

# 37º Encontro Anual da ANPOCS

## ST 03 - Estudos Legislativos: avanços e perspectivas

### Does The Electoral Rule Matter for Political Polarization? The Case of Brazilian Legislative Chambers

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#### Abstract

This study explores the effects of electoral rules on political polarization in the Legislative branch. Since, in Brazil, the districts are the States, and Senators are chosen according to the plurality majority rule, while Representatives are chosen with a proportional rule, the comparison between chambers enables one to test whether the plurality majority rule induces politicians to have a less moderate behavior and whether the proportional rule has the opposite effect. In order to estimate these effects, roll call data from 1988 to 2010 was analyzed and legislators' ideal points were estimated using *WNOMINATE*. Evidence in favor of the hypothesis was found, although not in every circumstance.

**Key words:** Polarization, Electoral Rules, Roll Call, *WNOMINATE*.

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# 1 Introduction

This article explores the influence that two particular electoral rules may have in the political polarization. More specifically, the polarization in the Legislative chambers, measured by the way legislators vote in roll calls. I am going to explore how two different vote counting rules affect the relationship between legislators and their parties. This relationship is understood by the concept of polarization. When the members of one party vote in one way and the member of the other party vote in another way, and if this behavior is observed most of the time, then we say that these two parties are polarized. In a roll call vote, a legislator can either cast a “yea” or a “nay” vote. As this procedure is done repeatedly in one legislature, we can measure how similar, aggregated, or even polarized, are the members of two or more distinct parties. Many can be the causes of polarization. In McCarty, Poole, and Rosenthal (2006) the authors argue that income, immigration and campaign finance affect polarization. Here I am going to argue that the method of counting the votes by which a legislator is elected also have an effect in polarization. The relevance of such a study becomes noticeable when there is a designing or reformation of an electoral system, for one may want to know what are the practical consequences of different electoral rules. The seminal work in the literature on the topic is Duverger (1951), in which the author shows that plurality majority rule leads to political systems with two parties, whereas proportional rule enables multi-parti systems to continue its existence. Nonetheless, the relationship between electoral rule and legislative behavior had not yet being fully scrutinized. If the plurality majority leads to a less fragmented party system, it is reasonable to expect that the legislators of a party behave in a more loyal way under this rule. This hypothesis is investigated in this paper.

Electoral rules are frequently analyzed with regard to its normative features, such as representativity and rationality. However, it is important to understand what are the practical consequences a rule may have, such as the political polarization. The Brazilian case, studied here, is helpful to test the effect of two electoral rules on political polarization, plurality majority and proportional rule. I will show that members of Congress elected by the plurality majority rule behave more extremely than members elected via the proportional rule, *i.e.*, they vote more often with their party. As will be explained presently, the different electoral rules in Brazil take the same district and transform it either on single member or on a multimember district.

The study of polarization on U.S. Congress gained scientific rigor with both the application of spatial models and the empirical estimation of ideology using large data sets. This confluence resulted in the ubiquitous mode of analysis enabled by softwares like *NOMINATE* and *Optimal Classification*. In this study an extension of *NOMINATE* called *WNOMINATE* is used. *WNOMINATE* takes the roll call records of legislators and two policy dimensions as input, calculate their proximity to each other and give the position of legislators in the policy space spanned by those

dimensions. The two dimensions are the fiscal and social ones, and they are constrained by the unit Euclidean circle. The algorithm normalizes the positions such that politicians that are conservatives in both fiscal and social issues receive coordinates on the positive orthant. History, detailed theoretical explanation, as well as application of this methodology to American Politics can be found in Poole and Rosenthal (2007) and McCarty, Poole, and Rosenthal (2006)<sup>1</sup>

U.S. Congress presents an added difficulty when comparing chambers though, because the pool from where the subjects are drawn differs from the House to the Senate. The members of the House are selected in smaller districts, while members of the Senate come from the states. This is not the case in Brazilian congress, and this feature is explored here. Brazilian legislative elections on the federal level provide us with an institutional design well suited to test the effects of two electoral rules on political polarization, namely, the plurality majority rule and the proportional rule. The electoral features that enable this test to occur are: first, and most important, each state covers a single district only, and there is no further division within it; and second, the electoral rules differ from one chamber to the other. Hence, we have the same district as single-member district, in the Senate case, and as a multimember district, in the House case.

## 2 Literature Review

The first two pieces on the topic of polarization were Poole and Rosenthal (1984), that works with interest groups classifications of legislators' behavior, and Poole and Rosenthal (1985), that stated using roll-call data directly via *NOMINATE*. The seminal work on the whole polarization literature is Poole and Rosenthal (1997), revised in Poole and Rosenthal (2007). In this book the authors seek to understand the structure of congressional voting in U.S., and explain the political realignment in American history. The impact of committees and interest groups are also investigated. The main result of this research is the finding that American politics have had alternated times of polarization on the past, but that a strong and increasing polarization pattern has arisen in the last decades. Among the exogenous causes of this phenomenon are income inequality and immigration. A study that claims different findings on polarization of American politics is Evans (2003). The author uses alternative statistical methods, along with survey data, to argue that the American voters are not as polarized as legislators, when it comes to economic issues, but the polarization of voters on moral issues is increasing.<sup>2</sup>

In the present study we do not have necessarily the American case in mind, as we seek to unravel the existence of an institutional cause of polarization. Our research approach is reversed, we

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<sup>1</sup>Further theoretical and empirical developments about the U.S. Congress and American Politics using the same approach are exemplified by Brady and Han (2004), and Shor, Berry, and McCarty (2010).

<sup>2</sup>Another different way of investigating polarization of legislators is via discourse and textual analysis; a good example is Cormack (2011).

posit an institutional cause of polarization and look for an empirical validation of the hypothesis. Also, we are interested in the behavior of the legislators only, not of the voters.

