Malapportionment and representation: party bias and responsiveness in Mexico*

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Abstract

Automated redistricting in consultation with parties since 1997 rid redistricting in Mexico of the most flagrant distorsions on representation. But more subtle ones remain. Rules and practice introduce some degree of malapportionment, small in comparative perspective (Samuels and Snyder 2001), but nonetheless substantial. We inspect district maps, votes, and seats in Mexico in search for two forms of political distorsion that may arise from malapportionment: party bias and responsiveness (otherwise known as plurality bias). State-level data reveal no evidence of systematic party bias. What bias there is is of another kind, a big bonus for larger parties (or vote responsiveness) typical of plurality rule in single-member districts. Since most states distribute few seats each, the large party bonus of states' federal districts doubles the estimate with national data. Since the PRI is the largest party in most states, it receives a substantial seat bonus.

Mexico has done population censuses every decade since 1920, and every five years since 1990. The relatively short inter-censal periods offer relatively precise estimates of how many live in boroughs in every corner of a country with rapidly changing demographics. This official and public data is priceless for planners of all stripes, marketers, and researchers, to name a few.

But not everyone has taken advantage of the data. Redistricters in the last decades are among them, routinely shunning fresh population data availability. Part of their

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reluctance finds explanation in a Constitution mandating the use of decennial censuses, not lustrum population counts, to do their job; with no attempt to estimate population change since the census is published; and, unlike the U.S., no obligation to redistrict as soon as a new census is available. But much of the blame falls on legislators, parties, and electoral regulators who have, to larger or smaller extent, but systematically lagged behind the constitutional obligation to ensure equal representation when updated information has become available.

To get an idea of this, consider that information used to draw a new map for the 1979 congressional was nearly a full decade old upon the map's inauguration. Rural flight was probably at its peak then. That same map had missed nearly 25 years of demographic change when it was last used to translate votes into seats, in 1994. But the problem has carried over to the democratic era. The first map map after transition was drawn with seven year old dataHad the lustrum count been used instead of the general census, the lag would have dropped to two years. And for reasons discussed below, when the 2015 midterm congressional election takes place, a decade-and-a-half gap will separate the map and actual district populations.

Malapportionment—when sparsely populated areas get the same representation as the more densely populated ones—arises as a consequence. This raises normative questions on the value of a vote in representative democracy (Balinski and Young 2001, Cox 1987, Dahl 1972). But positive quastions are no less important, as malapportionment may bias representative government in important ways. If some party or parties tend to be stronger in the smaller districts, they will enjoy undue influence in policy. With the PRI still playing the role of prize fighter in Mexico's countryside (Ames 1970, Magar 1994), the question of party bias arsing from malapportionment merits closer scrutiny.

This paper starts with a description of the redistricting process in use since 1997. Automated redistricting in consultation with parties rid Mexican districts of the most flagrant distorsions on representation, but problems remian. Next, the paper inspects one such problem: legislative malapportionment. The problem is shown to be substantive and systematic: by our estimates, in 2015 the most populated district will be four times larger than the least populated. The developments that have led to this situation are discussed. We next turn to some of its consequences for representation, with analysis of two distorsions of scholarly interest: party bias and responsiveness (or large party bias). Surprisingly, our estimates reveal no systematic party bias, but responsiveness is huge. [In future incarnations, the paper will also relate the party bias and responsiveness estimates to measures of malapporionment, in search of an

association at the state level. A discussion of how inter-election volatility may trump the effects of malapportionment will also be in order.]

1   Redistricting since 1997

Mexico adopted a mixed-member electoral system for the lower house of Congress for the 1979 congressional election. Three hundred single-member districts were drawn to elect three-fourths of the chamber by plurality rule. That proportion fell to three-fifths since 1985, but the number of single-member districts has not changed. No boundary lines are drawn for the compensatory, proportional representation seats; accordingly, we leave them out of the analysis. By seats/districts, in the paper, we always refer to the single-member kind. The original district map was redrawn in 1997, coinciding with the first free and fair congressional election (Lujambio and Vives Segl 2008). Redistricting occurred again in 2006, and was meant to be undertaken, but aborted, in 2015.

We name these maps by years in order to keep them distinct. We stick to the convention of using not the date when boundaries were actually redrawn and accepted, but that of the first election the map was (or would have been) used. Thus, there is a "1979 map" actually drawn in 1978, a "1997 map" drawn in 1996, a "2006 map" drawn in 2004–05, and a "2015 map" drawn in 2013, but never used.

Machine-assisted mapping has been in use since 1997. Details have changed, but the broad lines have not (Trelles and Martínez 2008). We describe the three major stages of the redistricting process: the apportionment of seats to states; the design of an optimization algorithm; and the strategic assessment of computer-generated district blueprints by technocrats with the active, but limited involvement of political parties.

Apportionment. Redistricting starts by redistributing a fixed number of seats among the 32 states.[1] Restrictions, reminiscent of the U.S., apply at this stage: no state may have fewer than two seats; the sole redistributive criterion above that minimum is state population; and no district may cross state boundaries. The next section elaborates the method of apportionment used and problems raised for representation.

Optimization. This stage adopts a set of desiderata for a new map drawn from the base geography. A technical committee, appointed by IFE's Council General, is in charge of optimization and proposing a map for assessment. The formal "cost

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[1]The Federal District, where Mexico City resides, is not a state proper, but is treated as one for the purpose of apportionment and redistricting.

function" devised for the 2015 map included four criteria: population balance (given a relative weight of .4 in the linear combination), municipal boundary preservation (weight .3), travelling times inside the district (weight .2), and district compactness (weight .1). Trade-offs between them would inevitably step in as district boundaries are calibrated. Assisted with computers, the process made marginal changes, repeatedly reassigning geographical blocks between districts, while systematically checking the cost. Through iteration with different random seeds, cost-minimizing district maps for each state were generated.[2] The building blocks are more than 66 thousand *secciones electorales* into which the Mexican territory is subdivided. *Secciones* are analogous to U.S. census tracts, but somewhat bigger. Median *sección* population in the 2010 census was 1,280 persons, with a maximum at 79,232.

Restrictions also apply at this stage: contiguity is a must, as no district can have exclaves; and guarantees for minority representation must be considered, not partitioning *municipios* (the lowest elected offices, similar to counties in the U.S.) with sizeable indigenous populations. IFE would tolerate population imbalance of up to 15% from mean district size (the threshold was 10% in 2006), and even deviations beyond that threshold with proper "technical justification" (IFE 2013). The last item is of much importance for our argument, and elaborate it further below.

