Co-sponsorship networks in the Brazilian Congress:
An exploratory analysis of Caucus influence◆

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Abstract

A defining characteristic of the Brazilian Congress is the informal self-organization of legislators from different parties into issue-specific caucuses, known as *bancadas*. Though not official entities and often loosely delineated, these groups many times play central roles in proposing and approving or blocking legislation. Presidents often negotiate directly with the more influential caucuses instead of going through formal political parties. Caucuses can thus have great influence on public policy, both as a locus of lobbying and rent-seeking or as means of representation and governability. In this paper we use network theory to measure the links between legislators using the co-sponsorship of proposed bills. The analysis identifies and ranks the main caucuses and provides a measure of their influence and power. The networks that emerge from these exercises show that, at least at the level of co-sponsorships, caucuses can provide a better description of the legislators' behavior and interaction than political parties.

Keyword

Caucuses, Political parties, Brazil, Networks, Congress.

Resumo

Uma característica definidora do Congresso brasileiro é a organização informal de legisladores de diferentes partidos em bancadas. Embora não sejam entidades oficiais, esses grupos muitas vezes desempenham papéis centrais na proposição e aprovação ou bloqueio de legislação. Presidentes costumam negociar diretamente com os grupos mais influentes, em vez de passarem por partidos políticos formais. Bancadas podem ter, portanto, grande impacto sobre políticas públicas, tanto por favorecer *rent-seeking* e lobby, como um meio de maior representatividade e governabilidade. Neste artigo, usamos a teoria das redes para medir os vínculos entre os legisladores usando o co-patrocínio dos projetos de lei. A análise identifica e classifica os principais provedores e fornece uma medida de sua influência e poder. As redes que

emergem desses exercícios mostram que as bancadas podem fornecer uma descrição melhor do comportamento e interação dos legisladores do que os partidos políticos.

1.   Introduction

A perennial controversy in Brazilian political science research revolves around the nature and impact of political parties. The Brazilian version of open-list proportional representation, federalism, campaign finance and other legislative rules is conducive to fragmentation and a large number of parties. Early research focused on the lack of ideology and coherence of Brazilian political parties, which it associated with gridlock, pork and high budget deficits (Ames 2002; Mainwaring 1999; Lamounier 1994). A subsequent view, however, analyzed roll-call votes and other data from legislative behavior to argue that despite the high level of churn of political parties and the apparent ideologically-incompatible switching by legislators across parties, these were nevertheless organic, institutionalized and coherent, as least within Congress if not so much in the electoral realm (Limongi and Figueiredo 1999; Santos 2003; Neto 2006; Pereira and Mueller 2003). In this view, parties play a crucial role in the intermediation process through which a strong agenda-dominating president negotiates support in exchange for pork. As bad as that sounds, this literature has argued that these political institutions can be conducive to higher governability and reforms (Alston and Mueller 2006; Pereira and Mueller 2000; Bertholini, Pereira and Renno 2018).[1]

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[1]   Many of the formal institutions that determine the power and function of Congress in Brazil are similar to those of the US Congress, though there are several important differences, and even more informal and contextual differences. The main role of Congress is to pass laws and to serve as a check on Presidential action. Congress is bicameral, composed of a House of Representatives (513 representatives distributed proportionally to state population serving four-year terms) and a Senate (81 senators, three per state serving staggered eight-year terms). Senators are elected by majoritarian rule and Representatives by proportional representation. This latter rule leads to a highly fragmented party system, so that the President's party is unlikely to have a majority and must therefore build a ruling coalition.

Much of this debate took place at a time in which the presidency was dominated by the two most clearly ideologically coherent parties (PT - The Workers' Party (2003-2015) and PSDB - Social Democratic Brazilian Party (1995-2002)). Recent changes in the Brazilian political context, however, raise the question of whether the basic logic of these analyses remains valid or if the system is undergoing a fundamental change. The two dominant parties have been emasculated by a series of scandals, an extended economic downturn and the inability to adapt to a new political landscape dominated by social media. The new President - Jair Bolsonaro - has weak connections to political parties and has made little effort to use traditional means to negotiate support with Congress, opting instead to seek support directly from his political base. He was elected after joining a small party that grew due to his influence in the 2018 presidential campaign. Less than one year later he had already left and by 2021 still did not have a stable party affiliation. In this shifting political landscape, however, it is not clear that political parties have been weakened or lost influence. In the vacuum left by the lack of presidential attention to executive-legislative relations, Congress has taken on a new protagonism, for example, leadership in approving the important reform of the social welfare system.

In this context of a fragmented and shifting multiple-party system, one of the most interesting adaptations has been the emergence of informal issue-specific trans-party groupings of legislators, known as *bancadas* or caucuses. Whereas a bipartisan system, such as that in the US, naturally reflects and accommodates most of societies' cleavages, a fragmented party system has trouble in partitioning the policy space and political agenda across over 28 different parties. It is natural that informal or non-institutionalized ways to deal with this pressure should arise through lobbying, the judicialization of politics, bureaucratic activism, NGOs, organized civil society, and lobbying, among other manifestations that seek to fill the void of more formal modes of representation.