The methodological foundations of the polarization research borrowed the Item Response Theory (IRT) from Psychology. In comparing attitudes among individuals towards similar questions, IRT provided a way of not only how to order subjects regarding their abilities, or preferences, but also how to measure the distance among those subjects. What political science researchers began to do, then, was to apply the IRT methodology to analyze and quantify ideological mappings, in Congress and Executive branches.<sup>3</sup> Firstly by the use of interest groups ratings of politicians, and afterwards by the use of roll call data via *NOMINATE*. A technical work on this issue, already made by a political scientist, is Poole (1984b).<sup>4</sup> Here we use roll call data, which became the standard way of investigate ideological mappings, for it is much more objective a data than interest groups evaluations. An introductory tutorial of the methodology used in the classification of legislators using roll call data is Everson, Valelly, and Wiseman (2008/2009); an intellectual, and as non-technical as it can ever be, recount on the origin and development of the *NOMINATE* family of methods is Poole (1998/1999).<sup>5</sup>

There remains only a few studies dealing with the topic of polarization in Brazilian politics. Leoni (2002) was the first study to bring the *NOMINATE* technology to Brazilian politics. That article describes the ideological map of parties in the House and the first three presidents after redemocratization, covering the 1991-1998 period. His results are in favor of a low dimensionality with the left-right spectrum explaining most of the legislative behavior. Morgenstern (2004) looks the period from 1995 to 1998 and argues that the Congress has more power than the President when it comes to law making. Desposato (2006b) studied the same legislatures as Morgenstern, but to test a party switching model.

Lauderdale and Zucco Jr. (2010) use survey data to correct ideological mappings using roll call data and find that there exist also a government-opposition cleavage in Brazilian congress, apart from the left-right dispute. Our research will encompass this issue when dealing with coalitions instead of parties. Cunow and Desposato (2011) use campaign contributions for the 2010 presidential, gubernatorial and congressional elections to estimate ideal points in Brazil. Their approach enables them to grasp also the ideology of the candidates who lost in the elections. They find mixed evidence of the impact of electoral rules on polarization. The first attempt to investigate

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<sup>3</sup>For the classification on the Judiciary branch see Bailey (2007).

<sup>4</sup>It is noteworthy that all this literature has relied on the assumption that the appropriate distance to study decision theory is the Euclidean one. In Eguia (2012) the author claims that the Minkowski distance with  $\delta = 1$  is better suited to describe utility functions. Let the vectors  $x^1, x^2 \in \mathbb{R}^n$  represent the ideal points of legislators 1 and 2, the Minkowski distance between them is defined by  $\|x^1 - x^2\|_\delta = (\sum_{i=1}^n (x_i^1 - x_i^2)^\delta)^{1/\delta}$ . A first attempt to find the best Minkowski distance to use in estimating ideological positions among legislators, made on an exploratory project by Jon Eguia, Howard Rosenthal, Keith Poole, David Armstrong, and the author of this paper, found that the distance with  $\delta = 1.5$  is the best in predicting legislators behavior.

<sup>5</sup>These two pieces, the primer and the intellectual history, can be found in *voteview.com*.

the effect of electoral rules in polarization in Brazil is Desposato (2006a). In this study the author uses a dispersion model to assess the legislators' behavior on the Senate and the House. He finds no evidence of impact of electoral rules on dispersion of legislatives of the same party; only 3 legislatures were analyzed, though. The present paper tries to improve on that study by analyzing all the 6 previous legislatures, and also by taking the coalitions into consideration. We find mixed evidence in favor of the existence of impact of electoral rules on polarization. In Poole (2003) the author argues that congress members in U.S. die with their ideological boot on, that is, once in office, they tend to remain close to their original ideological position throughout time. A similar study in the Brazilian case is yet to be done. Another possible research topic is to compare the polarization of legislators in state chambers with the ones in the federal chamber. A study in the polarization of state legislators in American states is Shor and McCarty (2011). One could also replicate such a work for the Brazilian case.

## 2.1 Theory

The Brazilian political system is closer to the American one than to most of the European ones. That means that the presidential elections are separated from the congressional ones, not throughout time, but votewise. Regarding congressional elections, though, Brazilian electoral rules vary according to the chamber. In Brazil, the district from which the representatives are elected is the same political territory as the state, from which the senators are elected. In other words, the states are the districts. But in the elections to the Senate a plurality majority rule is used, and so the candidate with more votes is elected, as in a single-member district,<sup>6</sup> while in the elections for the House a proportional rule is used, *i.e.*, the state becomes a multimember district; and thence the representatives of that district, or state, are elected in accordance with the proportion of votes their parties receive.<sup>7</sup>

The assignment to either one of the candidacies is a joint decision made by the candidate and the party; nonetheless, the party has the final authority in determining who runs for the office. From the point of view of the candidate, there could exist a self selection problem if either one of the offices was a better position than the other because then everyone would want to run for that best position. From the party's perspective, however, a candidate should be assigned to an office according with his or her chances of winning the election and the prospective behavior during

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<sup>6</sup>When there are two Senate seats in dispute we must call it a two-member district. Nonetheless, the theory and results that will be presented here rely more on the quantitative distinction between the electoral rules rather than on the qualitative ones, if any.

<sup>7</sup>As of the time this paper was written, the Brazilian system was that of open list, in which the voter votes for the party, but can also, in addition, vote for a particular candidate on the list, determining then the final order. The other proportional rule system is that of a closed list, in which the party orders the candidates and the voter cannot cast a vote for a particular member of that list, more precisely, the voter does not influence the final order.

incumbency. These issues are explored below in greater detail.

Under common sense, the Senate office is usually understood as a better position than the one in the House. Arguments in favor of that are, first of all, the mandate is eight year long, compared with the four year term in the House; second, the total number of senators is less than 16% the number of representatives, so the senators' vote on a bill will likely be much more valuable. While there is no discrepancy between salaries, the senators do enjoy a larger sum of money to spend.<sup>8</sup>

However, it is more difficult to obtain the party's nomination to run to the Senate, for there are only one or two seats per state per election, depending on the election year - each four years either one third or two thirds of the Senate seats are open. In the House, all seats open every four years, and the seats per district vary from eight to 70. These numbers follow a distorted proportionality with regard to the states populations.<sup>9</sup> In addition, each party can launch only one candidate per seat for the Senate, but 50% more candidates than the number of seats for the House. Reelection works exactly as in the Senate, *i.e.*, the incumbents can remain in office for an undetermined number of terms.