Assessment. In this stage, that we study elsewhere (Altman, Magar, McDonald and Trelles 2014), the technical committee, party representatives, and the Council General interact. The map proposal is distributed to the parties for analysis and discussion. Parties suggest modifications to district boundaries, which the technical committee accepts if they improve the score from the optimization algorithm. Revisions adopted become the starting point for a second, and final round of observations/amendments. The final plan is then presented to the Council General for formal approval. It is at this final stage that the 2015 redistricting was abandoned. The Council General opted to put the process on hold until the details of an ongoing major electoral reform in Congress became known. As a consequence, the 2015 midterm election will be held with significantly outdated districts.

2 How to read a map

A new map is a full description of district boundary changes. The common way to visualize maps is on paper. We look at them differently, with focus not in the physical

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[2]More refined optimization algorithms have been used in each redistricting round. The 2015 algorithm, described here, replaced a method of simulated annealing used in 2006.

Similarity between	min	25%	median	75%	max
initial 2015 proposal and status quo	0.128	0.419	0.584	0.755	1
final 2015 proposal and status quo	0.125	0.437	0.643	0.805	1
final and initial 2015 proposals	0.174	0.705	0.967	1	1

Table 1: District similarity of the 2015 map

lines and their relation to landmarks and geographic accidents, but in their political consequences. Putting the 2006 map and the 2015 final proposal drawings side to side reveals boundary shifts. But unless the drawing is quite data rich, or your command of political geography is outstanding, assessing even superficial effects of boundary changes visually is a challenge.

A similarity index (Cox and Katz 2002:15–7) illustrates our method, offering ground for systematic assessment of a pair of maps. Measurement identifies the parent district or single largest contributor of population to every new district. The similarity index divides the population that $parent$ and new district share in $common$ by their joint population: $s = c/(p + n - c)$. The range is zero (district shares no population at all with parent) to one (districts are identical). The statistic conveys an intuitive measure of how much districts changed in the new map. Table 1 describes 2015 map changes against the status quo (the 2006 map), including the technical committee's initial proposal for party assessment and the revised, final proposal sent for approval. Also compared are the final and initial proposals themselves.

Six percent of districts entertained no change in boundaries whatsoever vis-à-vis the status quo (18 districts in the initial proposal, 19 in the final),[3] and twice as many had at least nine-tenths of the population in common (40 districts in the initial, 44 in the final proposal). Inspecting which districts were a $priori$ chosen for marginal or no change might reveal systematic distortions of the automated redistricting algorithm. Party feedback left 39 percent of districts in IFE's first proposal intact, and 62 percent with up from nine-tenths of the population in common. Inspecting which districts the parties targeted for major amendment — presumably a partial reinstatement of a preferred status quo district — should shed further light into the subject. Note how median district similarity with the 2006 map augmented from first to final proposal. So did the third quartile. Accepted counter-proposals therefore reconstituted portions of status quo districts. This seems consistent with a view where parties protect strongholds that the algorithm may have split, but further analysis must be done— these are exciting lines that future versions of this project should pursue!

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[3]Slapin wrote: how did their populations change?

3 One person, one vote?

Of many ways in which malapportionment can arise (Snyder and Samuels 2004), two are of interest here: that ensuing from the distribution of seats between the states, and that ensuing from drawing district boundaries within the states. We discuss them in turn.

3.1 Between states

In sharp contrast to the U.S., little, if any public debate about alternative apportionment methods has been undertaken (Balinski and Ramírez González 1996, Szpiro 2010). The Hamilton method of largest remainders is used for apportionment of Mexico's national legislative seats to the states (Balinski and Young 2001:10). The quota Q (or price) of a seat is the nation's population divided by 300, the number of seats. A first allocation is made by dividing each state's population in the last general census by Q, rounded down. States with populations $< 2Q$ are nonetheless allocated two seats (Colima and Baja California Sur fell in this category in early apportionment rounds). Unallocated seats, if any, are awarded to states with largest fractional remainders.

Figure 1 summarizes state's representation in Congress. We estimated each state's population at the time of each federal election since 1997. Estimation between 1997 and 2010, inclusive, relied on linear interpolation of the lustra census populations,[4] and linear extrapolation for 2012 and 2015. With moving population estimates, a time-series of states' fair share of congressional seats was computed (time-varying Qs). The actual number of seats apportioned is subtracted, yielding the state's over- or under-representation at the time of the election. A state with perfect apportionment in every election would appear as a flat, horizontal line at zero in the Figure. The left panel reports this measure in absolute terms (so that +5 indicates a state with five deputies more than its fair share), the right panel relative to seats apportioned to the state (+5 indicates five percent more deputies than its fair share).

Since the first term of the subtraction is a real number and the second an integer, a fraction is bound to remain. Fractions in well-apportioned systems should all be less than 1 in absolute value—once that mark is passed, a full quota is reached, and a deputy is added or subtracted. The left panel shows that this is mostly the case for Mexico, but exceptions are, and have always been present. It is also plain that the

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[4]The years 1995 and 2005 had population counts, 2000 and 2010 had general censuses. The former collect much fewer attributes than the latter.
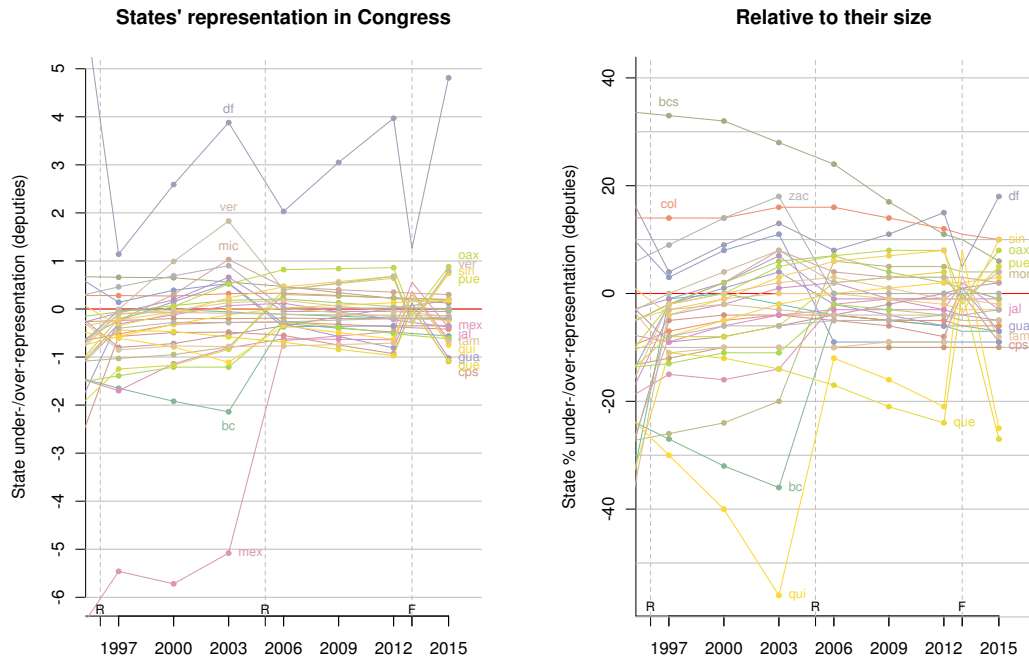
Figure 1: Demography and state apportionment. Lines connect the lower chamber seats aportioned to seats due difference for each state over time. Letters R in the horizontal axis indicate redistricting, letter F a failed redistricting attempt (reporting the effect it would have had).