In 2005 the House of Representatives institutionalized one of the early manifestations of the trend for legislators from different parties, but with some affinities in agenda, to self-organize. It started registering 'parliamentary fronts' (PF) which focused on a specific area of legislation supported by at least one-third of the members of Congress, and which had an official representative (Silveira and Araújo 2019). The fronts could use office space within the House but did not receive financing. They were not given any official rights or duties in legislative proceedings and there

is great variability in their level of organization. Despite the ambiguous role they played, the number of registered fronts had grown from 113 in 2003 to 241 by 2015. Typically, each new legislature brings a flurry of new registered fronts with the number falling by the next electoral year (Silveira and Araújo 2019). Although the parliamentary fronts arise from the incapacity of the traditional party system to mediate society's demands for representation, it is not the case that they supersede or substitute for political parties. Both Coradini (2010) Silveira and Araújo (2019) see a more synergistic relationship with parties and fronts not necessarily playing competing roles.

The fact that there are so many parliamentary fronts means that most of them tend to be focused on fairly specific themes or policy issues. For example, while there is a more encompassing Parliamentary Front for Human Rights, there is also a PF in Defense of the Rights of Women, another for the Rights of Children and Teenagers, as well as one for the Victims of Violence and another in Support for Indigenous People, among several other (Silveira and Araújo 2019). Because each PF must attain the registered support of one third of all legislators, the high number of fronts also reflects that there is a common strategy of each legislator freely supporting several fronts, which in a way debases the power of their representation, similar to the way grade inflation deflates the merit of achieving an A.

It was possibly these shortcomings of the parliamentary fronts that opened the way for the *bancadas*. These are also self-organized, thematic and transversal, but are not formally recognized or constrained, and consequently are typically larger and more encompassing in their interests. Yet, despite the greater size and reach, the better organized caucuses are able to overcome the problems of collective action and their disparate party origins to come together around their common interests. Recognizing the caucuses' ability to act in unity within the fragmented legislature, Presidents have often reached out directly to trade policies over specific issue for support on important reform agendas, circumventing traditional parties. For example, the Rural Caucus may receive policy concessions regarding environmental regulation, indigenous land demarcation and rural credit debt in exchange for support on social welfare reform. Similarly, the Evangelical Caucus may require obstruction of gay marriage legislation and of stem cell research in exchange for support on a tax reform bill.

While caucuses have become more prominent in the Brazilian legislative process in recent years, and especially in the Bolsonaro administration, their informal standing makes it hard to assess in greater detail what is the magnitude and nature of their impact. It is also not clear to what extent and in which realms of the legislative process and of political representation the *bancadas* supersede political parties. Because of the effect they can have on economic development and policymaking, understanding the role of *bancadas* in the Brazilian legislative process is important beyond their relevance to the political science literature. Congressional caucuses are one of the mechanisms through which interest groups and social forces affect the allocation and distribution of rents and resources through government policy in Brazil, and are therefore relevant for understanding the country's developmental process, including the persistence of inefficient policies and institutions.

In this paper we use network theory applied to co-sponsorship relations among legislators as a bottom-up method for identifying and ranking caucuses and measuring their level of coherence in relation to each other and to political parties. By using community detection algorithms on over 30 thousand co-authorship links between legislators we can identify which subsets of legislators form organic groups. These groups can then by analyzed to establish which issue area the community represents. Similarly, we can compare how well the emergent structure of the estimated network is explained by membership in the community relative to membership in political parties.

A co-sponsorship relation between two legislators arises when a legislator signs on as a co-sponsor to a piece of legislation being proposed by another. This practice has existed in the U.S. Congress as early as the 1930's (Campbell 1982; Fowler 2006a) and exist is some form or another today in most other countries' legislatures including Brazil.[2] Because a sponsorship does not seem to constrain posterior voting behavior, it is not obvious why this practice has become so ubiquitous. A relatively large literature has sought to explain co-sponsoring as forms of signaling to constituents (Campbell 1982), to other legislators (Kessler and Krehbiel 1996; Caldeira, Clark, and Patterson 1993), to interest groups and campaign contributors (Rocca and Gordon 2010), to facilitate logrolling (Bernhard and Sulkin 2009), to increase the chance of the proposal's approval (Browne 1985),

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[2]   See Briatte (2016) https://f.briatte.org/parlviz/ for graphs and code of several networks from different countries.

among other explanations. This literature claims that co-sponsorship patterns can provide valuable information about legislators' behavior and legislative outcomes and for many purposes is preferable to roll-call data (Aleman et al. 2009; Desposato, Kearney, and Crisp 2011).

Following the literature that analyzes co-sponsorships using network theory (Fowler 2006a 2006b; Burkett 1998; Porter et al. 2005), we interpret co-sponsorship relations as edges in a network where each legislator is a node.[3] This gives us a network with more than 30 thousand links originating from all legislators that participated as co-sponsors in the 55th legislature in the Brazilian House of Representatives (2015 - 2019), and including all proposals presented between 2011 and 2018. We analyze the network that emerges from this data to identify whether the groups that are revealed are simply the political parties or whether alternative patterns, such as the thematic caucuses, better explain the network's structure.

For most countries co-sponsorship relations align closely to party membership. Figure 1 shows a sample of co-sponsorship networks for other countries.[4] We show in this paper that, exceptionally, in Brazil this is not the case.

The paper is organized as follows. In Section 2 we estimate the co-sponsorship network and explore different ways to explain its emergent structure. We partition of the network, identify the communities and rank them according to their ability to overcome the problems of collective action. In Section 3 we investigate the major caucuses and give examples of the propositions they pursued. Section 4 repeats the exercise with data from the Senate. We find that in this higher chamber caucuses do not play a similar role as in the House. Section 5 concludes.