Moreover, there is one feature that has not been taken in consideration in this discussion; the ability to vote with the part. Note that for a politician who is not a head of a party, his or her power in determining the party's agenda is small. Then, if the politician's policy preferences are not exactly the same as the party ones, there will be a cost, in terms of effort, for the politician to support the party's exact agenda. The partisan behavior then, will be a function of the distance between the politician and the party, and the value he or she places in policy and office holding. If someone places more value in the office than in the policy, then it will be easier to follow the party, holding fixed the ideological distance between the party and the politician. On the other hand, if we hold the value placed in the office fixed, then the closer party and politician are ideologically, the easier for him or her to vote with the party. This will be an important issue, as we will see presently, for the party will expect a "better" behavior from the Senators than the Members of the House.

Hence, when a politician is deciding what kind of nomination to procure, it is not clear if the present expected value of a seat in the Senate is always greater than a seat in the House, *i.e.*, for

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<sup>8</sup>This and other information about the costs of Brazilian government, in all of the three branches in the federal level, can be found in [www.transparencia.org](http://www.transparencia.org).

<sup>9</sup>Although somewhat proportional, the seats per state are limited from below by eight, and limited from above by 70. By way of example, Roraima, a low populated state, counted in 2002 with roughly 208,000 voters and eight seats, while São Paulo, the most populous one, counted with roughly 26,000,000 voters and only 70 seats. If São Paulo were to have the same proportion of seats as Roraima did, it would have had 984 seats. This distortion is irrelevant for policy making though. The legislative behavior is, for the most part, partisan, not divided statewise. Representatives vote partywise more often than statewise, even if the policy is not beneficial to his or her state. These results can be found in Mignozzetti, Bernabel and Gaudino (2011). In this work a Monte Carlo simulation was ran using *WNOMINATE* estimates where the representation proportions were corrected and the new seats were filled with the proportions each party had previously.

every politician is better to try to run for the Senate than the House.<sup>10</sup> As we will show presently, the different offices are a better match to different politicians, accordingly to their ability in fulfill party's expectations.

From the point of view of party, though, a seat in the Senate is much more valuable than a seat in the House. One vote in the Senate counts for  $\frac{1}{81}$  of the total of votes, while one vote in the House counts only for  $\frac{1}{516}$ . It is true that when the party's heads are deciding among persons to nominate as candidates, they must seek to maximize their vote counting. Taking only this rationale into consideration, a more notorious, powerful and experienced politician should have precedence in running for the Senate. However, winning features are of no help if the candidate, once elected, turns his or her back on his or her party and votes with the opponents. In this way, it is fundamental that the party trusts someone before giving him or her the opportunity to run for the seat. Note that a defection by a House member would be less problematic for the party, since there are other representatives from the same party to pursue the party's agenda in the House. Moreover, the popularity of a candidate is something that affects the composition of the House more than that of the Senate. This is because a popular candidate in a party list helps electing more candidates of the same party or coalition.

Therefore, the electoral rule may be the very mechanism through which confidence and loyalty bounds are tied together, in other words, the channelling of polarization may be influenced by the electoral rule. Suppose that for any reason a politician secured his or her indication as candidate. Once in the office, the candidate should reciprocate, voting with his or her party, in order to ensure that, in the next election, the party will enable him to defend his or her seat. Hence, it can very well be the fact that, as a more restrictive procedure, the plurality majority rule, used in the election to the Senate, induces a more partisan behavior. Of course a person can be loyal to a party before even becoming a candidate, and this loyalty must be what, among other things, make the party give him or her an opportunity.

This framework resembles the screening problems in which a principal offers a menu of tasks with different levels of difficulty, and the agent self-select for a task according to his or her ability. Here, the two tasks would be the run for a seat and the appropriate behavior as an incumbent in

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<sup>10</sup>This cost/benefit relation is then blurred because the problem was pushed to an individual level, not the aggregated one anymore. Such a micro-causation reasoning will remain black-boxed in this study because we are more interested in the aggregated effect of electoral rules *per se*, not in individual evaluations of office and policy. What matters for the present study is that different rules select different behavior. Anyway, one can estimate an expected utility function to test the hypothesis that the seats in the Senate are more attractive a position. A possible model to start could take the senator's eight-year salary and multiply it by the probability of being nominated to run for the office and the probability of winning the election, all this multiplied by the party's expectation of loyalty and, finally, multiplied by the inverse of the ideological distance between the prospective candidate and the party. For the expected utility of a House seat one could take the four-year salary of a representative and multiply it by the probability of securing nomination by the party and the probability of being elected, all this multiplied by the party's expectation of loyalty and, finally, multiplied by the inverse of the ideological distance between the prospective candidate and the party. It is not within the scope of this work to run this estimation.

the Senate and the correlate for the House. The candidate then would evaluate not only his or her previous characteristics like popularity and partisanship history, but also how would he or she behave once in the Senate or House. As a defection in the House is less harmful than a defection in the Senate, we can call the assignment of a candidate to run for the House a *lower task*; and the assignment of a candidate to run for the Senate a *higher task*.

Once elected, any politician should abide by the reelection rationale mentioned above. The final test between the previous and post election effects could be done estimating how the same person behaves in the House and in the Senate. This task is left for a future study.

The same reelection logic does not work as well for the House, though, because a good candidate can bring benefits to the party even without being loyal. As the electoral rule for the House is proportional with an open list, a strong candidate may pull some other winners with him, and also the vote counts for a smaller fraction of the total. It therefore follows that even if this same candidate should misbehave in his or her seat, the party could internalize this cost, for the representative could again bring more elected candidates with him the next time around.

## 3 Analysis

### 3.1 Data

The study case explored in this article was done with data from 1989 to 2010. This covers almost the whole new democratic period, which started with the new Constitution and presidential elections in 1989. Also, data from the Senate was analyzed, which was not done yet.