2006 map corrected, to some extent, important distortions that the 1997 map had failed to rectify. Under-representation of Baja California, but especially of the Mexico State dropped from two and five deputies less than due (deficits of 30 percent and less than 10 in relative terms), respectively, to near parity. Over-represented Veracruz behaved near symmetrically to Baja in absolute terms (not relative). And a distortion strongly favoring the Federal District (+4 deputies) was somewhat attenuated in 2006, but never removed.

Persitent malapportionment is explained, in small part, by the allocation of two seats to small states. Relative over-representation of tiny Southern Baja and Colima was substantial, but only until recently. Population growth has made both worth their congressional seats. Yet relative over-representation remains substantial in migrant-worker-exporter Zacatecas up to 2003, and in the Federal District of late. Both states have lost population fast relative to the rest, and the system's design makes rapid demographic shifts slip away from grip.

When redistricting plans are drawn, malapportionment does not exist *de jure*. It exists *de facto*. Mexico's constitution provides that every redistricting process must rely on the most recent population census available, with no attempt to estimate population change since (and, unlike the U.S., no obligation to redistrict as soon as a new census is available). Nor does it contemplate the use of lustrum counts instead. As a results, the redistricting process has built-in features explaining the persistence of malaportionment—what Johnston (2002) calls "creeping malapportionment", whereby changes in constituency size over time create smaller seats. Compared to the 2000 census populations used for the 2006 map, the projection of 2000–2005 state population shifts are off by 9.7 percent on average, with a standard deviation of 6.9 percent.

With this in mind, it is puzzling that the redistributive nature of apportionment has not pushed for the adoption of alternative methods. The seventeen states that were under-represented in 2006 jointly controlled a majority (162) of single-member districts; fourteen of them have always been below the red line indicating fair representation. Does malapportionment have political consequences?

3.2 Within states

Despite automation and straightforward, formal redistricting criteria, Mexican parties in general, and IFE in particular, have been remarkably tolerant to unequally sized districts. This form of malapportionment is related in some degree to state imbalance

| | Absolute malapportionment | | | | |
Map in year	Min.	1st quartile	median	3rd quartile	max.
2006 map in 2006	< .01	3.4	6.5	12.4	54.8
2006 map in 2015	.02	4.4	9.9	18.0	147.2
2015 map in 2015	.01	1.9	4.2	8.1	50.6

Table 2: Changing malapportionment. For these statistics, each district's estimated population in 2006 and 2015 (from *seccin* 2005–2010 changes) is compared to its parent state's estimated mean district population.

in Congress, which perforce creates size differences across states' districts. But size inequality within states is also prevalent and substantial.

Small deviations around a state's mean district population are unavoidable. But what constitutes a small deviation is hard to define. Courts in the U.S. have struck down district maps bearing less than 1% differences without proper justification (Tucker 1985). Redistricting authorities generally view a *de minimus* population deviations of as little as one or zero persons between congressional districts as desirable to inoculate against litigation. In stark contrast, IFE has considered deviations between 10 (in 2006) and 15% (in 1997 and 2015) above or below mean state district size perfectly normal. Within such spread, a district at the bottom end is worth one-third more in Congress than another at the top end. Surprisingly, no party has ever challenged this in Court.

Redistricting automation should make districts within states tend towards zero malapportionment. Population balance is, after all, the criterion that weighs more in the cost function. But this criterion weighs less than the others combined in the algorithm, and appears to be trumped rather easily. The preservation of municipal boundaries, for instance, is achieved by exploiting tolerated leeway. Figure 2 shows how the imbalance tolerance band (in grey) is uniformly occupied by districts even right after a map's inception—in practice, the system does *not* push towards perfect balance. And it is notable that when estimated population shifts are taken into account (as the plot does, unlike IFE), as many 16 percent of new 2006 districts were patently *outside* the lax range of tolerance.[5]

The requirement to keep municipalities with large indigenous population within the same district may also explain exceptions. As seen in Table 2, median absolute district malapportionent of the 2006 map upon inauguration was 6.5%, the third