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[3] Although this method prevails in much of the co-sponsorship literature, the projection of the data into a one-mode matrix where all nodes are legislators, instead of using a two-mode matrix, where nodes are both legislators and proposals, may overestimate caucuses by finding partnerships that do not really exist. Future work on Brazilian *bancadas* should explore the extent to which this affects which caucuses are identified.
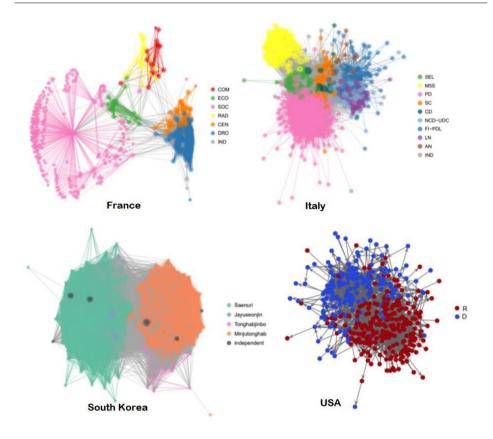
[4] See https://f.briatte.org/parlviz/ for plots and analysis of the co-sponsorship networks of over 20 countries.

Figure 1 - Co-sponsorship network for France, Italy, South Korea and the USA
Source: Briatte (2016).

2. Estimating co-sponsorship networks for the Brazilian House of Representatives

We use data on co-sponsorship in the Brazilian Chamber of Deputies obtained from House of Representative's online portal.[5] The network is composed of all legislators in the 55th legislature (2015-2019) who at any point took part in a co-sponsorship relation. Legislators are the nodes and the edges are given by the co-sponsorship of a proposition. We use all

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[5] https://www2.camara.leg.br/atividade-legislativa/projetos-de-lei-e-outras-proposicoes/ajuda-na-pesquisa-de-proposicoes/pesquisa-avancada-autor

propositions presented between 2011 and 2018, thus including some from the previous legislature, as long as the co-sponsors are part of the 55th legislature. We excluded proposals that require a high minimum number of co-sponsors, such as proposed amendments to the Constitution (PEC) and requests for the creation of a parliamentary commission of inquiry (CPI). These types of legislation regimentally require signatures from one third of deputies (171), so their nature is different from voluntary co-sponsorships. Whereas the latter reflect affinity of interests and signaling to voters and colleagues, the former are more often a sign of logrolling. Note also that we treat all co-sponsorship relations as symmetrical and do not distinguish between the first and subsequent co-sponsors in the list.

Figure 2 presents the co-sponsorship network. It contains 582 nodes and 31,122 edges. Although the total number of deputies is 513, there are cases where alternates step in for the original office holder, thus the number of 582 nodes. In this first figure we do not color the nodes nor change their size to reflect additional information. The average degree of the network, that is, the average number of co-sponsorships, is 106.95. In contrast, a random network created by using a 20% probability that each pair of nodes is connected, would have 33,913 edges and an average degree of only 58.47. We use 20%, as this is approximately the ratio of the average degree of the true network to the number of nodes.

The shape of the network and its average degree thus make it very unlikely that it is a random graph. While a random graph has a degree distribution that approximates a Poisson distribution, this is clearly not the case of the co-sponsorship network (Barabási et al. 2016). Yet, while the network does exhibit a non-random structure, the lack of major hubs indicates that it also does not follow a power-law degree distribution as is sometimes the case with complex social networks. Given that the co-sponsorship network is not randomly generated we would like to determine what is its data generating process.
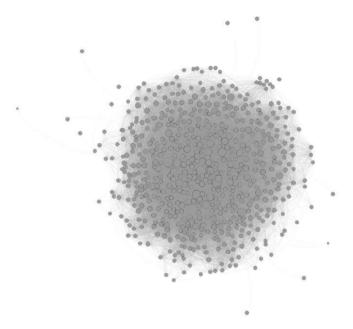
Figure 2 - Co-sponsorship network of the 55th legislature

Our original data is in the form of a bipartite matrix that links congressmen to bills. A link exists when two congressman co-sponsored a given bill. With such two-mode data, one approach is to directly model a bipartite network where both congressmen and bills are nodes. This direct approach has the advantage that the full structural features of the data are considered and shown. Another approach is to transform the two-mode data into one-mode projections, where congressmen are linked to other congressmen if they co-sponsored any bills in common, or where bills are linked to bills if they had co-sponsors in common. The conversion approach is often used when one mode is of more interest to the analyst than the other, so that the data on the other variable is simply used to indicate links for the variable of interest (Everett and Borgatti 2013).

In our case, the interest is in the relationship between congressmen, so we use the one-mode projection into a matrix where the nodes are congressmen. The disadvantage of transforming the data in this way is that it can entail a loss of information about the structural features of the data. Everett and Borgatti (2013) discuss the conditions when this loss of in-

formation from conversion is a problem and when it can be justified for allowing the use of a greater number of network analysis techniques that require square matrices. In addition, they discuss several methods that allow for the use of projections without the loss of information.

We recognize that by using a one-mode projection of our two-mode data we run the risk of overestimating the relationship between congressmen - a risk that the previous co-sponsorship literature also incurs (Fowler 2006a, 2006b; Zhang et al. 2008; Briatte 2016; Lee, Magallanes, and Porter 2017)). That is, it may be that we are identifying as members of the same community, individuals that are not really associated in this way. Extensions of this paper could explore methods to deal with this overestimated information and with present biased results. For now, and in an exploratory way, we continue to use a weighted matrix, as if it were binary, for the relationship between each pair of congressmen and the number of bills that they co-sponsored in common (Stram, Reuss, and Althoff 2017). This approach takes into account the different intensity of interaction across pairs of congressmen.

