Network Patterns of Party Polarization

in the French Parliament

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ABSTRACT

This paper measures the extent of party polarization in the French Parliament politics through the ebb and flow of legislative collaboration between its members. Drawing extensively on existing studies of cosponsorship networks in the U.S. Congress, we introduce similar data for both legislative chambers over the past seven legislatures. We then use exponential graph models to measure the influence of party affiliation on the likelihood of cosponsorship since 1986. Like roll-call spatial voting models of French legislative politics, our results tend to reveal a primarily one-dimensional policy space structured by left-right politics and strong party loyalty.[1]

1. INTRODUCTION

Previous studies of (co)sponsored legislation have found it to be a useful heuristic to how Members of Parliament (MPs) signal positions to other legislators (Kessler and Krehbiel, 1996), to the executive, or to constituencies such as interest groups and voters (Wilson and Young, 1997). This kind of position taking is further encouraged by the weakly constrained nature of (co)sponsorship, over which legislators generally enjoy more control than they do over votes (Schiller, 1995).

A large fraction of existing research on legislative networks is based on U.S. legislative chambers, for which there are large scale historical data available (Zhang et al., 2008; Clark et al., 2009). Drawing extensively from this literature, this paper examines the extent of party polarization expressed by members of the French Parliament through their propensity to cosponsor legislation together, as an alternative measurement strategy to roll-call voting records (Sauger, 2010).

Section 2 starts by introducing original network data built from around 100,000 cosponsored amendments and bills introduced in both chambers of the French Parliament over the past 27 years. Section 3 then presents a methodological framework that relies on exponential random graph models (Krivitsky et al., 2009; Cranmer and Desmarais, 2011) to measure the influence of party identification on cosponsorship in each of the seven parliamentary legislatures since 1986.

In accordance with roll-call spatial voting models of French legislative politics (Godbout and Foucault, 2013), the results presented in Section 4 tend to reveal a primarily one-dimensional policy space structured by left-right positions and strong party loyalty. Both random and fixed effects models of the cosponsorship data find moderate to strong party-based network patterns across all parliamentary groups that are largely consistent with longer historical patterns of party unity in postwar France (Sauger, 2010).

The overall results of our study, which we further discuss in Section 5, show that party polarization has increased in recent legislatures, as Members of Parliament sponsor more and more legislation within party lines. The two-by-two multi-party configuration popularized decades ago by Duverger (1968) under the name "quadrille bipolaire" is still empirically relevant to qualify both past and present left-right coalitions in Parliament, and is highly predictive of legislative interactions conducted under the control of highly disciplined party coalitions.

2. DATA

Although formally intended to encourage technical collaboration between branches of government over lawmaking (Heller, 2001), legislation also translates the struggle of government branches over the control of the legislative agenda. In several studies of U.S. legislatures, this struggle has been shown to form regular patterns of collaboration between legislators, the structure of which can help predict legislative productivity (Fowler, 2006; Cho and Fowler, 2010).

Members of the French Parliament are provided limited resources and enjoy only restricted control over the legislative agenda in comparison to the executive (Kerrouche, 2006; Baumgartner et al., Forthcoming). In that context, many bills introduced by MPs represent attempts by opposition parties to express defiance at the government and obstruct its legislative drive (Conley, 2011). Similarly, a large volume of amendments produced during parliamentary plenary debates serve to grant their authors a few minutes of speaking time during the passage of a bill.

Legislation therefore plays a role in framing parliamentarians as veto players in the policy process (Tsebelis, 1999). For that reason, as a previous study of the French National Assembly has observed, "the volume of private members' bills, especially those from minority deputies, may be regarded as a reasonable proxy

for the level of conflict between the government and opposition deputies. It will also reveal something of the extent of the government's political control over its backbenchers" (Kerrouche, 2006, p. 343).

2.1. *Sample definition*

In this study, we focus on the relational determinants of legislative behaviour, and measure legislative collaboration with the aim to control, rather than to account, for the volume of legislation passed. Our sampling frame thus consisted in all available legislation for which one MP could be nominally identified as the author, and one or more other MP(s) could be nominally identified as cosponsor(s). This design concentrates on ties between first authors and their cosponsors within each chamber, as does Fowler (2006) on similar data.

The legislation collected for this research consist of slightly over 103,000 items sponsored over the past 27 years, from 1986 to today. The 96,168 amendments and 6,864 bills used to build the cosponsorship networks presented in the next sections are distributed over seven legislatures, or roughly half of the Fifth Republic, and come from a larger sample approximately twice that size, which also includes single-sponsored MP legislation, government bills and nonbinding resolutions.

