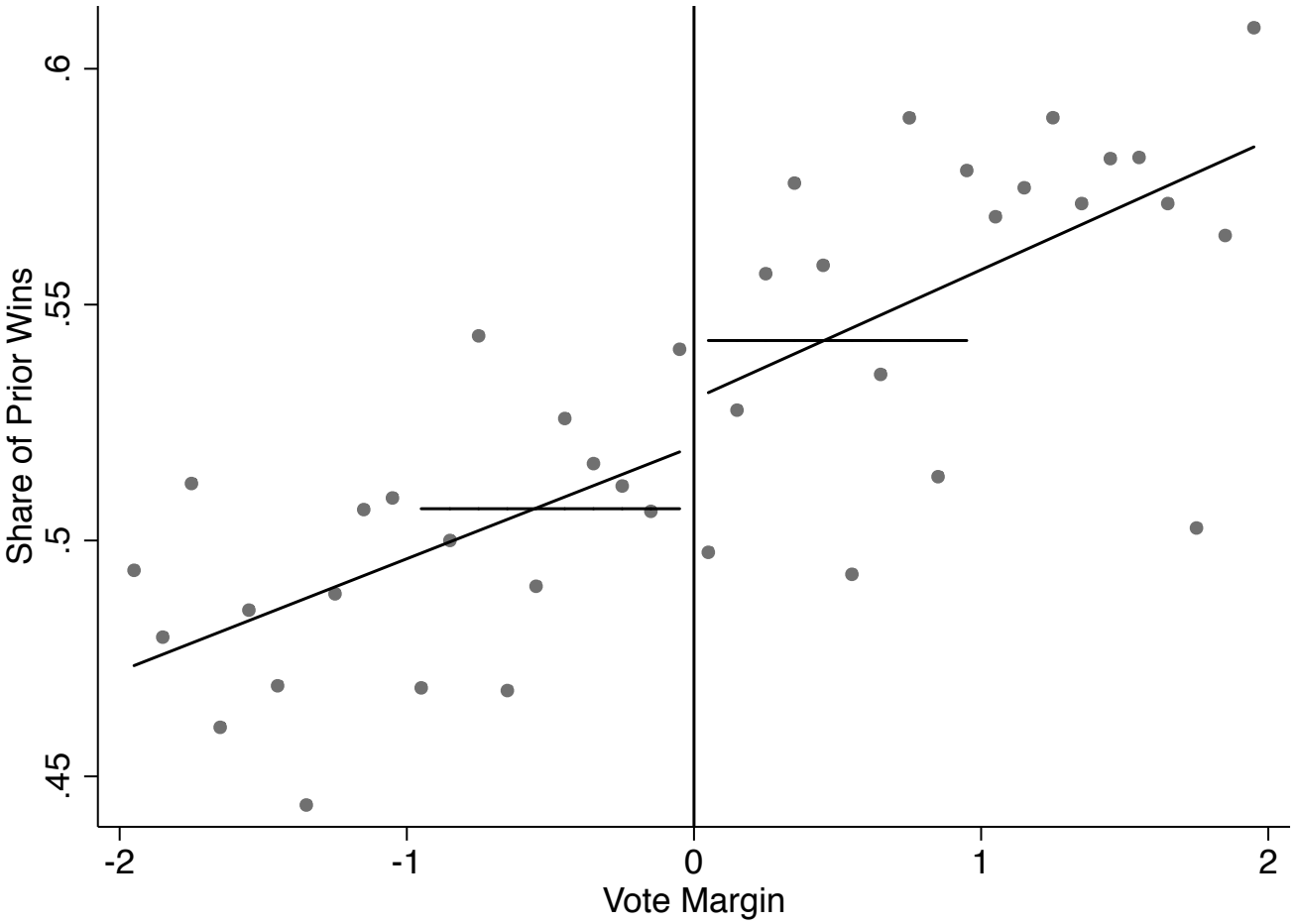


Figure B2: Testing for imbalances in lagged incumbent victory. We exclude bandwidths that subset the data to fewer than 60 observations.