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[5]Census data reported at the electoral *sección* level are available since 2005 only. We projected the 2005–2010 changes to 2006 and 2015 for this exercise. Since so many districts are made of full municipalities, we could use that unit to extend it to 1997.
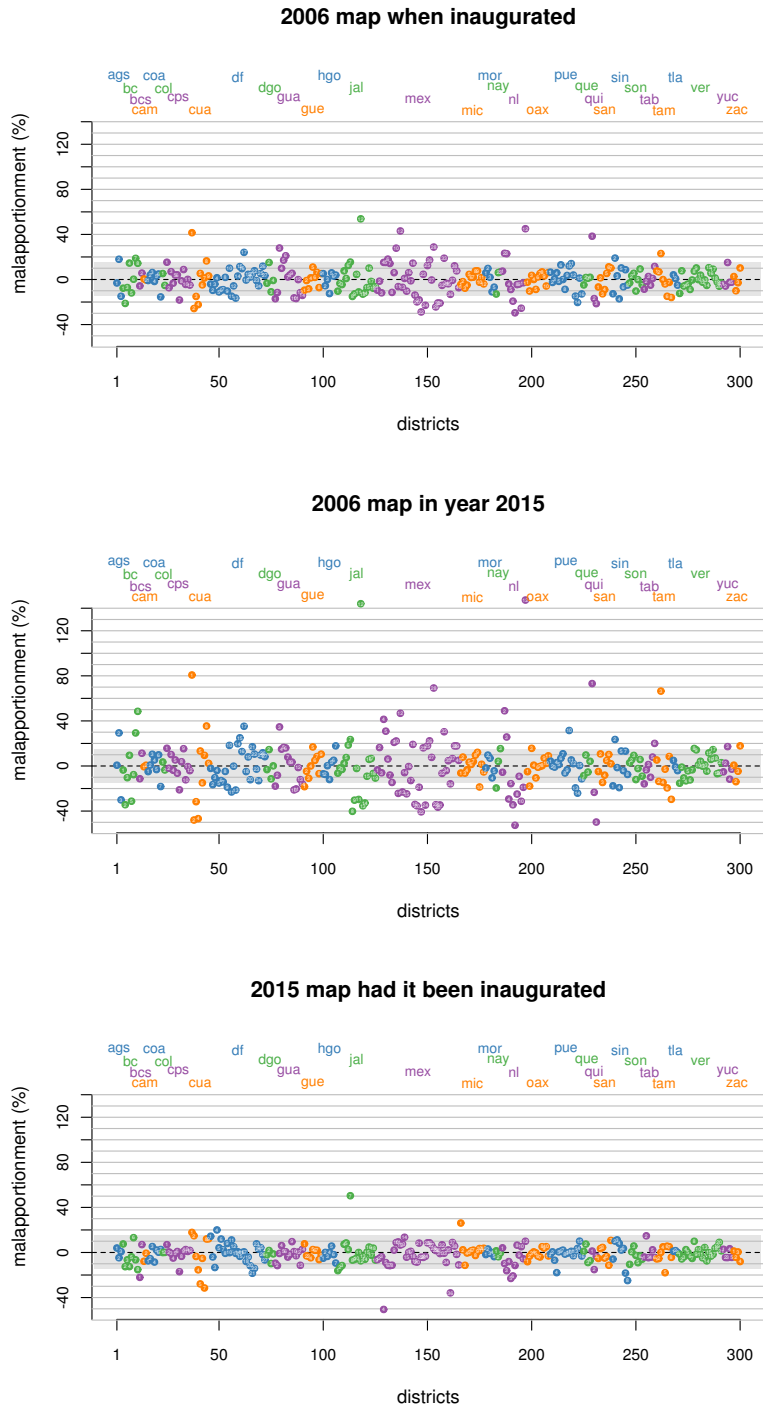
Figure 2: Malapportionment through years and maps. The *y*-scale measures district population relative to ideal (mean state population). The grey band is IFE's range of tolerance for district population imbalance (±15%).

quartile surpassing the ten point tolerance margin (then used) at 12.4% (also, Trelles and Martínez 2008). For next year's midterm election, the same descrepancies will be 9.9 and 17.9%, respectively. The abandoned 2015 map proposal did a much better job upon inauguration, with median absolute district malapportionment of 4.2% and third quartile at 8.1%.

Whether districts below and above fair representation behave differently merits closer inspection. Whether due to technical difficulties or discretion, malapportionment may be the source of meaningful distortions in democratic representation. To which we now turn to.

4 Party Bias and Responsiveness

This section estimates district responsivity and party bias—two effects of scholarly interest. Márquez (`http://bit.ly/1jgsQXE`) has approached this theme using national national-level electoral data aggregates over two decades, uncovering a degree of responsivity characteristic of Westminster systems and party bias against the PAN under the status quo. We proceed with state-by-state breakdowns over much a shorter span (2006, 2009, and 2012). Doing so, much higher responsivity (owing to fewer districts, 9 by state on average) is uncovered, but no apparent party bias in neither the 2006 map nor 2015 proposals.

4.1 Systematic Bias

Consider now the relation between party votes and seats at the state level portrayed in Figure 3. Each point reports the vote share that a party won in a state's federal deputy elections (x-axis) and the share of the state's congressional seats it received (y-axis). Colors distinguish the parties: PAN is blue, PRI is red, PRD is gold, Green is green, among others. For instance, the green dot floating to the left of the cloud is the Green party in Chiapas 2012, where it won 3 of 12 districts. The chart shows that 9 percent of the state's vote awarded the party 25 percent of the seats, an outstanding achievement for any party. The cloud manifests a steep upwards slope characteristic of first-past-the.post systems (Taagepera 1973).[6] Points below the diagonal indicate under-representation, those above over-representation. There are notable differences

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[6]Adding the excluded PR seats would level the slope considerably. Doing this would be easy with national aggregates. It is not evident how to carry it with state aggregates, since PR seats are awarded in five second-tier districts joining together several states each.
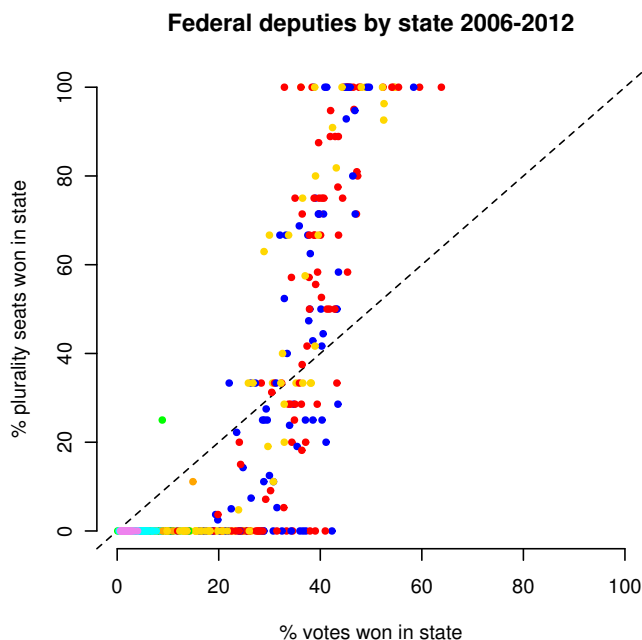
Federal deputies by state 2006-2012

Figure 3: Seats and votes in the states. Each point is a party-state-year, blue for PAN, red for PRI, gold for PRD, other colors for minor parties.

among major parties: the PRI achieved over-representation in three-fifths of election-states between 2006 and 2012, the PAN in two-fifths, and the PRD in one-fourth only.

With such setting, the possibility that districts are granting undue advantage to the PRI merits closer inspection. A priori, reasons to suspect IFE of cooking districts to favor one party or another are lacking. Major parties, after all, permanently influence the election regulator, ambition counteracting ambition (Estévez, Magar and Rosas 2008). But that those who draw the district lines can distort a fundamental link of the democratic process is well established in the literature (Altman and McDonald 2011, Balinski and Young 2001, Cox and Katz 2002, Engstrom 2006, King 1990, Otero 2003, Rossiter, Johnston and Pattie 1997). Has the insidious gerrymandering reared its ugly head in Mexico? This section estimates majority and party effects in the proposed districts and the status quo. Majority effects are huge, partisan effects negligible.