The co-sponsorship network is thus derived from a weighted adjacency matrix A of ties between congressmen, where $A_{i,j}$ is the quantity of bills that two congressmen mutually co-sponsored in the period. This is a symmetric matrix where diagonal elements are not considered, because a congressmen cannot have ties with himself. We have first listed, for each congressman, the bills he/she co-sponsored. Then, $A_{i,j}$ was found as the number of re-occurrences in the lists of congressmen i and j.

Co-sponsorship networks for most countries typically exhibit the clear clustering by political parties shown in Figure 1 (Briatte 2016). In Figure 3 we redraw our network by coloring the nodes according to the political party of the deputy and set the size of the node to reflect its degree (i.e., number of links). There are 27 parties in the network. Given high party membership turnover, we designate each deputy to the last party to which he/she belonged. The edges follow the color of one of the nodes. The caption shows the proportion of members from each party.
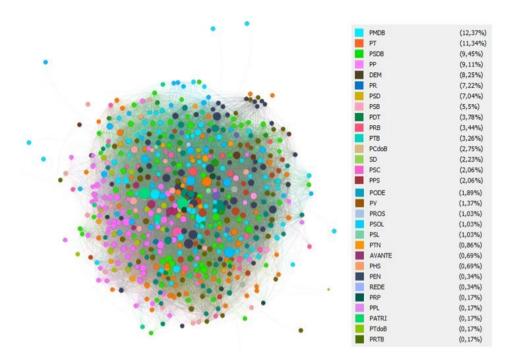
PMDB	(12,37%)
PT	(11,34%)
PSDB	(9,45%)
PP	(9,11%)
DEM	(8,25%)
PR	(7,22%)
PSD	(7,04%)
PSB	(5,5%)
PDT	(3,78%)
PRB	(3,44%)
PTB	(3,26%)
PCdoB	(2,75%)
SD	(2,23%)
PSC	(2,06%)
PPS	(2,06%)
PODE	(1,89%)
PV	(1,37%)
PROS	(1,03%)
PSOL	(1,03%)
PSL	(1,03%)
PTN	(0,86%)
AVANTE	(0,69%)
PHS	(0,69%)
PEN	(0,34%)
REDE	(0,34%)
PRP	(0,17%)
PPL	(0,17%)
PATRI	(0,17%)
PTdoB	(0,17%)
PRTB	(0,17%)

Figure 3 - Co-sponsorship network by political party

Contrary to what happens in other countries, there is no obvious division of the graph according to parties. This finding endorses the common view in public opinion and in much of the literature that parties are not the most relevant unit of analysis. For example, Gallagher (1991) points out that Brazil has the highest degree of party fragmentation in House elections among 100 countries. To investigate other patterns of organization in the network, we use community detection methods from network theory to try to explain the division of the graph. If not political parties, which groups do legislators divide into in Brazil? In the jargon of Brazilian political analysis, these communities are called *bancadas*. Thus, for now we use this as a generic term for the communities in the network.

We use a modularity seeking algorithm that partitions the network into groups that have a higher density than other divisions. Density is an intuitive measure of group cohesion. It is the number of existing relationships between nodes of a group divided by the number of all possible rela-

tionships between nodes. Thus, a group in which all nodes are connected will have a density of 100%. Communities are denser than other divisions, and we show that it follows from the division into communities that the *bancadas* we uncover are much denser than the parties themselves in the Chamber. Before doing so, however, we point out that two other potential criteria for dividing the network were investigated: according to the geographic region of the deputy and by whether the deputy was re-elected in 2018 or not (lost or did not run). Neither of these seem to suggest a discernible pattern that could explain the determinants of community self-organization.

Given that the network is not well explained by party, by region or by electoral performance, the next step is to partition the network into communities and then try to identify the underlying structure of that partition. A community is a group of nodes that has more relationships with each other than with the rest of the network, which is why in most countries the communities in a co-sponsoring network are the parties themselves.

To partition the network, we applied the Louvain modularity algorithm (Blondel et al. 2008) and the *ForceAtlas2* layout algorithm with each legislator allocated to one and only one community. The result is shown in Figure 4, with the network divided into 25 communities.[6] Each community was identified and labeled by examining the members of each group and using knowledge of their personal and political histories. The classification is straightforward, as in most cases the group's focal interest is reasonably obvious and uncontroversial. Most groups were identified as a thematic *bancada* or as a political party. In a few cases we were not able to pinpoint any common interest or origin of the group and these have been simply marked with letters. There is also one group for each year composed of the leaders of each party. This happens for regimental reasons that require the leaders to cooperate in some specific circumstances. In the next section we discuss some of the main caucuses identified, but first we attempt to quantify the relative strength of each group.