Elections to Congress occur every four years. 513 representatives are elected for a four-year term and either 54 or 27 senators are elected for an eight-year term. Some members of Congress left it before the completion their terms due mainly to certain reasons, such as taking an office at the Executive branch, running for governor, or being expelled from Congress by its colleagues in a political judgment. Hence, during each legislature, we may have more than 513 representatives and 81 senators. In the period studied, the House had 1958 representatives and the Senate had 273 senators. The House members voted on 1611 roll calls, while the senators voted on 752 roll calls. On a roll call vote, the legislator is required to cast a vote, and this vote is recorded, while in other types of procedures they may not need to do it. As an example, in a voice vote, votes are counted, but not recorded; in a proxy vote, a legislator tells another one to vote for her. In extreme, there can exist the case in which only the leaders of the parties vote, and the vote of the regular legislators are assumed as in accordance with the one casted by the parties' leaders.

Most bills start in the House and, if approved, go to the Senate. If the Senate approves the bill, then it becomes a law. If the Senate makes modifications though, it goes back to the House and



has to be voted again. This is the reason why the House has more roll calls than the Senate.

### 3.2 The Empirical Test

The empirical test proposed here does not have a control group *per se*, for any electoral rule could be seen as the treatment. Hence, this is an test where there are actually two different treatments, the plurality majority rule and the proportional one.<sup>11</sup> For the sake of clarity though, the plurality rule is denominated as the treatment and the proportional rule as the control. Hence, the legislators in the Senate are considered as the treatment group and the legislators in the House are considered as the control group.

The legislators' behavior is explored in terms of ideal points, a measure of distance among them as estimated by *WNOMINATE* package in *R*.<sup>12</sup> The *WNOMINATE* ideal points calculated here are two-dimensional and lie in the unitary circle as seen in the figures 1 and 2. The estimates displayed in the tables 1 and 2 are only the ones in the first coordinate; this coordinate represents the economic dimension.<sup>13</sup> A left-wing legislator, or, in the case of this study, party, will probably lie in the  $[-1, 0]$  interval. Conversely, a right-wing legislator or party should lie in the  $[0, 1]$  interval. Once the points each legislator has in the coordinates are estimated, the comparison is straightforward. One can look to the aggregated ideal points and see if the treatment has a significant effect in polarization, *i.e.*, if the estimates for a left-wing party are further to the left in the Senate than in the House, and if the estimates for a right-wing party are further to the right in the Senate than in the House.

Four estimations were ran for each chamber separately. First, the clustered parties' ideal points means over the whole period were estimated. Then, those means were disaggregated by legislature. Thirdly, the legislators were aggregated according to the coalitions they belonged to, *i.e.*, they either were members of the government coalition or not, and the effect was estimated for the whole period. Finally, the coalitions' behavior were estimated for each legislature separately. The estimations were ran for every member of the Congress, and then everyone participates in the results for the coalitions. However, the results for the parties cover only the main parties, Worker's Party (PT), Social Democracy (PSDB), Liberal Front (PFL-DEM) and Democratic Movement (PMDB).<sup>14</sup> Af-

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<sup>11</sup>Even though I use terms like *control* and *treatment* here, I do not have a randomized-experimental study. This would be the best way to test whether the electoral rules influence political polarization or not. The difficulty in doing such a study is to have candidates randomly assigned to run for the Senate and for the House. One way to approximate this feature, very imperfectly however, is to perform a matching analysis. This is left for a future study.

<sup>12</sup>A good reference on the measurement methods and software is found in Poole (2005). The reference for the *WNOMINATE* package is Lo (2007).

<sup>13</sup>The second dimension represents where the legislator or party dwells in the social liberal-conservative spectrum.

<sup>14</sup>The acronyms PT, PSDB, PFL-DEM and PMDB stand, respectively, for *Partido dos Trabalhadores*, *Partido da Social Democracia Brasileira*, *Partido da Frente Liberal-Democratas* e *Partido do Movimento Democrático Brasileiro*.

ter the redemocratization, Brazil have had more than two dozens of parties with representation in the Congress, but the four mentioned above count for roughly 60% of the members of the Congress. Among these main four, PT has always been the furthest to the left while PFL-DEM has always been the furthest to the right. PSDB shifted, in 1995, from the center-left to the center-right and has maintained this position until now. PMDB shifted from the center-right to the center-left in 2003 and has since remained so.

### 3.3 Hypothesis

The set of hypothesis derived from the theory and about to be tested is:

1. *The party's mean ideal point for the senators lies to the right of the party's mean ideal point of the representatives, for a right-wing party;*
2. *The party's mean ideal point for the senators lies to the left of the party's mean ideal point of the representatives, for a left-wing party;*
3. *The coalition's mean ideal point for the senators lies to the right of the party's mean ideal point of the representatives, for a right-wing coalition;*
4. *The coalition's mean ideal point for the senators lies to the left of the party's mean ideal point of the representatives, for a left-wing coalition.*

The ideal experiment to test whether the electoral rule affects the legislator's behavior would require having the same legislator being elected for both chambers at the same time, through different electoral rules, and voting on the same bills. This is probably not how most of parliamentary bodies throughout the world work, and certainly is not how it works on the Brazilian case. Moreover, even if such a fiction was real, there would still exist a remaining problem, the stable unit treatment value assumption would be violated. Note that the behavior a legislator would present on a chamber could, and probably would, be correlated with her behavior on the other chamber. It is unlikely that a person would vote differently on the same issue, at the same time, just because the bill was voted on different chambers. Therefore, we would face an influence of treatment on control group, or vice-versa.

An alternative would be to compare the behavior of the legislators that transit between the chambers across time. It is not unusual having representatives being elected for the Senate. One problem with this design is that the legislator would face different bills once in different chambers, for he or she was going to be member of the chambers at different times, and the bills are usually voted on during the same legislative period. Also, the problem of correlated behavior mentioned above would persist. Besides these problems, such a dynamic estimation can be preformed, with

the use of *DW-NOMINATE*, for example. *DW-NOMINATE* can estimate the individual legislator's behavior across time; the software is not openly available though.