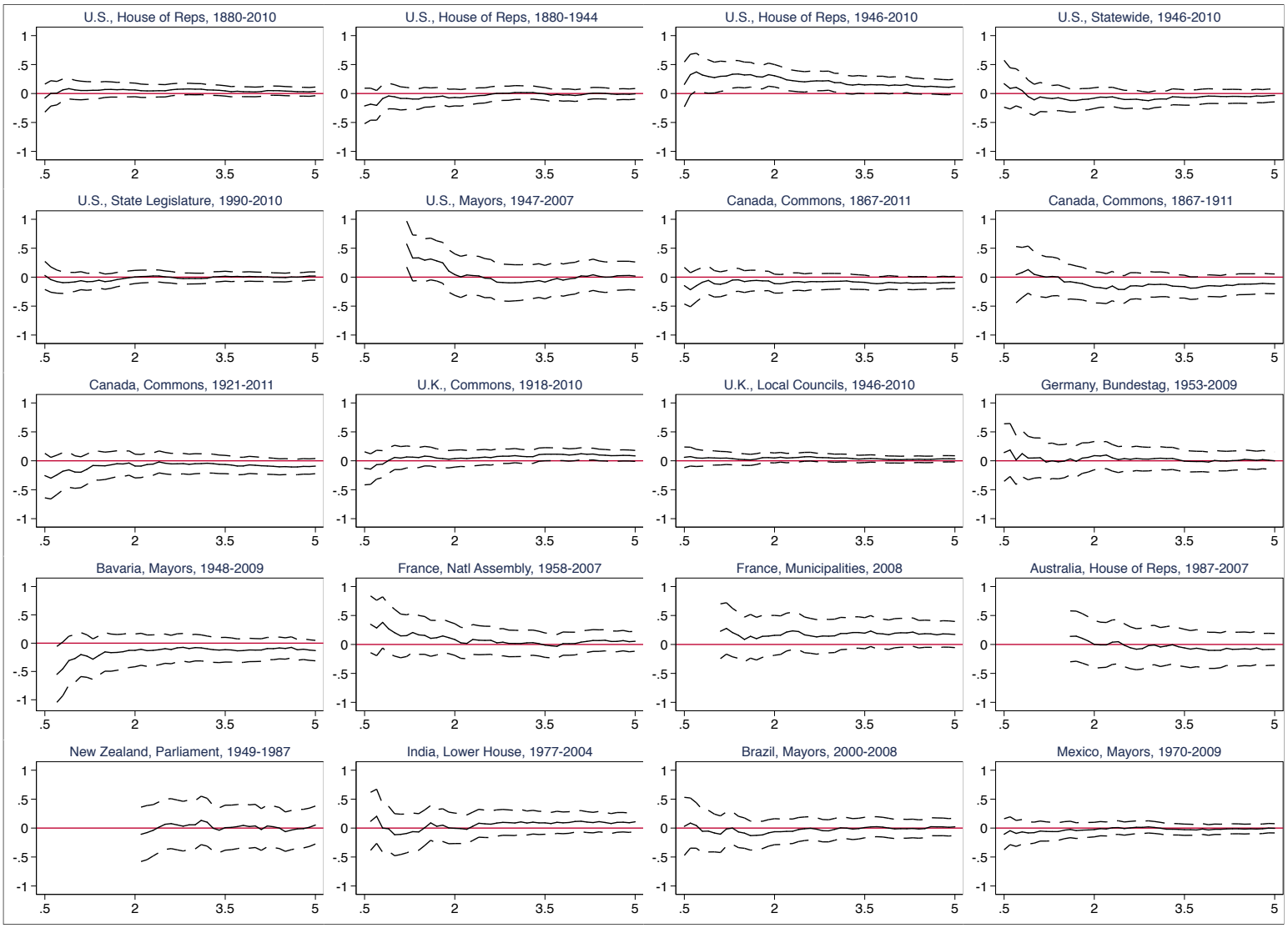


Figure B3: Testing for imbalances in lagged incumbent vote margin. We exclude bandwidths that subset the data to fewer than 60 observations.