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[6]   The choice of 25 communities is somewhat arbitrary as there is no established method for determining how many communities to look for (Newman and Reinert 2016; Riolo et al. 2017; Chen and Lei 2018). We used two criteria to determine this parameter. First, we chose not to have more communities than the number of political parties. Second, we sought a calibration in which the density of the largest communities would not be too diluted. The average density of the largest communities was highest with the number set at 25.
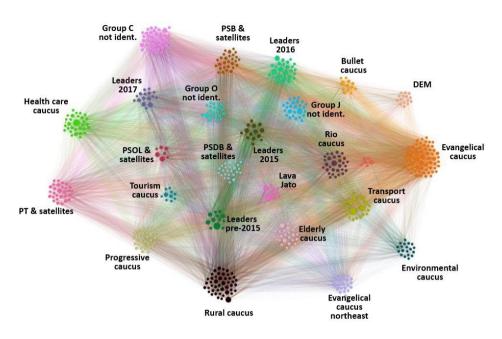
Figure 4 - Communities in the co-sponsorship network

Table 1 lists the size and density for all the communities and for each political party in Figure 4. The density for the network as a whole is 18.5%, but the average across the detected communities is 66.0%. This is almost twice the 35.8% average density of the 25 main parties. This is already one indication that *bancadas* can be relatively more influential than parties. But to meaningfully impact legislative proceedings cohesion may not be enough. It is also necessary for groups to be large and command enough roll-call votes. We measure this combination of size and cohesion through a metric we call 'strength'. It is calculated for each group by multiplying the group's percentage of all deputies in the House by the density of the group. The result is a relative measure that ranges from 0 to 100. A strength of 100 would occur in the hypothetical case of a community composed of all members of the Chamber and a density of 100%.

Table 1 - *Bancadas* **and parties by strength**

Community	Deputies	Density	Strength
Evangelical	61	73%	7.6
Rural	46	75%	6.0
Undefined C	38	90%	5.9
DEM	48	57%	4.7
PT	66	39%	4.4
Elderly	23	91%	3.6
Progressive	29	70%	3.5
PSB	32	61%	3.3
Evangelical Northeast	22	84%	3.2
Leaders 2016	25	72%	3.1
PSB	72	21%	2.6
DEM	15	100%	2.6
Transport	23	64%	2.5
Rio de Janeiro	30	49%	2.5
PSDB	55	24%	2.3
Leaders 2017	16	82%	2.2
Leaders 2015	14	90%	2.2
PSB & satellites	28	45%	2.2
PT & satellites	29	42%	2.1
Leaders pre-2015	12	97%	2.0
PSD	41	26%	1.8
Lava-Jato	12	85%	1.7
Health	31	30%	1.6
PRB	20	47%	1.6
PSDB & satellites	27	33%	1.5
Bullet	12	73%	1.5
PP	53	16%	1.5
PCdoB	16	48%	1.3
Environmental	19	40%	1.3
Undefined J	66	25%	1.1
PR	42	15%	1.1
Undefined O	21	28%	1.0
PSOL & satellites	7	81%	1.0
Tourism	10	51%	0.9
Bullet pre-2015	6	80%	0.8
PSOL	6	80%	0.8
PDT	22	20%	0.8
PTB	19	19%	0.6
PPS	12	30%	0.6
PODE	11	29%	0.6
PSC	12	26%	0.5
PTN	5	60%	0.5
SD	13	22%	0.5
PV (Greens)	8	25%	0.3
PHS	4	50%	0.3
PEN	2	100%	0.3
PSL	6	27%	0.3
PROS	6	13%	0.1
AVANTE	4	17%	0.1
REDE	2	0%	0.0

Source: Calculated by the authors.

The picture of political representation and legislative organization told by Table 1 and Figure 5 is much different from that found in most other countries, where the network usually partitions closely along partisan lines. Our results show that the *bancadas* are not mere window dressing or cheap talk. This seems to be the case instead for the legislative fronts (*Frentes Parlamentares*) as none of them show up in the network. Although these groups are formally registered and officially recognized, whatever collective action they engage in does not translate into a community in the co-sponsorship network. The *bancadas*, on the other hand, though informal and unofficial, are some of the entities with highest strength in Table 1. The two first places are held by the Evangelical caucus and by the Rural caucus. These have considerably greater strength than the first two parties in the list: DEM and PT. Of the first 10 communities in the list, 5 are *bancadas*, 3 are parties, one is unidentified and another is the group of leaders.

The relative rank of caucuses versus parties in Table 1 shows why presidents have increasingly circumvented traditional political parties to negotiate support for their agenda directly with these informal groups. Especially for contentious issues, such as pension reform, the President needs strong allies, that is, large and cohesive groups that can deliver support on the floor. Political parties in Brazil, however, tend to lack the cohesiveness to provide reliable support. Figure 5 shows the placement of the members of six major parties in our estimated co-sponsorship network. By comparing each isolated party's connections to the full network in Figure 5, it becomes apparent that parties do not have a homogeneous membership in terms of the interests expressed through co-sponsorships. The Brazilian party system does provide party leaders some means to discipline their members and get them to act in concert for many issues. Yet, the fact that party members have such diverse interests, illustrates some of the forces party leaders are up against. For many issues, it may be easier for Presidents to negotiate directly with the caucuses.
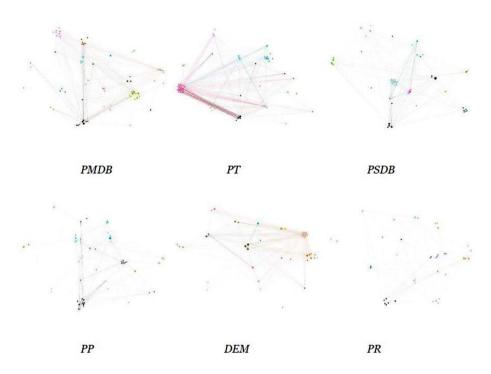
Figure 5 - Parties within the co-sponsorship network

3.   Which are the most important caucuses?

In this section we discuss some of the most prominent *bancadas* revealed by the co-sponsorship network. We give examples of the issues and specific legislation that they sought to promote, block or alter. Not only is there no applied literature on co-sponsorship networks for the Brazilian Congress, but empirical efforts toward defining *bancadas*, based on data, are also missing. For Cascione (2018) it is noteworthy that an issue which is so prominent in national politics is so absent from academic scrutiny.