The data were produced by scraping sponsor details from the National Assembly (`http://www.assemblee-nationale.fr/`) and Senate (`http://www.senat.fr/`) websites. Legislation data for the National Assembly were retrieved from its online pages, and legislation data for the Senate were retrieved from the SQL database dumps of its open data initiative (`http://data.senat.fr/`). Less than 2% of the data could not be processed due to missing information or parsing issues.

Figures **??** and **??** show the time distribution of the data over each National Assem-

bly term (*législature*), which coincide with executive terms from 2002 onwards. Legislatures 8 (1986-1988), 10 (1993-1997) and 11 (1997-2002) include periods of divided government (Baumgartner et al., Forthcoming), with three leftwing parties in government during legislature 11; all other periods represent periods of government under leftwing or rightwing two-party coalitions.

[FIGURE 1]

Table 1 provides further information on the number of MPs and parliamentary party groups represented in the cosponsorship data. The number of MPs per legislature is sometimes superior to the number of seats due to replacements and delays in legislation that allowed sponsors from multiple legislatures to cosponsor the same bill. The number of groups indicates how many parties have more than 9 members in the cosponsorship sample, which is the lowest threshold to form a party group in (Senate) parliamentary rules.[2]

[TABLE 1]

The most serious limitation in the data explains the highly unequal number of items before and after 2002 in both chambers: amendments data were available only since 2004 in the National Assembly or since 2001 in the Senate, and do not include amendments submitted to specialised committees, where a lot of "invisible" legislative collaboration occurs (Kerrouche, 2006, p. 357). Another major issue specifically affects legislature 10 in the National Assembly bills series, which is composed of only a few cosponsored bills at the end of the legislature. For both reasons, we first ran our analysis on amendments and bills separately, and then on the combined series.

2.2. Network construction

Cosponsorship networks were built out of the ties formed between the first author of a bill amendment, and all other sponsors of the proposed legislation. This definition of network ties matches the criteria used in network analyses of cosponsorship in the U.S. Congress (Fowler, 2006; Gross, Kirkland and Shalizi, 2012), and relies on a similar constructor, namely a two-mode edge list of the form

$$\{a_8, b_1\}, \quad \{a_{31}, b_1\}, \quad \{a_{27}, b_2\}, \quad \ldots$$
$$\vdots$$
$$\ldots \quad \{a_{36}, b_{n-1}\}, \quad \{a_{120}, b_n\}$$

with MP sponsors denoted a_i and legislation items denoted b_k, regardless of their kind. The construct under examination is therefore an initially bipartite, or two-mode, network of $a \times b$ ties between MPs and legislation items. To focus the study on collaboration between legislators, we collapse this construct to a one-mode network containing strictly MPs, by connecting the first author of each item to all other sponsors of the item. The resulting adjacency matrix A of directed ties between MPs (i, j) is an asymmetric matrix with elements

$$A(i,j) = \begin{cases} 1 & \text{if MP } j \text{ cosponsored an amendment or bill by MP } i, \\ 0 & \text{otherwise.} \end{cases}$$

and where all diagonal elements describing network self-loops — MPs hypothetically cosponsoring legislation with themselves — are discarded.

Since cosponsorship between MPs i and j can occur more than once during a legislature, the ties of their network must then be valued to reflect their different

strength. To do so, we followed Gross, Kirkland and Shalizi (2012, Equation. 1) by weighting all cosponsorships in inverse proportion to the overall number of cosponsors on the item, and by normalizing their sum to the maximum number of possible cosponsorships between MPs i and j.[3]

Finally, for the purpose of this study, we recoded a myriad of parliamentary party group affiliations to a simplified list of seven leftwing and rightwing political families. Our recoding is broadly similar to that of Godbout and Foucault (2013, p. 310): for instance, we also coded the Red-Green leftwing 'GDR' coalition of legislature 13 (2007-2012) as a single group. This classification offers a spectrum of four leftwing and three rightwing party groups: Communists/Red-Greens, Greens, Socialists and Radicals on the leftwing, and Centrists, Conservatives and the *Front national* on the rightwing.[4]

Three slight differences exist between our classification and the one used by Godbout and Foucault (2013, p. 310). First, in order to better capture leftwing party divisions (especially in the Senate), we did not collapse Radical MPs with Socialists MPs when both formed separate parliamentary groups. We also decided to code *Démocratie libérale* (DL) National Assembly MPs as rightwing Conservatives (RPR/UMP) rather than Centrists. Last, we left all unaffiliated MPs (*non inscrits* and *sans étiquette*) out of our classification. These differences create nontrivial differences in party codes between both classifications, but do not seriously threaten the overall comparability of the samples used.