With the impossibility of a natural experiment, the identification strategy relies on the Brazilian electoral and legislative design. Remember that for electoral purposes, the only thing that distinguishes how legislators are elected for the different chambers are the electoral rules. That means that the district and state are the same thing, and then there is no demographic confounders in the analysis, for senators and representatives from the same state face the same constituency.

Moreover, every bill has to be voted on both chambers in order to become law, and if one chamber makes amendments to a bill, the amendments also have to be voted on the other chamber. Hence, it is not the case that polarization occurs because of the kind of issues raised on the different chambers. These characteristics provide us with a suited environment to test the effect of the electoral rules on polarization. Evidently, a better test would have legislators being randomly assigned to run for an office across different chambers. However, if there is a selection problem in the sense that one type of legislators select itself, or is selected by the party, to one of the chambers, while another type is assigned to the other chamber, this does not necessarily invalidate the hypothesis that the electoral rule is the polarization mechanism. If these types are in some manner correlated with the electoral rule, then the hypothesis remains sound. This possible confounder will last black boxed until data is gathered on possible causes of selection bias, for example, seniority in the party, previous loyalty, popularity, and economic power. Such a dataset is not yet available though.

### 3.4 Results

The main hypothesis being tested in this study is that the Senate treatment, *i.e.*, the plurality majority rule, has a positive effect in causing polarization. Two sets of strategies were used to estimate the effect of electoral rule on polarization; the aggregated effect in the whole period, and the effect separated by legislature. Inside these two sets, a further division is done taking the either the four main parties individually, or the coalitions they formed. The party or coalition ideological mean was estimated using *WNOMINATE*. This algorithm takes roll call data to order legislators relatively to their peers. Even though the whole sorts of bills that are voted constitute a multidimensional space, it is usually the case that the behavior of legislators in any bill is predictable by one or two dimensions, the economic and social ones. The accuracy of this predictions will appear presently. More than ordering the legislators, *WNOMINATE* estimates the Euclidean distance among them in two dimensions, and in this way every individual is located on a unit disc. For the numerical analysis that follows, only the legislators' coordinate on the first dimension was taken into consideration. The first dimension, the economic one, describes how legislators locate on the usual left-right spectrum, and is the most explicative, or predictive, dimension. This means that the behavior of a legislator in this dimension can be used to predict how the same legislator is going

to vote on other dimensions. Anyway, for the sake of rigor, one may say that here polarization is being investigated regarding the economic spectrum. There is evidence that the main hypothesis is true, *i.e.*, the plurality majority rule has a positive effect on polarization, although not all of the findings are unequivocal in confirming that..

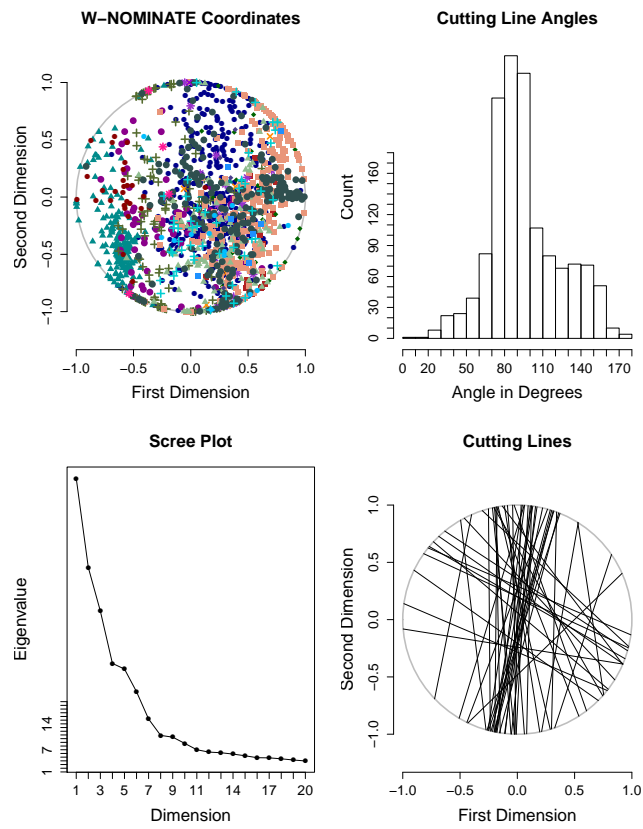
### 3.4.1 Aggregated Effect for Parties

Figure 1 is a graphical summary of the calculations for the House in the 1989-2010 period. The coordinates circle contains the disposition of the members of the House with a different symbol for each party. PT is represented by the green triangles, PSDB are the green circles, PFL-DEM are the orange squares and PMDB are the blue circles. Note that PT members are dispersed on the left, PSDM and PMDB members somewhat on the center, and PFL-DEM members on the right. This is just a descriptive plot to help the visualization of legislator in the ideological space. As the number of representatives is much larger than the number of senators, a comparison between the coordinates disposition on figures 1 and 2 is not sufficient to test the hypothesis. The plot showing cutting line angles indicates that the first dimension is well suited to explain the cleavage in the House, *i.e.*, most of the bills separate legislators in the economic left-right spectrum. This plot just shows the distribution of cutting lines. We can see the cutting lines plot below, and an explanation will be given presently. The scree plot shows the factor analysis in which gains in explanation are still to be obtained when we increase the dimensionality of the legislatures in the model. In contrast to U.S. legislatures, Brazilian legislatures present a higher dimensionality, for the line flattens out only after the 8<sup>th</sup> value. At each value on the horizontal axis, the value on the vertical axis shows what is the gain in explanation moving away from the previous dimensionality. We can see that substantive gains in explanation can be achieved using 2 instead of 1 dimension, or 4 instead of 3, for example. After the 8<sup>th</sup> dimension no significant gain is obtained. Still, for the purposes of this study, this higher dimensionality does not represent a threat, since finding polarization on the first dimension will already evince confirmation of the hypothesis. Finally, the cutting lines displayed are a random sample of how legislators were separated in the roll calls, and we can again see that most of them separate legislators on the first dimension. As the Euclidean distance is used, these lines are the separating hyperplanes in two dimensions.<sup>15</sup> Note that superimposing the cutting lines plot on the coordinates plot result in the separation of PT members and PFL ones. Even the more horizontal lines separate these two sets of legislators, which indicates that among the four main parties in Brazil, PT is the most fiscal and social liberal party, and PFL-DEM is the most fiscal and social conservative one.<sup>16</sup>