3.1. The Evangelical Caucus

We identify the largest group, with 61 members, as the Evangelical caucus. It is sometimes referred to in public discourse as the Bible caucus and tends to call itself the Family caucus. These less popular denominations are closer to the truth because the group includes some Catholic legislators. Figure 6 isolates this community and shows the names of the participating legislators. Node sizes have been made proportional to centrality. The density of the group, despite its large size, is high, at 72.9%. Only two political parties, PSOL and PEN, have a greater level of cohesion (Table 1). No medium or large party comes close to the density of the Evangelical caucus.
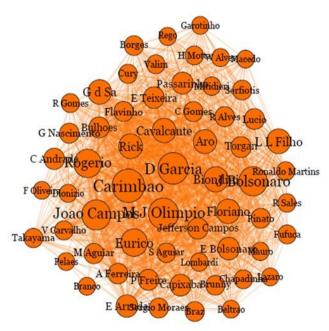

Figure 6 - The Evangelical caucus

The most popular proposition supported by this group has an impressive number of 40 co-sponsors within the group. It seeks to block the Executive's act that criminalizes discrimination of transvestite and transsexual people in educational establishments. Other propositions of interest to this group are related to policies that deal with sexual orientation

and the decriminalization of abortion, which makes it straightforward to identify the focus of this group.

Two salient proposals that they promoted were Amendment No. 41 of 2012, to Project No. 2,330 of 2011, with 13 co-sponsors, and Bill No. 4,754 of 2016, with 11 co-sponsors. The first sought to ban the sale of alcoholic beverages at football stadiums during the 2014 World Cup. The second tried to criminalize behavior of Supreme Court Judges which they saw as usurping the authority of Congress or the Executive (presumably in issues such as abortion or drugs). The Figure shows that Jair Bolsonaro, who was subsequently elected as President of Brazil, is part of this *bancada*. Although he was often described as a backbencher from a small party with a meagre legislative resume, our methodology identifies him as one of the most relevant legislators in the largest community in the Chamber of Deputies.

3.2. The Rural Caucus

The second largest community in the co-sponsorship network is identified as the Rural caucus (Figure 7). It stands out for its high cohesion, as shown by the network graph and by the density level at 75.4%. This is a higher density than any of the largest parties and is one of the highest among all the big caucuses. Remember that density measures the number of existing connections for a given group in relation to the total number of possible connections. Density is therefore a good indicator of group articulation, organization and like-mindedness. In the case of the Rural caucus the high density fits the perception of the group by the media, public opinion and by the academic literature as a strong and influential group (Alston and Mueller 2007; Vigna 2007; Simionatto and Costa 2012; Lima 2017). They are strong because they are both numerous and cohesive. That is, they can act concertedly despite their internal differences (Araújo 2013).
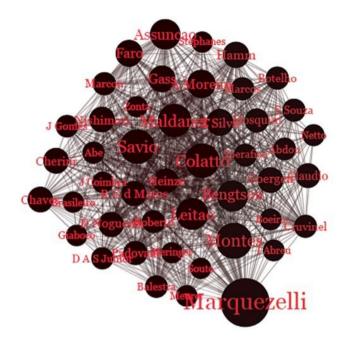
Figure 7 - The Rural caucus

The range of activities of the Rural caucus is wide and its means are varied. One of the main proposals in the time period of our data, with 17 co-sponsors, sought to sustain a normative instruction from the Executive Branch that approved phytosanitary requirements for coffee from Vietnam - that the sector saw as unfair competition. Another, also with 17 co-sponsors, appealed for a public hearing to pressure for more investments toward paving the BR-163 highway, considered strategic for the flow of agricultural production in western Brazil.

The list of propositions reveals action by the group aimed at entities as diverse as the National Traffic Council (*Contran*), public banks and the *Itamaraty* (the Brazilian Foreign Office). In addition to uncontroversial issues in straightforward agricultural areas, such as animal disease, there is also a discernible attention to corporate issues, including: commercial protection; access to public bank financing; renegotiation of rural credit debts; taxation; sanitary requirements; public procurement; trucking legislation, among others.

The salience of the rural caucus in the network seems to be a corollary of a very well defined set of strategies used to pursue their interests. Among the more aggressive instruments used by this group are demands for depositions by ministers, which are harsher than simple invitations because they are more atypical and imply a crime of responsibility in the case of absence. There had been summons during this period, for example, for the Minister of the Environment to address the activities of the Brazilian Institute of the Environment and Renewable Natural Resources (Ibama), for the Minister of Finance (debt renegotiation), and for the Minister of Justice (demarcation of indigenous lands).