The replication material for this paper, which was written in R (R Core Team, 2013), contains all necessary functions to download the raw data and process it to weighted network objects, which can be easily visualized using several placement algorithms (Butts, 2008) or converted to other formats. The replication material contains the postprocessed legislation data up to April 6, 2014, which we used in the present analysis. [5]

3. METHODS

The cosponsorship networks under study are large-scale objects built out of primarily weak signals between individual actors (MPs) who carry only limited information with regards to the overall topology of legislative collaboration occuring in the network as a whole. Assessing the extent of cohesion or divisiveness expressed at the level of parliamentary party groups therefore requires paying attention to the structural properties of cosponsorship networks along other covariates (Kirkland and Gross, 2012).

For this reason, we focus our analysis on characterizing each legislature through network-level properties, rather than through ego-level measures of influence such as rankings of MPs by legislative productivity. In order to preserve some of the benefits of exploring egocentric networks (Box-Steffensmeier and Christenson, 2014, see, e.g.), we offer an interactive visualization of the cosponsorship network data, available online at `http://briatte.org/sigma`, that shows force-directed graph representations of the fourteen networks under study.

We start by measuring the overall level of party polarization in the cosponsorship network of each legislature, finding variations in time as well as between chambers that are consistent with previous studies of party cohesion in the French Parliament. We then explain how we estimated party effects through exponential random graph models, using both random and fixed effects approaches (Krivitsky et al., 2009; Cranmer and Desmarais, 2011).

Figure 2 shows some weighted network properties for the fourteen legislature networks present in the data. The top row of graphs shows counts of nodes and ties in each networks, with a clear difference in network density when large volumes of amendments data are available in the series. The middle row shows weighted graph-level measures of centralization, distance and clustering in the networks (Opsahl and Panzarasa, 2009; Opsahl, Agneessens and Skvoretz, 2010), which underline the higher intensity of cosponsorship activity in the National Assembly, in which cosponsors are more connected, more clustered and more numerous overall.

[FIGURE 2]

The bottom row of network measures provides information on network modularity, which compares the proportion of network ties formed within a given vector of groups to that same proportion in a randomized network of identical dimensions. The further away the observed network is from the randomized 'null' model, the more efficient the group vector is at partitioning the network into meaningful communities (Newman, 2006). In a party-based setting, modularity therefore measures the level of within-party collaboration against random collaborative ties, and serves as a proxy for party polarization expressed in network data (Zhang et al., 2008; Waugh et al., 2009; Kirkland, 2013).

The methodology to compute modularity is retraced in Waugh et al. (2009) and Kirkland and Gross (2012). For a given network partition membership variable g, which in this case is the parliamentary party group affiliation of each MP, the modularity M represents the fraction of weighted network degree m contained inside the community g, minus the expected total degree of all cosponsorships in the network:

$$M = \frac{1}{2m} \sum_{i,j=1} [A(i,j) - P(i,j)] \delta(g_i, g_j)$$

where $m = \frac{1}{2} \sum_i k_i$ is the total number of cosponsorships in the network, $P(i,j)$ is the expected total degree of the network, g_i is the community to which a given MP belongs, and $\delta(g_i, g_j) = 1$ if the MP i and her cosponsor j belong to the same community, or 0 if they do not. The randomization component used in the null model preserves the weighted degree distribution of the network by being equal to $P(i,j) = \frac{k_i k_j}{2m}$, where $k_i = \sum_{j=1} A(i,j)$ is the weighted sum of cosponsorships per MP (Newman, 2006).

We further followed Waugh et al. (2009, Section 3) into maximizing our modularity estimates. We first obtained two alternative membership vectors for the observed networks from the Louvain (Blondel et al., 2008) and Walktrap (Pons and Latapy, 2006) algorithms, which identified optimal partitions through multilevel classification and through 1–50 random walks respectively. We then compared empirical party-based modularity with the highest modularity score of these 'maximized' partitions, $\max M$, by taking their ratio. All three measures are plotted in the bottom row of Figure 2 and shown in Table 2.