<sup>15</sup>A hyperplane  $H_a^\alpha \in \mathbb{R}^n$  is the set of points  $\mathbf{x} \in \mathbb{R}^n$  such that  $\langle \mathbf{a}, \mathbf{x} \rangle = \alpha$ , with  $\mathbf{a} \in \mathbb{R}^n$ , and  $\alpha \in \mathbb{R}$ ; *i.e.*,  $H_a^\alpha = \{\mathbf{x} : \langle \mathbf{a}, \mathbf{x} \rangle = \alpha\}$ . The hyperplane  $H_a^\alpha$  separates two sets  $\mathbf{X}$ , and  $\mathbf{Y}$  if for every  $\mathbf{x} \in \mathbf{X}$ ,  $\langle \mathbf{a}, \mathbf{x} \rangle \geq \alpha$  and, for every  $\mathbf{y} \in \mathbf{Y}$ ,  $\langle \mathbf{a}, \mathbf{y} \rangle \leq \alpha$ .

<sup>16</sup>The term *liberal* here carries the meaning it has on the American political debate.

Figure 1: House 1989 - 2010



*WNOMINATE* applied to the 1858 legislators and 1611 votes in the House from 1989 to 2010 have a Correct Classification of 89% of the votes in a single-dimension linear model and 90% in a two-dimension linear model. This means that the model predicts correctly how a legislator is going to vote. When using only one dimension the model is wrong in only 11% of the predictions, and 10% when using two dimensions. There are two more technical measures that should be reported, the  $APRE = 0.55$  and  $APRE = 0.59$  for one and two dimensions respectively, and  $GMP = 0.76$  and  $GMP = 0.79$  going from one to two dimensions.<sup>17</sup>

Figure 2 shows a similar picture for the Senate. Now the orange squares represent the PT, the green diamonds are the PSDB, the green triangles are the PFL-DEM and the green crosses are the PMDB. Again, the coordinates, cutting line angles, and cutting lines plots show that the first dimension does a good job in separating legislators that behave in a polarized way. In the same period, for 273 legislators and 752 votes in the Senate, the Correct Classification in one and two dimensions are 88% and 89%, the APRE's are 0.44 and 0.46 and the GMP's are 0.74 and 0.77.

Table 1 shows the first coordinate estimates for the parties' aggregated means taking the whole period of study into account. All of the estimates are as expected. The PT's coordinate for the Senate is to the left of the PT's coordinate for the House, and for all the other three parties, the coordinate for the Senate is to the right of the coordinate for the House. Remember that PMDB was a center-right party for the majority of the time period considered in the study, so it is reasonable to get positive coordinates estimates for it.

A *t*-test was ran with the null hypothesis being that there was no increase in the "extremeness" in the legislators' behavior in the Senate compared to the House. The increase in the polarity was found to be statistically significant with a 95% level for PSDB and PFL-DEM, with a 90% level for

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<sup>17</sup>The Aggregate Proportional Reduction in Error (APRE) explains the behavior of legislators who voted with the minority. This measure is defined by

$$APRE = \frac{\sum_{j=1}^q (\text{minority vote} - \text{classification errors})_j}{\sum_{j=1}^q (\text{minority vote})_j}.$$

Here the results are 0.55 and 0.59 in one and two dimensions, respectively. An APRE equal to zero means that the models does not explain anything, while an APRE equal to 1 means that the model provides a perfect classification. The Geometric Mean Probability (GMP) demonstrates whether the overall classification is accurate, with the model being better than an educated guess. In other words, a fair coin toss would correctly predict half of the time how a legislator vote, the GMP shows whether the model is better than a fair coin. Formally, following Poole (2005), we have that:

$$L = \sum_{i=1}^p \sum_{j=1}^q \sum_{\tau=1}^2 C_{ij\tau} \ln P_{ij\tau},$$

where  $\tau$  is the index for Yea and Nay,  $P_{ij\tau}$  is the probability of voting for choice  $\tau$ , and  $C_{ij\tau} = 1$  if the legislator's actual choice is  $\tau$ , and 0 otherwise." Then we have

$$GMP = e^{L/pq}.$$

It also shows, for the numbers found, that the gain in explanation with an increase in the dimensionality is small.

PT and statistically insignificant to PMDB. This statistical analysis therefore presents evidence that the the legislators in the Senate are more polarized than in the House, and, therefore, hypotheses 1 and 2 are not falsified by these results. This results become blurred, however, when parties are disaggregated by legislature and also when studying the coalitions instead of parties.