4.2 Two Classes of Distortion

Undue advantage is known, in the specialized literature, as partisan bias, and is one goal that strategic redistricters pursue. It is not, however, alone: scholarship highlights district responsiveness, also know as majoritarian bias, as another goal. These ought to be distinguished (this paragraph draws heavily on Cox and Katz 2002, ch. 3). Partisan bias helps the beneficiary buy seats with fewer votes than others. Because seat distribution is a constant sum game, bias in favor of someone always implies bias against someone else. One way of introducing party bias in district lines is with the conventional redistricting strategy known as packing: group your adversary's voters in few districts, wasting votes to win unnecessarily safe seats, raising the price of victory. Responsiveness, on the other hand, is the feature granting a seat bonus to large parties. Maximal responsiveness occurs within each single-member district in isolation: the winner takes all, the rest nothing. The same could be achieved in a whole state by drawing lines so that every district is representative of the state's electorate (Cox and Katz's microcosm strategy). The party with most votes wins every seat, maximizing the vote responsiveness of the proposal.

Formalizing party bias and responsiveness opens the way towards estimation of these district characteristics. The two-party case is simpler and extends to multiparty systems (King and Browning 1987, Taagepera 1973, Tufte 1973). It is a generalization of the cube law stipulating that

$$\frac{s}{1-s} = e^{\lambda} * \left(\frac{v}{1-v}\right)^{\rho} \iff \texttt{logit}(s) = \lambda + \rho * \texttt{logit}(v) \qquad (1)$$

where s is the seat share that party 1 won with vote share v; λ is party 1's bias relative to party 2 (positive values favor party 1, negative values favor party 2); and ρ is the districts' responsiveness. With $\lambda = 0$ a system with no party bias ensues. Figure 4 shows how the parameters affect the vote-to-seats conversion.

Non-grey lines lack party bias to illustrate variable responsiveness. A system with $\rho = 1$ is perfectly proportional representation, the ideal type against which the evaluation of real districts are often contrasted. It appears as the dotted green diagonal: every party winning $x\%$ of the vote gets, precisely, $x\%$ of seats. $\rho = 3$ characterizes the classic cube law, the red curve over-representing the winner (points above the diagonal). Here a party with 55% of the vote earns two-thirds of the seats, but with 33% it earns only one-tenth of the seats. As responsivity grows, the curve gets steeper, until barely crossing the majority threshold suffices to win all the

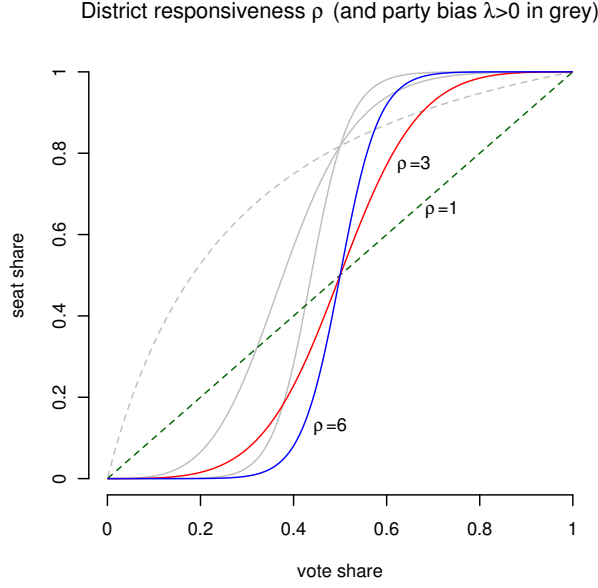District responsiveness ρ (and party bias λ>0 in grey)

Figure 4: Illustration of estimated parameters. Party bias is set to $\lambda = 0$ in non-grey lines. Grey lines replicate the colored ones with $\lambda = +1.5$.

available seats.

Grey lines replicate the values of ρ just discussed but with $\lambda = 1.5$ added. Bias in favor of the party produces a leftward pull of lines. In other words, a bias-favored party requires less effort to reach the threshold for large-party over-representation. (The grey dotted line demonstrates how, due to logit links in Equation 1, party bias also reshapes the function's trace.)

A multiparty and estimable version of equation 1 (King 1990) establishes that party j's $(j = 1, 2, \ldots, J)$ expected seat share is

$$E(s_j) = \frac{e^{\lambda_j} * v_j^\rho}{\sum_{m=1}^{J} e^{\lambda_m} * v_m^\rho} \tag{2}$$

with data and parameters indexed to identify the parties. (Another, with application to Argentine federalism, is Calvo and Micozzi 2005.) Setting $\lambda_2 = 0$, as done below, forces the remainder $\lambda_{j \neq 2}$ to express party bias with relation to the PRI's ($j = 2$ for this party in the dataset). This is convenient to test the presumption of PRI-favoring bias:. if present, $\hat{\lambda}_{j \neq 2} < 0$ would result.

A common estimation strategy relies on a time-series of national aggregates (this is what Márquez did for eight elections 1991–2012, uncovering substantive anti-PAN bias

and high responsiveness). The estimation strategy here is with state-level data. One disadvantage of the approach is that states have few districts (9.4 on average), and this will amplify the system's responsiveness (Taagepera 1973). The advantages are many. The approach multiplies observations. This is evident in Figure 3, with many points despite reporting three elections only. It holds the actual district structure constant—redistricting in 1997 and 2006 invalidates district comparability before and after. And it takes advantage in the variation of state party systems (this draft fails to take full advantage of this variance, but this could be exploited further).

The method of estimation is MCMC (Jackman 2000).[7] As expected, district responsiveness is extremely high, between 5 and 6 depending on the year selected (the steepest line in illustrative Figure 4 has $\lambda = 6$). Figure 5.a reports point estimates (the black circles are the median of the posterior sample of the responsiveness parameter) for each year separately, all years pooled together, and comparing actual districts to the first and third redistricting proposals. Estimate precision is assessed with the cloud of grey points (technically, it is the full sample of posterior ρs). The redistricting proposal makes little change to district responsiveness, it just makes it slightly more volatile from one election to next. Owing to few districts per state, the estimated responsiveness at the state level ($\hat{\rho} \approx 5.5$) is twice Márquez's nationwide ($\hat{\rho} = 2.6$). All three parties experience situations of large party bonus and small party penalty that, to a good extent, cancel each other in the national statistic.