[TABLE 2]

Both empirical and maximized measures of modularity are, by our estimates, indicative of much higher party polarization in recent legislatures, possibly since legislature 10 (1993-1997), but most visibly and increasingly so since legislature 12 (2002-2007), following the last period of divided government. This characteristic of the network data is consistent with high measures of party unity in roll-call votes during the same period (Godbout and Foucault, 2013, p. 320), and also conforms to expectations driven by the presence of highly amended legislation in recent

decades, such as finance and social security laws.

We finally learn from the measure of party-based modularity in the observed networks that Senate networks express a higher degree of party differentiation, which translates into more inter-party collaboration being observable in the National Assembly. This measure, however, does not separate variation within and outside of the left-right cleavage that structures party coalitions (Sauger, 2010, p. 72-74). and guides the modeling strategy outlined below, which aims at decomposing left-right and party differentiation into more specific probabilities.

3.2. *Network models*

In a simplified view that overlooks only small numbers of MPs, French parliamentary politics over the observed period are configured as quadrangular conflicts between a ruling two-party rightwing or leftwing majority and a two-party opposition, modulo one additional minority party when leftwing majorities include Green MPs. This representation of the policy space translates the original insight of the "quadrille bipolaire" (Duverger, 1968), from which we derive three possible types of hypothetical interactions within the cosponsorship networks:

H1 *Partisan cohesion* might be measured as the level of intra-group collaboration, when legislation is produced exclusively or quasi-exclusively within party lines. In this case, the cosponsorship networks will express strong homophily, with ties being much more likely to occur between MPs of a same party, and especially so when party polarization in the chamber is high.

H2 *Left-right distance* might be measured as the (negative) likelihood of collaboration between rightwing and leftwing MPs, as opposed to the likelihood of collaboration between two MPs of either majority. Since we assume high

levels of party polarization overall, we expect left-right distance to be systematically present in all parliamentary configurations under study.

H3 *Social covariates* might finally explain further associative or dissociative behaviour in the networks. Past research in legislative collaboration has found higher likelihood of MPs to cosponsor legislation by MPs who are in similar in sex or seniority to them (Bratton and Rouse, 2011; Clark and Caro, 2013), and we also expect some reciprocality between pairs of mutual cosponsors.

Our first series of ERGMs takes a 'random effects' approach to party differentiation by recovering information about party membership from a latent space model. The second series takes a 'fixed effects' approach by measuring within-party homophily and left-right distance after controlling for graph-level (network) structure and node-level (MP) covariates.

Random effects model We start by estimating a series of latent cluster random effects models (Krivitsky et al., 2009), which estimate a two-dimensional Euclidean space containing as many latent clusters as there are party groups in the observed legislature network. This latent space serves a hypothetical two-dimensional policy space parametered to match the number of cosponsorships, MPs and party groups in the legislature, which assumes that each chamber might act as a veto player, as might each party group within it (Tsebelis, 1999).

The model identifies the latent space position of each MP i by approximating the count distribution of her cosponsorship ties Y_{ij} with all other MPs j as $\mu_{ij} \sim \text{Poisson}(\mu_{ij})$, controlling for overall network size and for the random propensity of each MP i and j to cosponsor legislation. The model therefore amounts to maximizing

$$log(\mu_{ij}) = \beta_0 - \|\bar{Z}_i - \bar{Z}_j\| + \delta_i + \gamma_j$$

where $\bar{Z}$ denotes the latent positions of MPs, and δ_i and γ_j are random effect terms that capture the propensity of each MP to form either send or receive cosponsorship ties (Krivitsky et al., 2009, Equation 4). This design aims at assigning MPs to latent clusters based on similarities in their cosponsorship records, controlling only for variance in legislative activity per cosponsor.

The model, which comes from Hoff, Raftery and Handcock (2002) and Hoff (2003) for the suggestion to add random effects, is implemented with the `latentnet` package (Krivitsky and Handcock, 2008). The Markov chain Monte Carlo (MCMC) estimation used a chain burn-in of 100,000 iterations, an MCMC sample size of 5,000 and an interval between successive samples of 10 iterations.