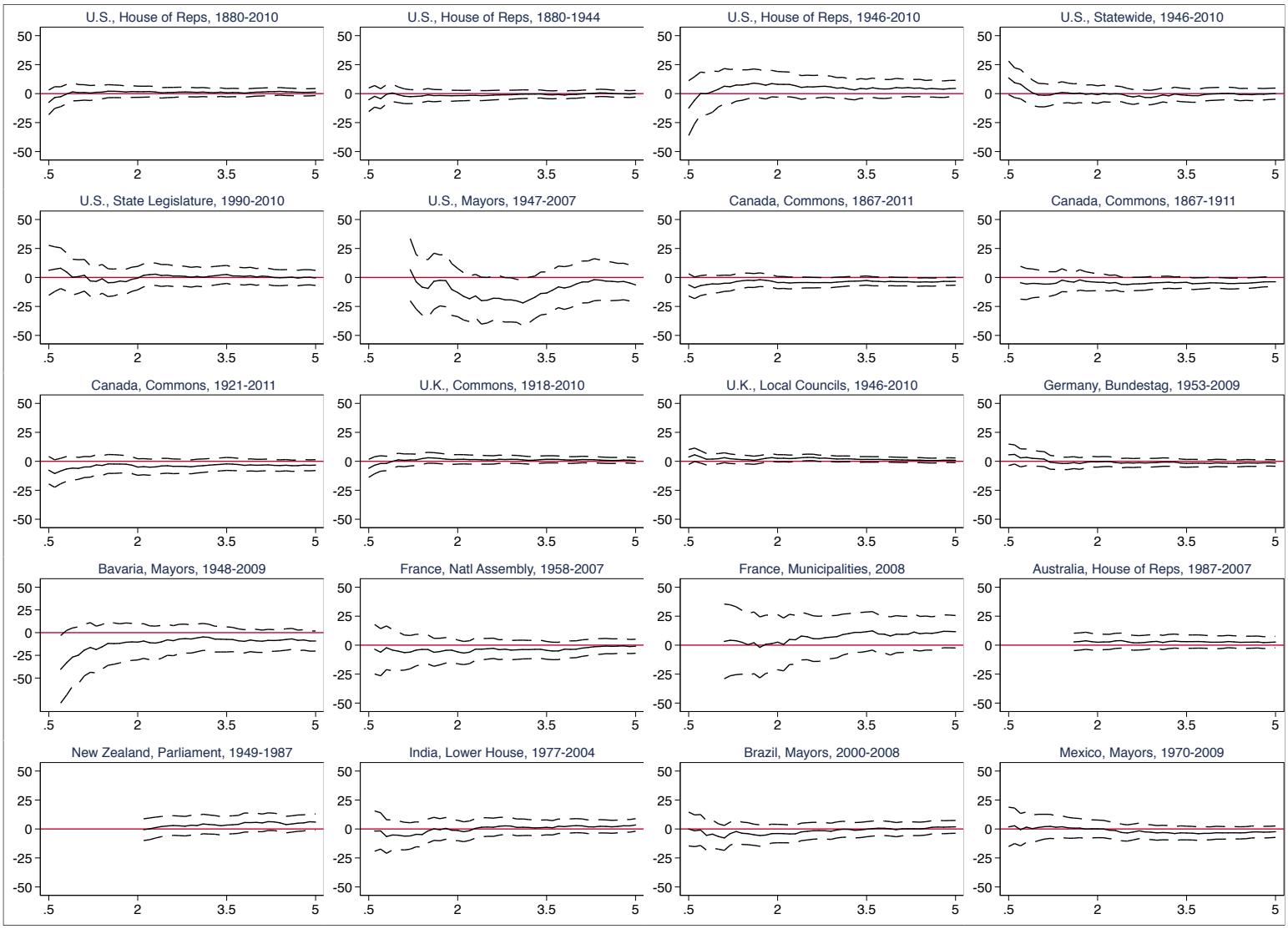


Figure B4: Testing for imbalances in lagged incumbent victory. All cases pooled.