Regarding party bias, signals that are not weak all tend to be accompanied by a good deal of noise, with few exceptions. At the national level, and over a longer haul, Márquez discovers bias in favor of the PRI, but mostly in favor of the PRD, and against the PAN, that seems not the product of chance alone. Analysis at the state level reveals no such biases. As said, Figures 5.b–d express bias relative to the PRI. Although PAN experienced weak signal in its favor in the whole 2006–12 period, a fair density of the blue cloud is, in fact, negative. PRD vs. PRI bias is clearly centered at zero in the full period. The left did experience significant bias in isolated years: against in 2006, in favor in 2009. Perhaps many voters who strategically abandoned the hopeless PRI presidential candidate in 2006 to vote for López Obrador did so in districts where PRI's congressional candidates still won. No other year for no other party reveals any bias unaccompanied by much noise.

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[7]Three chains were iterated 10 thousand times, taking every fiftieth observation of the last 5 thousand to sample the posterior distribution. Convergence was gauged visually with traceplots of the separate chains for each of the model's parameters. Estimation performed with JAGS (Plummer 2003), implemented from R (R Dev. Core Team 2011) using package R2jags (Su and Yajima 2012). Data and code to replicate the analysis can be found at HTTP...
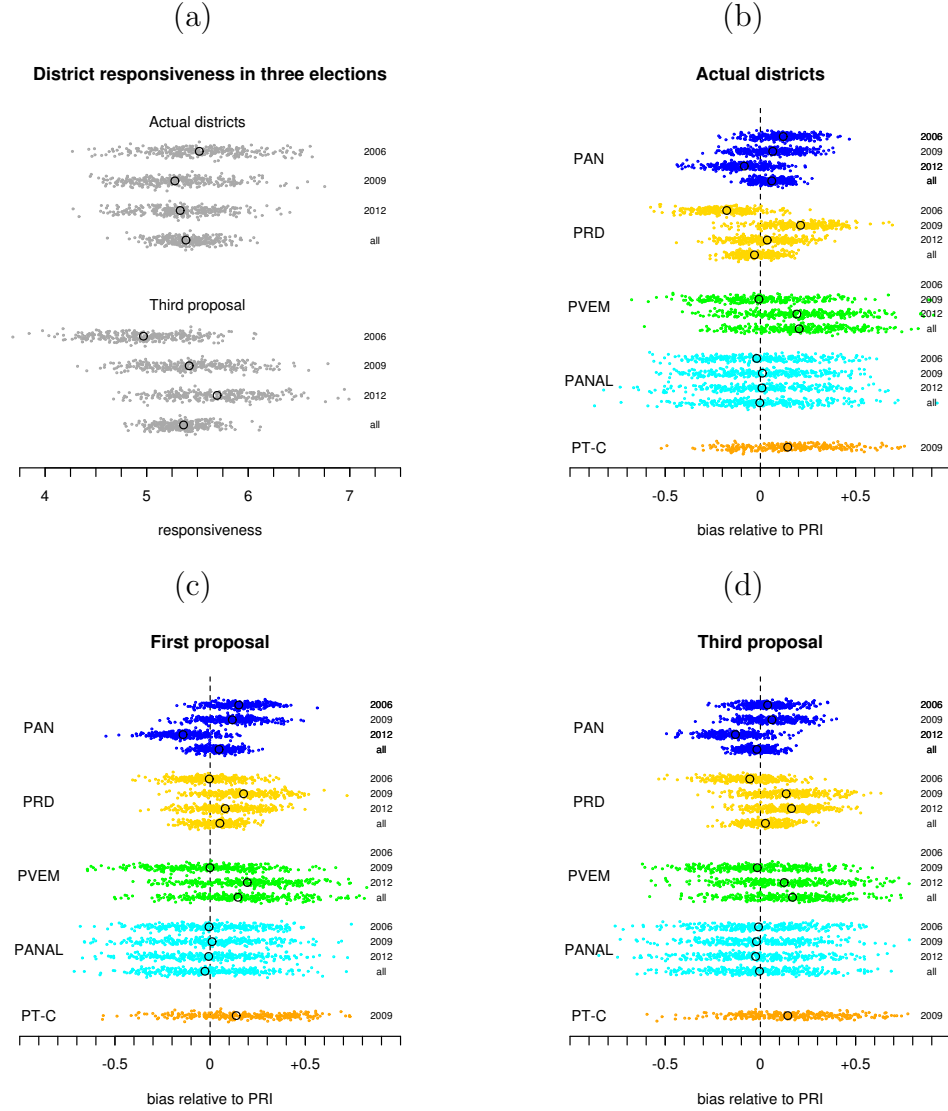
Figure 5: Redistricting, responsiveness, and party bias. Plots report the posterior sample of model's parameters λ_j for four parties and ρ, and the median value (black circles).

	min.	25%	median	75%	max
district volatility	.08	.19	.25	.31	.52
mean PAN margin	−.49	−.23	−.10	.01	.28
mean PRI margin	−.43	−.09	−.01	.07	.28
mean PRD margin	−.51	−.31	−.21	−.04	.39

Table 3: 2006 map district volatility and party margins in three congressional elections

5 Electoral volatility

* * To be written * * May help explain why malapportionment has no larger consequences.

One factor that may explain the absence of party bias is electoral volatility. By being larger than malapportionment, it may be ecplipsing its potential to create bias...

Noting that victory margins began widening in the mid-1960s, Mayhew (1974) saw gerrymandering as one possible explanation, incumbents influencing the preservation of safe districts. While the argument opened the heated incumbency advantage debate, the intuition may guide our inquiry. District volatility should capture a key element for analysis of map similarities. District d volatility is $v_d = 1/2\sqrt{\sum_{p=1}^{P}\sum_{t=2}^{3}(v_{d,p,t} - v_{d,p,t-1})^2}$ with p indexing the competing parties and $t = 1, 2, 3$ for the 2006, 2009, and 2012 congressional elections respectively.[8]

Mexican party strength is not proportional to the formidable entry barriers they enjoy and massive public subsidies they receive yearly (Magar 2015). Evidence of this is their inability to cultivate loyal voters. District volatility is remarkably high, as shown in Table 3. The median district saw 25 percent of votes change party hands between 2006 and 2012 (not exactly how the index reads, but close enough). With so many volatile districts around, parties should have attempted to redress strongholds that automated redistricting split beyond recognition. How much were strongholds affected by the initial 2015 proposal? To what extent did party counter-proposals redress them? This should be a promising line of inquiry.