Figure 2: Senate 1989 - 2010

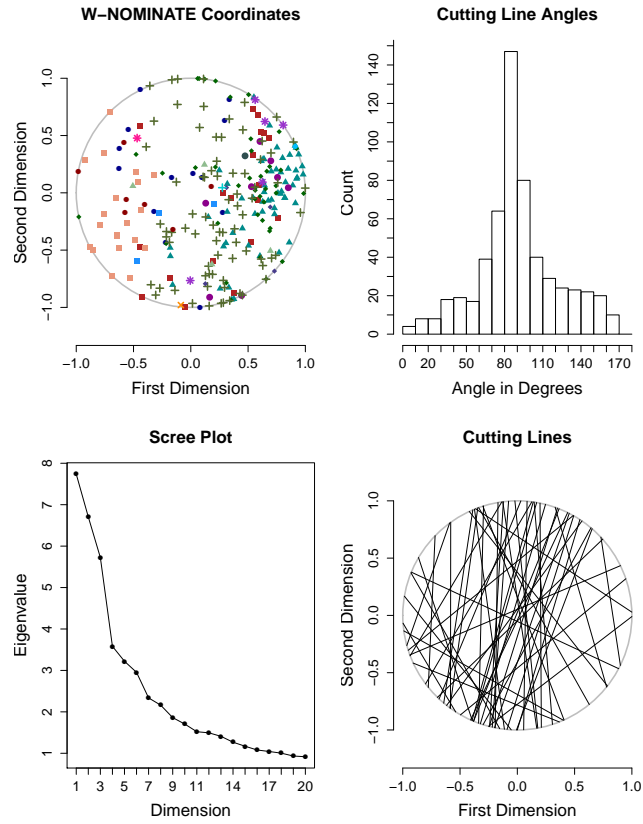


Table 1: Party-Clustered Effect (1989-2010): 1<sup>st</sup> Coordinate mean

	Party			
	PT	PSDB	PFL-DEM	PMDB
House	-0.60 (0.19)	0.36 (0.37)	0.51 (0.25)	0.21 (0.25)
Senate	-0.63 (0.17)	0.43 (0.39)	0.60 (0.29)	0.24 (0.33)
<i>t-test: Senate - House</i>				
<i>sample mean</i>	-0.03	0.11	0.10	0.02
<i>95% C.I.</i>	(-0.07, 0.00)	(0.04, 0.18)	(0.06, 0.14)	(-0.02, 0.06)
<i>p-value</i>	0.09	0.00	0.00	0.42
Cells show <i>WNOMINATE</i> mean aggregate estimates with standard error in parenthesis.				



### 3.4.2 Time Series for Parties

Below, the effect by party in each legislature separately is explored. There were six legislatures in the period studied, two chambers and the categorization party/coalition. Hence, there are 24 sets of estimates. In practically all of them, the Correct Classification is around 90%, the APRE is 0.6 and the GMP is 0.75. The exception is with the Senate, where the APRE for the years 1991-1994 is around 0.2.

Figures 3 and 4 display the behavior of each party separately, in the House and in the Senate. They cover all the legislatures since the redemocratization, excluding the current one, which started in 2011 and is not included in the data set.<sup>18</sup> The previous result remains unequivocal to the behavior of legislators from PT only. In every legislature, the senators from PT were more polarized than their relatives in the House, *i.e.*, the PT's coordinates in the Senate are to the left from the PT's coordinates in the House.<sup>19</sup> The hypothesis is verified for PSDB in the first three legislatures only, and fails for the last three. PFL is in accordance with the expectations in the periods 1989-1990 and 1999-2002 only. Finally, PMDB has a more polarized behavior in the Senate in 1995-1998, 2003-2006 and 2007-2010. As we have the means in table 1 describing a different picture than the time series, it is reasonable to think that, in periods when the polarization in the Senate is higher than in the House, we have that the effect of the polarization in the Senate is stronger than the effect of polarization in the House. This is another route left for further studies.

As a simple measure of success of this hypothesis, the instances where the polarization was as expected were counted and divided by the opportunities to be as expected, *i.e.*, the number of times a party behaved as it "should" was added and divided by the total number of possible times a party could have behaved as it "should". As a result, was discovered that, out of 23 opportunities to evidenciate the claim, 13 successes were observed; a 56% rate of success. Separating this by parties' orientations, the right-wing parties had 14 opportunities and the polarization in the Senate was higher in only four instances. It is noteworthy though, that for the left-wing parties, the behavior was in accordance with the hypothesis in all nine opportunities. This may indicate that there is a heterogeneous treatment effect, that affects the legislator behavior more strongly when this person is member of a left-wing party.

### 3.4.3 Aggregated Effects for Coalitions

Although a presidentialism, Brazil shares an important feature with parliamentary systems in the Congress, the multiparty dynamics. Given the multiparty system, the presidents had to gather

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<sup>18</sup>In 1986 the 48<sup>th</sup> legislature was elected with the main task of writing the current Constitution. That was done in 1987-88, the presidential elections took place in 1989 and the first directly elected president since 1961 began his mandate in March 1990. The data set keeps records from the roll calls since 1989, the year the Constitution entered into force.

<sup>19</sup>PT had no senator in the 1987-1990 legislature, so a comparison is not possible for this party in that period.

Figure 3

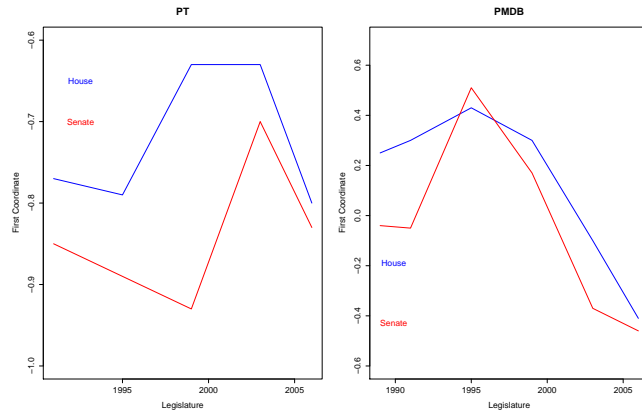


Figure 4

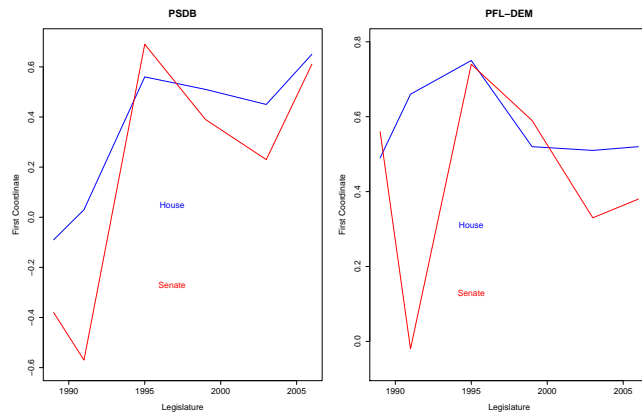


Table 2: Coalition-Clustered Effect (1989-2010): 1<sup>st</sup> Coordinate mean

	Coalition	
	Left	Right
House	-0.08 (0.45)	0.36 (0.30)
Senate	-0.04 (0.52)	0.43 (0.35)
<i>t-test: Senate - House</i>		
<i>sample mean</i>	0.05	0.06
<i>95% C.I.</i>	(-0.01 , 0.10)	(0.03 , 0.10)
<i>p-value</i>	0.09	0.00

Cells show *WNOMINATE* mean aggregate estimates with standard error in parenthesis.

votes in Congress beyond their own parties in order to pass their legislative agendas. Since every government had to form a coalition, one can separate the legislators as in a two-party system.