Fixed effects model In the second stage of our analysis, we fit each cosponsorship network to a fixed effects ERGM that estimates the likelihood of cosponsorship against both left-right and party differences, controlling for network size, cosponsorship reciprocality and similarity attraction by gender or seniority. The dependent variable is the probability of a cosponsorship tie Y_{ij} to exist between each pair of MPs i and j in the network, which the model expresses conditionally to other specified dyadic independence terms, as in

$$P(Y_{ij} = 1 | n, Y_{ij}^c) = \text{logit}^{-1} \left(\sum_{k=1}^{K} \theta_k \delta(\Gamma_{yk}) \right)$$

where n is the total number of MPs in the network, Y_{ij}^c denotes all pairs of cosponsors other than Y_{ij}, Γ_{yk} is a set of K network statistics expected to differentiate the observed network from other possible networks of similar dimensions where Y is randomized, and θ are the parameters estimated to maximize the likelihood of observing the network (cited from Cranmer and Desmarais, 2011, p. 71 and Equation 5).

Within-party homophily is estimated from a differential homophily term

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(Krivitsky and Handcock, 2008) that captures the (expectedly positive) variation in likelihood of cosponsorship when both MPs come from that party. The (expectedly negative) likelihood of cosponsorship between two cosponsors coming from opposing left-right majorities is estimated from a network dyad dummy that codes for an absolute categorical difference of left-right affiliation in each pair of cosponsors.[6]

The model includes similar statistics to control for the likelihood of cosponsors to be similar in sex or seniority. We also follow Cranmer and Desmarais (2011) in adding a control for mutuality in the network structure, in order to avoid inflating within-party homophily coefficients with reciprocal cosponsorships. Stronger network structure effects were too limited in most observed networks to require passing additional controls for cyclicality and transitivity.[7].

We further follow Cranmer and Desmarais (2011, p. 78) in designing a parameter to subsample the network data prior to modeling it. Because our cosponsorship data are much sparser than they are in the U.S. Congress (Fowler, 2006), the role of the threshold parameter in our design is less to 'thin' the network than to operate as a sensitivity test for the ERGM coefficients, by regaining the information on edge weights lost in passing a dichotomized projection of the cosponsorship ties to the model. This approach led us to run four parallel series of constrained and unconstrained models along the results that we report, which affected the standard errors of our results without affecting coefficient signs.[8]

The model is implemented by MCMC estimation through the `ergm` package (Hunter et al., 2008), with a chain burn-in of 10,000 iterations, an MCMC sample size of 10,000 and an interval of 10 iterations between MCMC draws.

4. RESULTS

4.1. *Random effects approach*

Figures 3 and 4 show the results of latent cluster random effects models for the earliest legislature of the National Assembly, during which the *Front national* formed a parliamentary party group, and for the latest legislature of the Senate, in which Radicals and Greens both sit in their own party groups. The plots overlay cluster assignments to empirical party membership in order to illustrate the strengths and limitations of the model, which are both present in the shown series.

[FIGURES 3 AND 4]

The graphs show MPs placed by their scaled coordinates Z_1 and Z_2, or Minimum Kullback-Leibler (MKL) estimates, in the latent space $\bar{Z}$ (Krivitsky et al., 2009, p. 7). Because the estimates control for collective and individual differences in the amount of legislation produced, MPs with low cosponsorship activity are clustered with their more active cosponsors, instead of being represented as 'hub and spoke' star subgraphs around them (Krivitsky et al., 2009, p. 10). We illustrate the difference by showing the model results along a force-directed representation of the same network, using the Fruchterman-Reingold algorithm (Fruchterman and Reingold, 1991) implemented by Butts (2008).

In the language of partisan veto players (Tsebelis, 2002), the latent cluster space shows party groups centered around their ideal points in a two-dimensional policy space, which offers four possible directions for party groups to distantiate themselves from each other. The model shows how smaller opposition party groups occupy this space by placing them differently around the ruling or opposition ma-

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jority groups, as illustrated in Figure 4.

Despite some limitations in the cluster assignment procedure, as when the identification of a subgraph of isolated cosponsors causes all other unassigned MPs to join a single large residual group, the model successfully assigns large fractions of each parliamentary group to substantively meaningful clusters: for most parties, the models grouped roughly 80% of members into a single cluster, and almost always assigns all remaining single-cluster outliers to the other leftwing or rightwing party cluster, as expected in a "quadrille bipolaire" two-party configuration characterised by high party cohesion (Duverger, 1968; Tsebelis, 2002).

To summarize the overall quality of our latent estimates of party differentiation, we compare empirical party groups to latent cluster assignments in each legislature by computing the Fowlkes-Mallows index, a quality metric of their crosstabulation that converges to 1 as the quality of the hierarchical clustering increases (Fowlkes and Mallows, 1983).[9] We compute the same index to assess the success of hierarchical clustering in each chamber, legislature and party group, as well as in every left-right coalition of party groups, by fusing leftwing and rightwing parties together prior to comparing them to latent clusters.