6 Conclusion

** To be written **

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[8]The measure of volatility proposed is inspired in measures of disproportionality, replacing the seats–votes difference with vote first differences. It is a squared version of a Loosemore-Hanby index (Gallagher 1991, Loosemore and Hanby 1971).

Mexico's federal districts exhibit no party bias when analyzed at the state level. Big system responsiveness, typical of first-past-the-post system in units with few federal districts, is associated with the districts. So PRI's tendency to be over-represented more than PAN and PRD, and the PRI's winning of a couple extra seats with the redistricting proposal is not the product of partisan bias. If the PRI wins more this is due to its status as the largest party in more states that the other two major parties combined.

Appendix 1: code

```
bugsModel <- function() {
    for (i in 1:I){      # loop over state-years
        for (j in 1:J){ # loop over parties (dummy selects those who ran that year)
            S[i,j] ~ dbin(pi[i,j], D[i])  # D is number SMD seats in obs. i's state
        }
        numerator[i,1] <- dummy[i,1] * exp( lambda[1] + rho * log(v[i,1]) )
        numerator[i,2] <- dummy[i,2] * exp(             rho * log(v[i,2]) )
        for (j in 3:J){
            numerator[i,j] <- dummy[i,j] * exp( lambda[j-1] ) * v[i,j]^rho
        }
        for (j in 1:J){ # loop over parties (dummy selects those who ran that year)
            d1[i,j] <- dummy[i,1] * exp( lambda[1] ) * v[i,1]^rho
            d2[i,j] <- dummy[i,2]                    * v[i,2]^rho
            d3[i,j] <- dummy[i,3] * exp( lambda[2] ) * v[i,3]^rho
            d4[i,j] <- dummy[i,4] * exp( lambda[3] ) * v[i,4]^rho
            d5[i,j] <- dummy[i,5] * exp( lambda[4] ) * v[i,5]^rho
            d6[i,j] <- dummy[i,6] * exp( lambda[5] ) * v[i,6]^rho
            d7[i,j] <- dummy[i,7] * exp( lambda[6] ) * v[i,7]^rho
            denominator[i,j] <- d1[i,j]+d2[i,j]+d3[i,j]+d4[i,j]+d5[i,j]+d6[i,j]+d7[i,j]
            pi[i,j] <- numerator[i,j] / denominator[i,j]
        }
    }
    ### priors
    for (p in 1:6){ # there are 7 party labels in the 3-election data, PRI is reference
        lambda[p] ~ dnorm( 0, tau.lambda )
    }
    tau.lambda <- pow(.25, -2)
    rho ~ dexp(.75) # this has positive range, median close to 1, mean 1.25, max 4.5
}
```

Appendix 2: elasticity

Compare this to Linzer (2012).

How elastic a district is to a party's statewide (nationwide?) vote swings is interesting. Elasticity should shape redistricting preferences. A district is highly elastic for the PAN when small shifts in the party's vote statewide correspond to sharp district vote hikes. It is inelastic when it corresponds to more modest district vote changes. Negative elasticity is even conceivable, the district vote growing when the rest of the state shrinks. Local effects on mobilization and voting can move against state effects. If every *sección* in the district is a microcosm of the state's electorate, unit elasticity ensues.

The measure regresses a party's three-year vote change in the *sección* Δ_s on the the parent state vote change Δ_e thus:

$$\Delta_s = \sum_{d=1}^{D_e} \alpha_d + \beta_d \Delta_e. \tag{3}$$

Fixed effects for each district are considered, fitting separate α_d and β_d regression coefficients for every district (indexed d). The model is estimated for every state separately because doing it nationwide involves too many *secciónes* (67k) and parameters (600) for my machine.

References

Altman, Micah, Eric Magar, Michael P. McDonald and Alejandro Trelles. 2014. "The Effects of Automated Redistricting and Partisan Strategic Interaction on Representation: The Case of Mexico." Presented at the 2014 Annual Meeting of the American Political Science Association, Washington DC.

Altman, Micah and Michael P. McDonald. 2011. "BARD: Better Automated Redistricting." *Journal of Statistical Software* 42(4):1–28.
URL: *http://www.jstatsoft.org*

Ames, Barry. 1970. "Bases of support for Mexico's dominant party." *American Political Science Review* 64(1):153–87.

Balinski, Michel L. and H. Peyton Young. 2001. *Fair representation: Meeting the ideal of one man, one vote.* 2nd ed. Washington D.C.: Brookings.
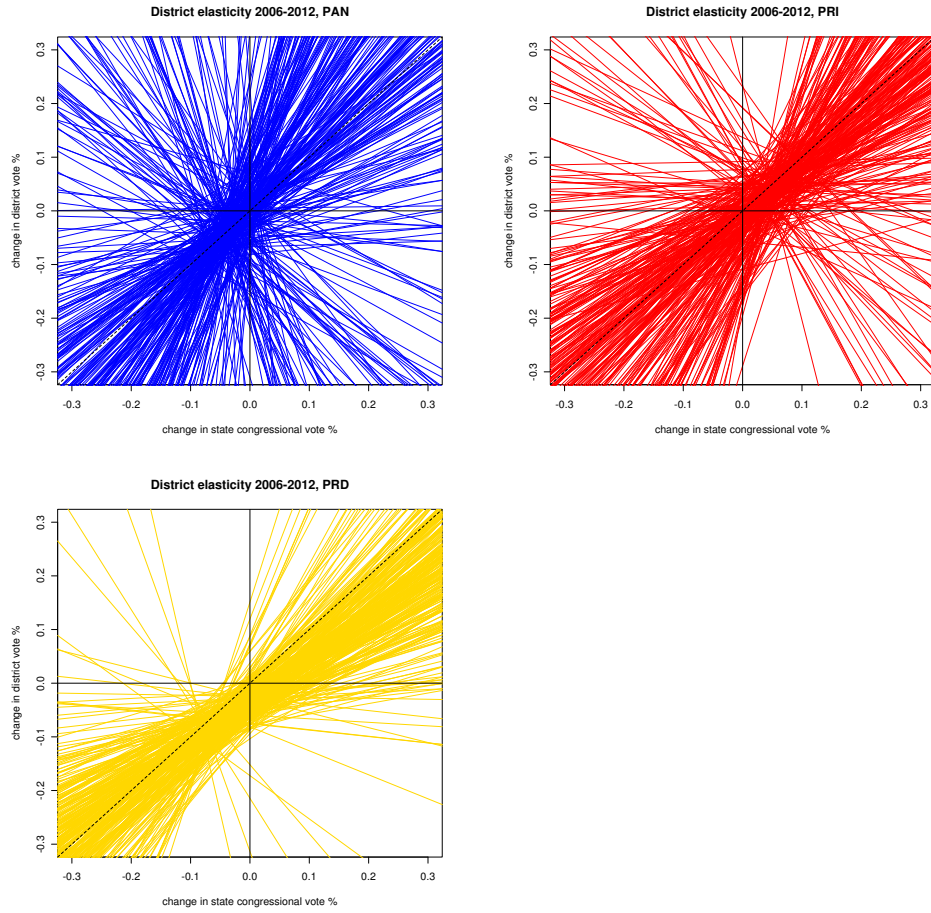
Figure 6: Parties' district elasticities