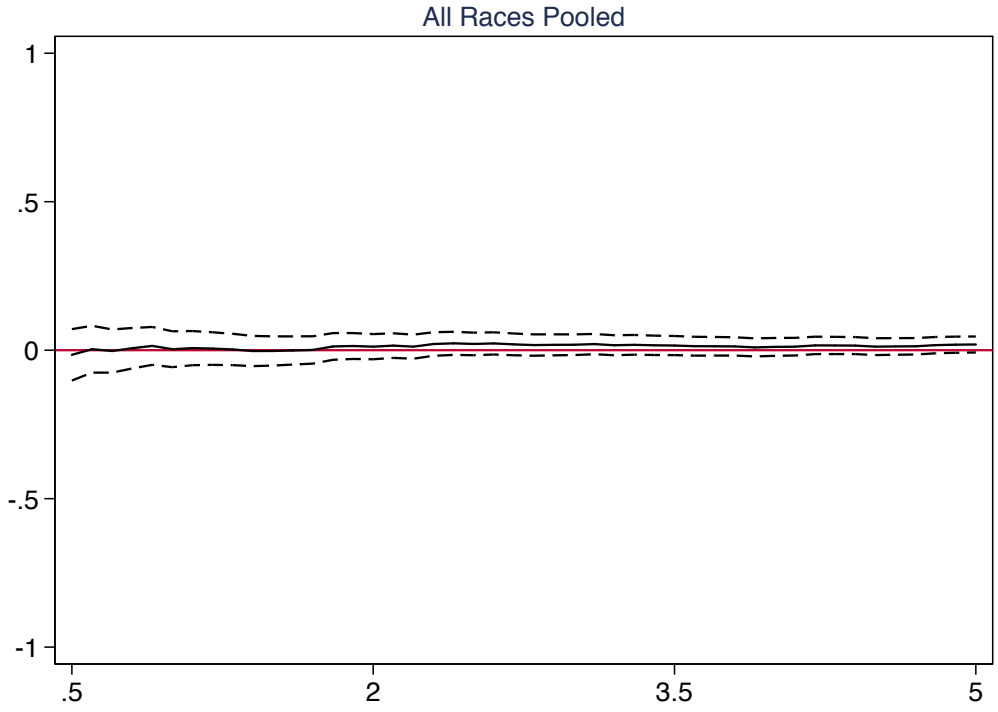
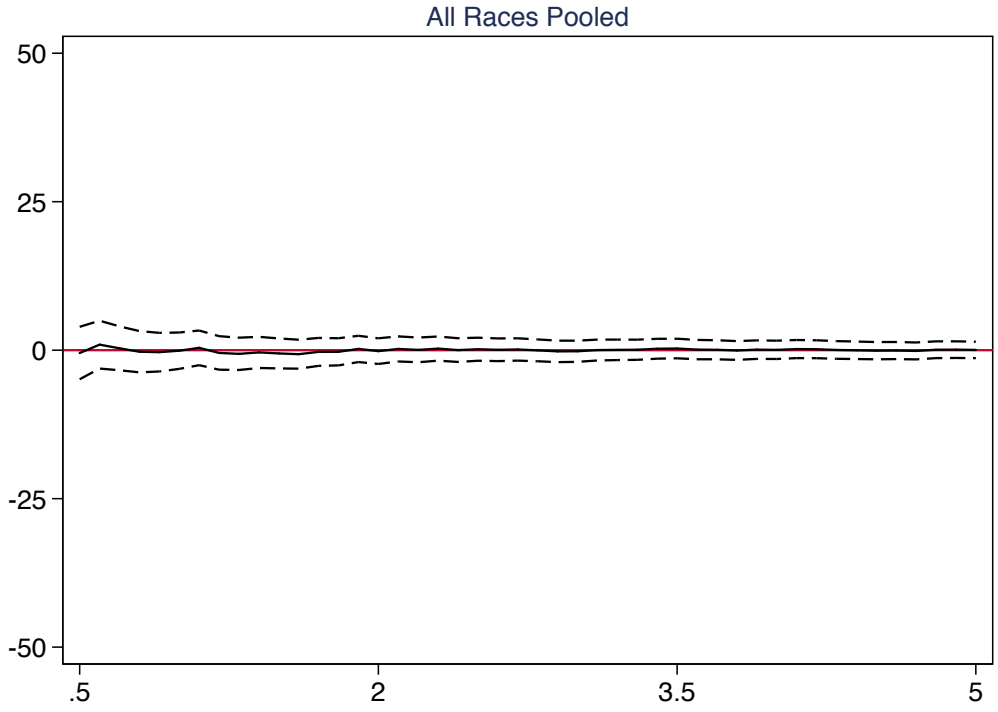


Figure B5: Testing for imbalances in lagged incumbent vote margin. All cases pooled.