The results, shown in Figure 5, are moderately high in both chambers, very high in highly disciplined party groups, and generally higher in recent legislatures, for which the predictability of party affiliation from the latent space of cosponsorships has increased from approximately 0.6–0.7 to 0.8–0.9. From the patterns of their cosponsorships, the most predictable MPs are Communists, and the least predictable MPs are Senators from the Centrist (rightwing) and Radical (leftwing) party groups, which is consistent with the longer history of these party formations (Sauger, 2010, p. 70-71 and 77-78).

[FIGURE 5]

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The results also show a clear observable difference in the overall predictability of left-right coalition alignment in each chamber: in aggregate, two random MPs from the same leftwing or rightwing party coalition had a systematically higher probability to be assigned to the same cluster in the National Assembly than in the Senate, where the predictability of left-right alignment is only moderately high by that metric. This difference persists even if Radical Senators, who include both leftwing and rightwing MPs, are removed from the computation (as suggested in Sauger, 2010, p. 80).

4.2. *Fixed effects approach*

We further explore left-right alignment and party cohesion from a fixed effects perspective. Figure ?? shows ERGM coefficients for the 'full' model detailed in Section 3.2 (p. 13), along with the coefficients of a 'baseline' model that includes all predictors except the within-party differential homophily term, for which coefficients are shown separately in Figure ??. Standard errors and Bayesian Information Criteria (BIC) are reported in Tables ?? and ?? at the end of this section.

[FIGURES ?? and ??]

Three series of estimates in Figure ?? show signs of strong dyadic dependence in the cosponsorship networks. The first row simply shows intercepts for network edge counts. The second row shows the high influence of reciprocity in cosponsorship, especially among Senators (see also Cranmer and Desmarais, 2011, p. 78). The last row of coefficients further shows that, in the 'baseline' (party-free) model, Senators are generally as likely to be mutual cosponsors as they are *unlikely* to come from different leftwing and rightwing coalitions. The same relationship exists for the National Assembly, but to a lesser extent that leaves more influence to

left-right alignment than to mutuality.

The remaining rows of ERGM coefficients show that similarity in gender and seniority generally have very little influence on the formation of cosponsor dyads. All estimates for the latter are insignicant effects ranging near zero, whereas gender homophily has a single remarkable positive effect in legislature 11 (1997-2002) of the National Assembly. For this chamber and legislature, gender homophily is estimated to be predictive of cosponsorship within the same order of magnitude than reciprocality, and is robust to controlling for within-party homophily. This effect might be traceable to bill-specific events, such as welfare and women's issues (Clark and Caro, 2013), but our bill-level data are too limited to explore that hypothesis fully.

Figure ?? finally shows the differential homophily coefficients for major party groups, which measure the strength of intra-party ties after controlling for the previous covariates. In the previous series of results, the strongest node-level effects designated left-right differentiation as the strongest (negative) predictor of cosponsorship. In this part of the model, the complementary (positive) effect of party loyalty is estimated on a range of magnitude that only slightly exceeds that of all other estimates, from approximately 0 to 5 log-odds, with most effects between 0 and 2. Taken overall, the coefficients show either weak effects of party homophily in early legislatures, or stronger effects in recent ones, along with larger standard errors.

Some estimation issues appear in the ERGM of legislature 13 (2007-2012), for which most coefficients have very large standard errors. This limitation precludes any firm conclusion on the precise variation of within-party homophily in recent years. Our estimates therefore confirm that party cohesion is very high in both chambers, but only suggest that it is currently on the rise: within-party homophily among Conservatives, for instance, is currently exceptionally high in the National As-

sembly, but this level of intra-party loyalty might be accounted for by intensive obstruction strategies against highly politicized government bills like gay marriage, which generated an exceptionally high volume of (mostly single-authored) obstructive amendments, and might fade out later on.

Further statistical significance issues affect the small Communist and Socialist party groups in early legislatures of the National Assembly, in which very small numbers of authored bills cause the ERGM coefficients to switch to negative values. The issue affects legislature 9, for which there are only seven Socialist-authored bills in the network sample, and legislature 11, during which Socialist MPs led a three-party leftwing coalition and again contributed only a very small fraction of all MP-authored bills (around 5%). These issues are thus both explainable from the composition of the network sample but might still be different in nature, insofar as the odd result of legislature 11 might be substantively explainable.