3.3.   The Centrão

This is the third strongest community in Table 1. We cannot connect it to a specific theme, but the membership suggests it fits the description of the "*Centrão*", a somewhat amorphous group of central (more median) legislators that often are more interested in pork rather than policies. Most are part of the "lower clergy", which is what backbenchers are often called in Brazil. The group has a very high level of cohesion at 90%. It is well connected to other groups, is heterogeneous in terms of party origin and has come together to support different topics. It is not quite accurate to call this group the "*Centrão*" (big Center), as this term makes it sound as if it is a homogeneous group of legislators with similar center ideology, whereas it is actually very diverse in many dimensions but has in common the greater focus on pork rather than policy.

The main mobilization by this group was for a proposal to stop an act of the Federal Audit Court (TCU) that required bidding in more than 6 thousand lottery companies. Other themes that brought together members of the group include the tightening of penal legislation, the inclusion of the name of Miguel Arraes (a historic politician from the northeast) in the Book of Heroes of the Fatherland, as well as themes dear to the evangelical and rural caucuses.

3.4.   Health caucus

The projects that unite this community of co-sponsors do not seem to be related to corporate interests. It is therefore not a caucus for interests such as health plans or pharmaceutical companies. Instead, it seems to represent diffuse interests of voters and consumers. The term "health" is used here because the propositions cover not only the Unified Health System (SUS), but also guidelines referring to women, social assistance, people with disabilities, and early childhood. Themes that stand out have to do with the career of community health agents, violence against women and early childhood (for example, microcephaly). Proposals that deal with the approval of the use of the substance phosphoethanolamine, an experimental drug for cancer patients are emblematic of this caucus.

3.5.   Other Caucuses

In addition to the caucuses described above several other smaller groups were also identified in the network. The fifth largest community represents interests of the state of Rio de Janeiro. Among the issues they pursued were demands for policies and action by federal agencies and organizations, such as the Pedro II School, Ipea (Institute for Applied Economic Research), Petrobras and federal hospitals. The Transport caucus is made up mostly of members of the PMDB and focused on infrastructure projects. The Environmental caucus turned out to be relatively weak with only 19 legislators and density of 39.8%. This pales in comparison with their main rivals for policies, the Rural caucus. This is probably an indication that whereas the latter seek to influence policy directly in Congress, environmental interests in Brazil adopt indirect strategies by convincing voters to pressure politicians rather than doing so directly (Yu 2005).

4.   Co-sponsorship network in the Senate

The analysis thus far has referred exclusively to the Brazilian House of Representatives. Are the findings that caucuses play an important role in legislative proceedings also valid for the Senate? In this section we replicate the same analysis using co-sponsorship data for senators from the 54th

(2011-2019) and the 55th legislature (2015-2019), since the terms in the Senate are 8 years long.

The network that emerges has 97 nodes (greater than the number of 81 senators because of substitutes) and 3,868 edges. The average degree is 79.75. This is a very high number, equivalent to 82% of nodes. For the Chamber, in the same period, the average grade was 106.95, or 18% of nodes. Thus, there is a much higher degree of cooperation in the Senate. This is in line with its stereotype of being a more collegiate and less fragmented chamber. In part this may be due to the smaller size of the Senate, but it can also be related to the different electoral rules (majoritarian rather than proportional). Also, the 8-year terms implies that the senators tend to have longer relationships.

While in the House the average density was 18.5%, in the Senate it is an impressive 83.1%. Because density measures the number of effective connections out of the total possible number of connections, this reflects a high level of cohesion in the Senate. Figure 8 shows the network, with nodes colored by party and proportional to the centrality of intermediation. Once again, we can see that it does not resemble a random network. There is however an important difference from the network estimated for the House. Here parties seem to matter. This interpretation is confirmed in Figure 9 where we use the community detection algorithm, setting the partition to four groups to keep the proportion of legislators per community similar to what we did with the House data (we ignore the isolate nodes).
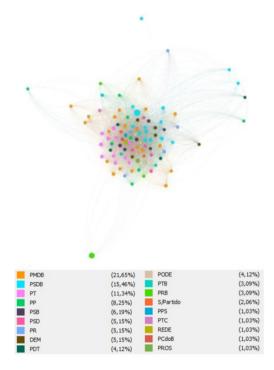
PMDB	(21,65%)	PODE	(4,12%)
PSDB	(15,46%)	PTB	(3,09%)
PT	(11,34%)	PRB	(3,09%)
PP	(8,25%)	S/Partido	(2,06%)
PSB	(6,19%)	PPS	(1,03%)
PSD	(5,15%)	PTC	(1,03%)
PR	(5,15%)	REDE	(1,03%)
DEM	(5,15%)	PCdoB	(1,03%)
PDT	(4,12%)	PROS	(1,03%)

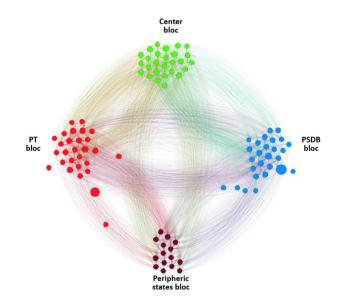**Figure 8 - Co-sponsorship network in the Senate, colored by party**

Figure 9 - Communities in the co-sponsorship network in the Senate

Two communities are readily identified. The first is the PT Bloc, with 28 members. It is composed of most of the PT and PDT senators, and all of the PCdoB and Rede senators. This was the support coalition for President Dilma and against President Temer. The density for this group is 82.3%. Among the main propositions were 15 co-sponsors requesting a vote of reproach for the governor of Paraná (from the PSDB) "for the brutal action by Military Police against teachers", 17 co-sponsors demanding a plebiscite to require a new election for President in 2016 after the impeachment of President Dilma, and 19 co-sponsors for a bill to provide free bus passes to all students in the country.