## Supporting Information Appendix C: Model of pre-electoral manipulation

How could pre-election behavior result in sorting of the kind discovered in the postwar U.S. House? Here, we adopt a theoretical model that captures the essence of the strategic campaigning hypothesis offered by Caughey and Sekhon or similar *pre-election* explanations. We use this model to assess the level of precision that relevant political actors would need to have in predicting election results in order for strategic pre-election behavior to explain the pattern of imbalances that we observe in the Post War U.S. House.

The model works as follows: incumbent candidates receive a signal about their expected vote share in the upcoming election—an indication of how they will perform if they proceed with a normal campaign. However, the signal is imperfect as there is some error in the candidate's prediction of the exact vote shares, and in the model, we assume that candidates are aware of the average level of error. This is analogous to the political polls that provide a signal to campaigns about the expected result and the known level of error associated with these polls, on average. After receiving the signal, incumbent candidates then decide whether to deploy a "secret weapon"—an extra campaign resource that will improve their vote share by a known amount. We could think of the secret weapon as extra effort, extra campaign resources, calling in favors, etc. Importantly, the deployment of this weapon is costly, so candidates will only use it if it will increase their probability of victory by a particular amount—whatever threshold at which the costs of deploying the weapon are equal, in expectation, to the benefits of such an increase in the probability of winning the election.

More formally, we can write the model as follows:

$$Inc\ Vote\ Share = signal + error + \kappa \cdot secret\ weapon, \tag{A.1}$$

where $signal \sim N(.62, .15^2)$—approximating the distribution of incumbent vote share in the U.S. House, and $error \sim N(0, \epsilon^2)$. The variable $\kappa$ represents the effect of using the secret weapon on vote share, and *secret weapon* is a binary variable indicating whether the incumbent chooses to deploy the secret weapon. Our primary variable of interest is $\epsilon$ which indicates the average level of error in predicting vote shares. Specifically, we would like to find the largest possible value of $\epsilon$ that could produce the type of imbalance that we observe in the Post War U.S. House.

First, let us examine the decision of the incumbent to deploy the secret weapon. She must calculate her probability of victory if she deploys the weapon or abstains from doing so and then calculate the difference in these two probabilities. Specifically, the incumbent's probability of victory can be written in the following form:

$$\begin{aligned} Pr(signal + error + \kappa \cdot secret\ weapon > .5) & \\ &= Pr(error > .5 - signal - \kappa \cdot secret\ weapon) \\ &= Pr(error < \kappa \cdot secret\ weapon + signal - .5) \\ &= \Phi(\frac{\kappa \cdot secret\ weapon + signal - .5}{\epsilon}) \end{aligned}$$

Therefore, the effect of deploying the secret weapon on the incumbent's probability of victory is

$$\Phi(\frac{\kappa + signal - .5}{\epsilon}) - \Phi(\frac{signal - .5}{\epsilon}),$$

and the incumbent will only use this resource if

$$\Phi(\frac{\kappa + signal - .5}{\epsilon}) - \Phi(\frac{signal - .5}{\epsilon}) > \alpha,$$

where $\alpha$ represents the cost of deploying the secret weapon divided by the benefits of winning the election. Having evaluated the decision of the incumbent to employ the secret weapon, we can rewrite the distribution of incumbent vote share as

$$Inc\ Vote\ Share = signal + error + \kappa * 1\left\{\Phi(\frac{\kappa + signal - .5}{\epsilon}) - \Phi(\frac{signal - .5}{\epsilon}) > \alpha\right\}, \tag{A.2}$$

and evaluate how the distribution of incumbent vote share changes as a function of $\epsilon$, $\kappa$, and $\alpha$.