With these limitations in mind, the results still provide sufficient evidence to confirm the presence of very high party homophily, coupled to high levels of cosponsor mutuality and left-right differentiation in the observed networks. The unlikelihood of left-right legislative collaboration is higher in the National Assembly, which is consistent with the previous finding that left-right coalitions in this chamber were also relatively more successfully clustered from the latent space model covered. Finally, party homophily is generally similar in both chambers, and possibly higher in the recent period.

[TABLES ?? AND ??]

5. DISCUSSION

Our analysis aimed at examining party polarization in the French Parliament from a network approach, using a set of fourteen legislature-level networks that cover both chambers since 1986. As a firsthand approach to the data, we started by modeling random effects and latent clusters in each cosponsorship network, passing party affiliation and all other covariates to a two-dimensional latent space that captured both left-right and party differentiation.[10] We then estimated left-right and party differentiation parameters as fixed effects, controlling for network structure and social covariates.

Consistent with studies of party discipline from roll-call votes (Godbout and Foucault, 2013), our results confirm very high levels of party discipline under a variety of parliamentary configurations that all express a strong level of left-right differentiations between party groups. The variations that we found in the networks are also generally consistent with other research that underline the higher volatility of Centrist and Radical MPs, and the higher discipline of far-left party groups.

Our results also underline the need for more exhaustive legislative data in machine readable format (Sauger, 2010, p. 82). Although we used a quasi-exhaustive sample of all cosponsored legislation available from the National Assembly and Senate websites, the scope of parsable legislation before 2002 is limited to bills, which in turn limits the identifiability of weak collaborative signals like cosponsorship ties, especially for smaller party groups.

Notes

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[2]The threshold to form a party group in the National Assembly was lowered from 20 to 15 members in 2009. Our figure futher ignores unaffiliated MPs.

[3]The resulting weights are bounded between 0 and 1 and are approximately log-normal in several of the collected networks.

[4]The *Front national* formed a single party group in legislature 8 of the National Assembly (1986-1988).

[5]See `https://github.com/briatte/neta`. The replication material can update the data past its current endpoint, so that legislature 14, which started in 2012, can be supplemented with more information as it becomes available.

[6]Rightwing groups are Conservatives, Centrists and *Front national* MPs. Leftwing groups are Communists, Greens, Radicals and Socialists.

[7]Furthermore, unlike Cranmer and Desmarais (2011, p. 78), the party homophily coefficients of our model did not turn insignificant when we experimented with adding triangle terms into the model equation for legislatures with sufficient transitiveties.

[8]Given that the distribution of edge weights was approximately log-normal in several networks, we used quantiles of the logged edge weights to parameter a default 95% interval that dropped all edges weighted outside the 2.5% and 97.5% percentiles. We then ran the model on subsamples with no upper bound, no lower bound, on the full data and on a harsher sample that dropped up to 10% of outlying network ties.

[9]The Fowlkes-Mallows index is computed from $(\sum T^2 - N)/\sqrt{(\sum P^2 - N) \times (\sum K^2 - N)}$, where T is the crosstabulation of true party groups p and latent cluster assignments k, $\sum P^2$ and $\sum K^2$ the squared sum of MPs in each of them, and N the total number of MPs.

[10]We might call this world 'Flatland', to make its nature clearer to those who are privileged to live in Space (Abbott, 2009, p. 35).

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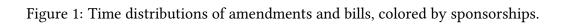URL: `http://justinhgross.web.unc.edu/files/2012/03/Multilevel-2mode-cosponsorship_main.pdf`

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Figure 1: Time distributions of amendments and bills, colored by sponsorships.

Legislature	Σ items	Σ bills	Σ amdts	Σ groups	Σ sponsors
1986-1988 (8)	222	222	0	4	368
1988-1993 (9)	388	388	0	4	355
1993-1997 (10)	34	34	0	3	378
1997-2002 (11)	542	542	0	5	619
2002-2007 (12)	7838	818	7020	4	677
2007-2012 (13)	28839	1258	27581	4	673
2012– (14)	24111	550	23561	6	613

(a) National Assembly

Legislature	Σ items	Σ bills	Σ amdts	Σ groups	Σ sponsors
1986-1988 (8)	128	128	0	5	257
1988-1993 (9)	307	307	0	5	387
1993-1997 (10)	315	315	0	5	402
1997-2002 (11)	953	411	542	5	451
2002-2007 (12)	13687	287	13400	5	420
2007-2012 (13)	14601	542	14059	6	524
2012– (14)	8363	204	8159	6	454

(b) Senate

Table 1: Total counts of amendments, bills, unique party groups and MP sponsors over legislatures 8–14 (1986-2014).