The second group, with 27 members, concentrates almost all PSDB senators and almost all DEM senators (except one in each case). It includes members from other parties, but 67% are from the PSDB or the DEM. It is a mirror image of the previous bloc, opposition to the Dilma government, but supporting Temer. The density is 80.1%. Among its main propositions, are 17 co-sponsors sending a letter to the President of Venezuela defending democratic principles, 17 co-sponsors in favor of reproaching the President of Unasur for a declaration against the impeachment, and 19 co-sponsors for the creation of a committee to present a proposal to switch Brazil to a parliamentary system of government.

The dominance of these two groups in the network shows that contrary to the House, the main organizing principle in the Senate are not the caucuses, but rather party blocs.

The third group, also with 27 members, has representatives from 11 parties. In addition to being heterogeneous, there is a temporal component, since it harbors many of the senators who made their debut in the 55th legislature. The group's cohesion is 99.7%. Among the main propositions, are 14 co-sponsors supporting the continuation of the constitutional amendment project for increasing internal control on public policy, 15 co--sponsors for a project promoting *capoeira* (a traditional fight/dance), and 18 co-sponsors for the continuity of a project about products containing phenylanine.

Finally, there is a bloc of Peripheral States with 15 members, mostly from the PMDB, PP and PR. Its composition seems to be determined by regional criteria with no members from the South or from rich states like São Paulo and Rio de Janeiro. There is over-representation of the Midwest, and

of the 10 states with the largest population, only 1 is represented. Among the 10 states with the lowest population, 7 are represented. Its cohesion is 100%. This bloc is an artifact of the electoral rules that gives less populous states more power in the Senate in relative terms.

The analysis of the co-sponsorship network suggests that the Chamber of Deputies is in fact a more fragmented house, more prone to the formation of *bancadas*. In contrast, in the Federal Senate, not only is the network organized primarily along party lines, but the level of collaboration between legislators is higher. The communities present themselves as party blocs, with an emphasis on the division between government and opposition.

It is possible that these differences are related to electoral rules (proportional versus majoritarian); size of the Houses (513 x 81), number of committees; and length of the term in office (4 years x 8 years). In Lijphart et al. (1999)'s terms, the analysis suggests "strong bicameralism".

5. Conclusions

We have shown evidence that in the House of Representatives in the Brazilian Congress caucuses are an important organizational form besides parties. We identified a caucus or a *bancada* as a community in the network of bill co-sponsorships. Because a community is a group of nodes that has more relationships with each other than with the rest of the network, communities in the legislative network are a good measure for caucuses: groups of legislators who act together.

Although this result is in line with the conventional view in Brazil that parties are not the main organizing principle in Congress, it differs markedly from dozens of other parliaments across the world, where the communities of co-sponsorship networks almost always align with parties. In the House of Representatives during the 55th legislature (2015-2019) only a fraction of the members of PT, PSB, PSDB and DEM were organized as communities, and only PSOL has all its members in the same community. This does not mean that parties do not matter, as the co-sponsorship data reveals information on only some types of interactions among legislators. It does, however, suggest that the formation, working and impact of caucuses in the Brazilian Congress deserves more attention.

This exploration is the first to build co-sponsorship networks for Brazil and also seems to be the first attempt to create a method to identify Brazilian caucuses from public data. A better understanding of these networks and *bancadas* is relevant for the political economy literature. Several authors, such as Lisboa and Latif (2013), share the diagnosis that low economic growth in Brazil is explained by extractive institutions. They highlight that there is a "broad system of rent-seeking policies" and that "excessive protection and the dissemination of benefits resulted in high social costs". These policies are opaque, and Lisboa and Latif (2013: 51) conclude that "there is still a lot of work to be done, such as collecting all the evidence on the rent-seeking mechanisms, their economic effect and distortions, and assessing the role played by the political process on the development". We view this work as a part of that effort and hope that future studies can shed more light on the legislative decision-making process.

Interestingly, we did not find the same role for caucuses in the Senate, where there is instead greater cohesion among legislators. Whereas in the House it was possible to identify caucuses as large and cohesive communities, this was not the case in Senate where cohesion is already high in the chamber as a whole (four times higher than in the Chamber). Thus, parties seem to have a more relevant role in the Senate when it comes to organizing legislators. If in the Chamber we speak of *bancadas*, in the Senate we speak of "blocs", aligned according to situation and opposition.

There are several directions for future research to explore. The first is to use a two-mode network instead of the one-mode projection, as the latter may bias community detection leading to overly dense caucuses. A second extension is to investigate the sensitivity of the results, that is, identified caucus composition, to using given criteria for cutting the data. A third direction is to try different ways of dividing the network into communities. We allocate each legislator to one and only one community. But other rules, for example allowing multiple affiliations, might be a more accurate depiction of legislator behavior. Another extension involves looking at how the community structure changes from one legislative year to another, and from one legislature to another, and how this is related to the changing salience of the political debates of the day. Yet another possible extension might be establishing a higher threshold of co-sponsorship to connect legislators, which is not trivial but could prove insightful (see Everett and Borgatti (2013)). Also, modern exponential random graph models (ERGM) could be used to model the data as a two-mode network and use the

data to predict support for the proposed projects (Lusher, Koskinen, and Robins 2013). Finally, it would be useful to replicate the same community identifying methods using other sources of data on legislator interaction as the edges in the network.

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