Our goal is to assess the possible values of $\epsilon$ that could potentially produce the type of imbalance observed in the U.S. House. As discussed in the main text, the imbalance observed in this setting is limited to the narrow sample of elections where the two-party vote percentage fell between 49.75 and 50.25. Incumbents were more likely to fall in the small bin just above the winning threshold (between 50 and 50.25 percent) than they were to fall in the small bin just below the threshold (between 49.75 and 50 percent). In the sample analyzed by Caughey and Sekhon (2011), the incumbent party fell into the winning bin 75 times but only fell in the losing bin 35 times, so the incumbent party was approximately 2.14 times more likely to fall just above the winning threshold than just below. We use this ratio between the number of incumbent observations just above and just below the electoral threshold as our metric of imbalance, and determine the largest possible value of $\epsilon$ that could produce the same level of imbalance (2.14) that we observe in the U.S. House.

Assessing imbalance as a function of $\epsilon$, $\kappa$, and $\alpha$ is analytically difficult but can be easily accomplished through statistical simulations. For any given values of $\epsilon$, $\kappa$, and $\alpha$, we can generate one million observations resulting from this distribution of incumbent vote shares and estimate the level of imbalance produced by these specific values of these parameters. We repeat this procedure for approximately 2.5 million different possible combinations of parameters, ranging $\epsilon$ and $\kappa$ from .001 to .05 (0.01 to 5 percentage points) and ranging $\alpha$ from .01 to .99. Across all simulations, the largest possible value of $\epsilon$ that can produce the same level of imbalance in the U.S. House is .0026 or 0.26 percentage points. Within the model, in order for strategic pre-election behavior to produce the kind of imbalance observed in the U.S. House, incumbents or their campaigns would have to predict their expected vote shares at most within one-quarter of one percentage point, on average, and this is for only the best possible values of $\kappa$ and $\alpha$. This result confirms the intuition described in the main text. As we explain the main text, it seems implausible that real campaigns can obtain this level of precise knowledge about their expected vote shares, suggesting that strategic campaigning is not a convincing explanation of the imbalance that we observe in the U.S. House. STATA code for reproducing our simulation results is provided below.

```
***STATA Code for Simulation***
clear
set more off
```

```
postfile results uncertainty weaponsize cost sorting ///
     using "SortingSimulationResults.dta", replace
forvalues epsilon = .001(.0001).05 {
     forvalues kappa = .001(.001).05 {
          forvalues alpha = .01(.01).99 {
               clear
               qui:set obs 1000000
               g signal = .62 + invnormal(uniform())*.15
               g error = invnormal(uniform())*‘epsilon’
               g secretweapon = (normal((‘kappa’ + signal - .5)/‘epsilon’) ///
                    - normal((signal - .5)/‘epsilon’)) > ‘alpha’
               g voteshare = signal + error + ‘kappa’*secretweapon
               qui:sum voteshare if voteshare > .5 & voteshare < .5025
               scalar winning = r(N)
               qui:sum voteshare if voteshare > .4975 & voteshare < .5
               scalar losing = r(N)
               scalar ratio = winning/losing
               post results (epsilon) (kappa) (alpha) (ratio)
          }
     }
}
postclose results
clear
use "SortingSimulationResults.dta"
sum uncertainty if sorting > 2.14
```

## References

Ade, Florian and Ronny Freier. 2011. "Divided Government Versus Incumbency Externality Effect: Quasi-Experimental Evidence on Multiple Voting Decisions." *DIW Berlin Discussion Paper No. 1121* .

Caughey, Devin and Jasjeet S Sekhon. 2011. "Elections and the Regression Discontinuity Design: Lessons from Close US House Races, 1942–2008." *Political Analysis* 19(4):385–408.

Dell, Melissa. 2012. "Trafficking Networks and the Mexican Drug War.". Unpublished Manuscript.

Horiuchi, Yusaku and Andrew Leigh. 2009. "Estimating Incumbency Advantage: Evidence from Multiple Natural Experiments.". Unpublished Manuscript.