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Figure 2: Graph-level properties of the cosponsorship networks. Estimates that include amendments in addition to bills are shown with dots. Legislature 10 of the National Assembly is shown as a grey dot due to very sparse network data.

Legislature	Modularity	max M	$M/\max M$
1986-1988 (8)	0.32	0.52	0.61
1988-1993 (9)	0.26	0.38	0.68
1993-1997 (10)	0.46	0.75	0.61
1997-2002 (11)	0.46	0.58	0.80
2002-2007 (12)	0.45	0.57	0.79
2007-2012 (13)	0.52	0.57	0.91
2012– (14)	0.60	0.63	0.95

(a) National Assembly

Legislature	Modularity	max M	$M/\max M$
1986-1988 (8)	0.53	0.78	0.69
1988-1993 (9)	0.50	0.70	0.71
1993-1997 (10)	0.42	0.63	0.67
1997-2002 (11)	0.43	0.64	0.67
2002-2007 (12)	0.55	0.64	0.86
2007-2012 (13)	0.60	0.64	0.93
2012– (14)	0.63	0.67	0.94

(b) Senate

Table 2: Network party-based modularity, compared to its algorithmic maximization, $\max M$, and to their ratio.

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(b) Force-directed graph

Figure 3: Network representations of the National Assembly under legislature 8 (1986–1988). Colors correspond to actual party colors, and numbers correspond to $K = 4$ latent cluster memberships. Circle positions and diameters are proportional to latent cluster means and variances.

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(b) Force-directed graph

Figure 4: Network representations of the Senate under legislature 14 (2012–). Colors correspond to actual party colors, and numbers correspond to $K = 4$ latent cluster memberships. Circle positions and diameters are proportional to latent cluster means and variances.

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Figure 5: Fowlkes-Mallows indices for the latent cluster random effects models.

	All legislatures	SE	Leftwing governments	SE	Rightwing gove
Network structure					
Edges	-1.9	(0.07)	-1.22	(0.13)	
GWESP	1.04	(0.02)	1.1	(0.03)	
GWDSP	-0.07	(0)	-0.08	(0)	
GWD cosponsors	-1.51	(0.07)	-0.64	(0.11)	
GWD authors	-7.93	(0.13)	-7.31	(0.22)	
Reciprocity	0.97	(0.01)	1.03	(0.01)	
Balancing effects					
Same gender	0.12	(0.01)	0.13	(0.02)	
Diff. seniority	-0.05	(0)	-0.03	(0)	
Diff. left-right	-0.44	(0.04)	-0.58	(0.06)	
Party homophily					
Both Communist	4.43	(0.15)	4.81	(0.29)	
Both Green	2.61	(0.14)	2.2	(0.15)	
Both Socialist	0.99	(0.07)	1.45	(0.12)	
Both Radical	3.53	(0.34)	3.05	(0.34)	
Both Centrist	1.09	(0.05)	0.9	(0.08)	
Both Conservative	0.6	(0.05)	0.87	(0.07)	
Both FN	2.66	(0.22)		(NA)	

	All legislatures	SE	Leftwing governments	SE	Rightwing gove
Network structure					
Edges	-1.19	(0.07)	-1.2	(0.12)	
GWESP	1.1	(0.01)	1.07	(0.02)	
GWDSP	-0.06	(0)	-0.06	(0)	
GWD cosponsors	-2.2	(0.07)	-2.52	(0.11)	
GWD authors	-6.64	(0.11)	-6.65	(0.16)	
Reciprocity	1.6	(0.02)	1.54	(0.03)	
Balancing effects					
Same gender	0.2	(0.02)	0.07	(0.03)	
Diff. seniority	-0.09	(0.01)	-0.11	(0.02)	
Diff. left-right	-0.75	(0.03)	-0.89	(0.05)	
Party homophily					
Both Communist	2.38	(0.09)	2.76	(0.15)	
Both Green	2.78	(0.28)	3.13	(0.39)	
Both Socialist	1.33	(0.06)	1.82	(0.1)	
Both Radical	0.91	(0.08)	0.92	(0.13)	
Both Centrist	1.25	(0.06)	1.44	(0.1)	
Both Conservative	0.69	(0.05)	0.51	(0.09)	