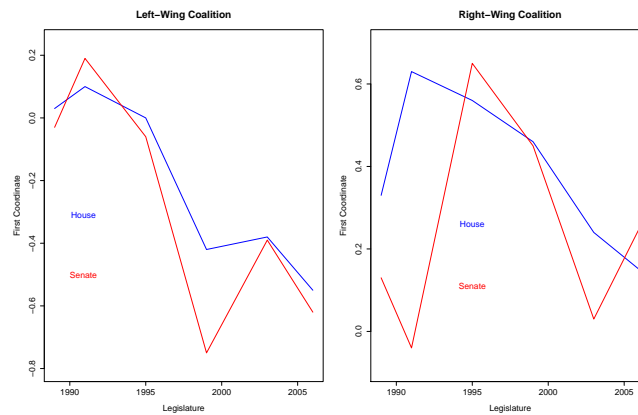
The coalitions were recorded in the data set as government and opposition, not into left and right *per se*. However, one can use the ideological orientation of the president to label each coalition. As showed in Leoni (2002), the first three presidents after the return of direct elections, Fernando Collor, Itamar Franco and Fernando Cardoso, had *WNOMINATE* coordinates to the right in the left-right spectrum. The last president in the period studied, Luiz da Silva, was a member of the House in 1987-1990, and his *WNOMINATE* coordinate calculated during this period is -0.96. The president during the democratic transition was José Sarney, he then became a senator and his first coordinate in the period 1991-1994 is 0.15. Hence, the first three government coalitions, covering the 1989-2002 period were classified as right-wing coalitions, and the last two, covering the 2003-2010 period were classified as left-wing ones.<sup>20</sup>

First, the estimation used all the coalitions in the period studied, *i.e.*, not separated by legislature. The *WNOMINATE* single-dimension linear model applied to the House presented a Correct Classification is 89%, an Aggregate Proportional Reduction in Error of 0.55 and a Geometric Mean Probability of 0.76. For the Senate the respective values are 91%, 0.60 and 0.79.

Table 2 shows that the right-wing coalitions are more polarized in the Senate than in the House, according with hypothesis 3, but hypothesis 4 is not confirmed, *i.e.*, left-wing coalitions are not more polarized in the Senate than in the House. The *t-test* states that the difference in the polarization is statistically significant at the 95% level in the right-wing case, and at 90% level for the left-wing coalitions. Interestingly, the broad result is somewhat inverse when the estimations were ran with disaggregated legislatures.

<sup>20</sup>Itamar Franco was Fernando Collor's vice-president and took the office in the period 1992-1994 after a presidential impeachment. Fernando Cardoso was president from 1995 to 2002 and Luiz da Silva held office from 2003 to 2010.

Figure 5



### 3.4.4 Time Series for Coalitions

Figure 5 displays the legislators' behavior aggregated by coalitions and disaggregated by legislature. Here, the members of left-wing coalitions are more polarized in the Senate than in the House. It should be noted that this has not been verified for the 1991-1994 period only. On the other hand, the right-wing coalition is more polarized in the Senate in only two occasions, 1995-1998 and 2006-2010. The odd behavior observed in 1991-1994 period by the left-wing coalition, with positive coordinates, and by the right-wing coalition in the Senate, with negative coordinates, may be explained by the politico-institutional crisis that took place in 1992, where corruption scandals resulted in a loss of support of the president in the Congress, culminating with his impeachment.

## 4 Conclusion and Future Research

The hypothesis that the plurality majority rule induces more polarization is confirmed, but not to its full extent. In the comprehensive test, using the aggregate data for almost the whole democratic period, the Senate treatment had a positive effect in causing its legislators to behave more extremely. This claim is not as apparent as when the data by legislature and coalition were separated. In general, left-wing parties and coalitions are more affected by the treatment than their right-wing opponents.

Comparing the comprehensive treatment effects of the aggregated cases with the heterogenous ones in the legislature-by-legislature instances is difficult due to software specificities. The particular issue lies in fixing fiscal conservatives and social conservatives legislators in the complete data set in order to determine the polarity result in different coordinates estimates from the estimates in the disaggregated data sets. This occurs because the particular legislators chosen in the first case

are not in every legislature, forcing other choices.

This problem of the same party or member of the Congress in different legislatures may be resolved in a dynamic estimation, using *DW-NOMINATE* and a common space for the legislatures, for example. Another possibility of further investigation is to perform a sort of twin-design experiment. Also with dynamic methods, and using the fact that some members of the House eventually became members of the Senate, this experiment could be performed in order to compare directly, *i.e.*, in the same person, the effect of the control and treatment. Again, this would require the assignment of a common space, but now for both chambers. Finally one can extend the analysis for all of the parties, to explore whether there is a similar effect of the electoral rules on the polarization for the smaller parties in the Congress.

As a last note, I do not make any judgement of value here regarding political polarization. It may be good. It may be bad. It may be sometimes good and sometimes bad. I use the terms found in the literature. Hence, one should not think that words like *extremists*, *moderates*, and *polarized* have any value hierarchy in this paper. They might have in some of the studies mentioned, but not here. The analysis in this paper is mostly descriptive, and somewhat inferential. There is no attempt to recommend any sort of policy implementation.

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