Balinski, Michel and Victoriano Ramírez González. 1996. "A case study of electoral manipulation: The Mexican laws of 1989 and 1994." *Electoral Studies* 15(2):203–17.

Calvo, Ernesto and Juan Pablo Micozzi. 2005. "The Governor's Backyard: A Seat-Vote Model of Electoral Reform for Subnational Multiparty Races." *The Journal of Politics* 67(4):1050–74.

Cox, Gary W. 1987. *The Efficient Secret: The Cabinet and the Development of Political Parties in Victorian England.* New York: Cambridge University Press.

Cox, Gary W. and Jonathan N. Katz. 2002. *Elbridge Gerry's Salamander: The Electoral Consequences of the Reapportionment Revolution.* New York: Cambridge University Press.

Dahl, Robert. A. 1972. *Polyarchy: Participation and Opposition.* New Haven: Yale University Press.

Engstrom, Erik J. 2006. "Stacking the states, stacking the House: The partisan consequences of congressional redistricting in the 19th century." *American Political Science Review* 100(3):419–427.

Estévez, Federico, Eric Magar and Guillermo Rosas. 2008. "Partisanship in Non-Partisan Electoral Agencies and Democratic Compliance: Evidence from Mexico's Federal Electoral Institute." *Electoral Studies* 27(2):257–71.

Gallagher, Michael. 1991. "Proportionality, Disproportionality, and Electoral Systems." *Electoral Studies* 10(1):33–51.

IFE. 2013. "Acuerdo del Consejo General por el que se aprueba la propuesta de criterios para la división del territorio nacional en trescientos distritos (CG50/2013)." Instituto Federal Electoral `http://www.ife.org.mx`.

Jackman, Simon. 2000. "Estimation and Inference via Bayesian Simulation: An Introduction to Markov Chain Monte Carlo." *American Journal of Political Science* 44(2):375–404.

Johnston, Ronald J. 2002. "Manipulating Maps and Winning Elections: Measuring the Impact of Malapportionment and Gerrymandering." *Political Geography* 21(1):1–31.

King, Gary. 1990. "Electoral responsiveness and partisan bias in multiparty democracies." *Legislative Studies Quarterly* 15(2):159–181.

King, Gary and Robert X. Browning. 1987. "Democratic representation and partisan bias in congressional elections." *American Political Science Review* 81(4):1251–1273.

Linzer, Drew A. 2012. "The relationship between seats and votes in multiparty systems." *Political Analysis* p. mps017.

Loosemore, John and Victor J. Hanby. 1971. "The Theoretical Limits of Maximal Distorsion: Some Analytic Expressions for Electoral Systems." *British Journal of Political Science* 1(4):467–77.

Lujambio, Alonso and Horacio Vives Segl. 2008. From politics to technicalities: Mexican redistricting in historical perspective. In *Redistricting in Comparative Perspective*, ed. Lisa Handley and Bernard Grofman. Oxford: Oxford University Press.

Magar, Eric. 1994. Elecciones municipales en el norte de México, 1970–1993: Bases de apoyo partidistas y alineaciones electorales BA. thesis Instituto Tecnológico Autónomo de México.

Magar, Eric. 2015. The electoral institutions: party subsidies, campaign decency, and entry barriers. In *Mexico's Evolving Democracy: A Comparative Study of the 2012 Elections*, ed. Jorge I. Domínguez, Kenneth G. Greene, Chappell Lawson and Alejandro Moreno. Washington, DC: Johns Hopkins University Press pp. 63–85.

Mayhew, David R. 1974. "Congressional elections: The case of the vanishing marginals." *Polity* pp. 295–317.

Otero, Jimena. 2003. ¿Gerrymandering en México? La geografía política federal, 1994–1997 PhD thesis Instituto Tecnológico Autónomo de México.

Plummer, Martyn. 2003. JAGS: A Program for Analysis of Bayesian Graphical Models Using Gibbs Sampling. In *Proceedings of the 3rd International Workshop on Distributed Statistical Computing*. Vienna, Austria: .
URL: *http://www.ci.tuwien.ac.at/Conferences/DSC-2003*

R Dev. Core Team. 2011. "R: A Language and Environment for Statistical Computing." R Foundation for Statistical Computing `http://www.R-project.org`.

Rossiter, D.J., R.J. Johnston and C.J. Pattie. 1997. "Estimating the Partisan Impact of Redistricting in Great Britain." *British Journal of Political Science* 27(2):319–31.

Samuels, David J. and Richard Snyder. 2001. "The Value of a Vote: Malapportionment in Comparative Perspective." *British Journal of Political Science* 31(4):651–71.

Snyder, Richard and David J. Samuels. 2004. Legislative malapportionment in Latin America. In *Federalism and Democracy in Latin America*, ed. Edward L. Gibson. Washington, DC: Johns Hopkins University Press.

Su, Yu-Sung and Masanao Yajima. 2012. *R2jags: A Package for Running jags from R.* R package version 0.03-08.
URL: *http://CRAN.R-project.org/package=R2jags*

Szpiro, George G. 2010. *Numbers Rule: The Vexing Mathematics of Democracy from Plato to the Present.* Princeton NJ: Princeton University Press.

Taagepera, Rein. 1973. "Seats and Votes: A generalization of the cube law of elections." *Social Science Research* 2(3):257–75.

Trelles, Alejandro and Diego Martínez. 2008. Fronteras electorales: aportaciones del modelo de redistritación mexicano al estado de California Ba. thesis ITAM.

Tucker, Harvey J. 1985. "State legislative apportionment: legal principles in empirical perspective." *Political Geography Quarterly* 4(1):19–28.

Tufte, Edward R. 1973. "The relationship between seats and votes in two-party systems." *American Political Science Review* 67:540–554.