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Structure and evolution of a European Parliament via a network and correlation analysis

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HIGHLIGHTS

- Statistically Validated Networks of a European parliament are built.
- Communities of members show how they collaborate when co-sponsoring bills.
- Network evolution is monitored, critical change in Parliament's structure is detected.
- Change corresponds to the rise of a right-wing populist party.
- Different behavioral patterns are revealed between government and opposition parties.

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ABSTRACT

We present a study of the network of relationships among elected members of the Finnish parliament, based on a quantitative analysis of initiative co-signatures, and its evolution over 16 years. To understand the structure of the parliament, we constructed a statistically validated network of members, based on the similarity between the patterns of initiatives they signed. We looked for communities within the network and characterized them in terms of members' attributes, such as electoral district and party. To gain insight on the nested structure of communities, we constructed a hierarchical tree of members from the correlation matrix. Afterwards, we studied parliament dynamics yearly, with a focus on correlations within and between parties, by also distinguishing between government and opposition. Finally, we investigated the role played by specific individuals, at a local level. In particular, whether they act as proponents who gather consensus, or as signers. Our results provide a quantitative background to current theories in political science. From a methodological point of view, our network approach has proven able to highlight both local and global features of a complex social system.

1. Introduction

Since the seminal papers by Watts and Strogatz [1], Barabasi and Albert [2], and Newman, Watts and Strogatz [3], the use of networks to describe the structure and evolution of complex social systems has become a standard approach in the scientific literature. Emergent structures have been studied in social networks [4] as well as their evolution [5,6].

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Table 1
Summary statistics for each parliament: N is the number of initiatives signed by at least 2 members, h_i is the heterogeneity of initiatives, that is, the range (min–max) of signatures initiatives receive, M is the number of members who signed at least 2 initiatives, h_m is the heterogeneity of members, that is, the range of signatures members affix (min–max).

Dataset summary statistics				
	I	II	III	IV
N	2467	3163	3143	1808
h_i	2–144	2–175	2–136	2–150
M	179	186	183	199
h_m	2–445	4–524	2–696	2–793

Political systems such as the European parliaments and the US congress represent a class of social systems. The structure of similarity of the US congress has been investigated by using network theory methodologies in Ref. [7], where the authors built a hierarchical tree of congress members based on law initiatives they cosponsored and attempted to characterize the two biggest communities found in terms of parties (Republicans and Democrats), by using the concept of modularity.

Although being placed in this framework, our work focuses on a typical European parliament, it takes into account more than one kind of initiatives (legislative and budget ones), and quantitatively addresses the problem of noise in a dense network, as well as the statistical significance of attributes, such as party or district, which characterize communities [8] in the network.

The political system under scrutiny is the Finnish parliament, which is a typical parliamentary system among its peers in Europe. In addition to the government, the parliament also has the right to initiate legislation. The thousands of private initiatives by members of the parliament (MPs) have a primary signer, however, they are rather often supported by a multitude of co-signers, thus forming a network of co-sponsorships. We are interested in studying the network of these relationships among MPs and the evolution of its structure over the years.

Our goal is to gain a quantitative understanding of the system by observing it with different techniques and by following the dynamics of its structure over time. In order to do so, we take a network approach to discover the internal ordering of the system in communities and to characterize them, and perform a correlation analysis of MPs, in order to study the hierarchical structure of communities [9–11] and investigate its evolution. Specifically, we study how correlations inside each party and between parties, as well as within and between government and opposition, vary over time, by using the Frobenius distance to measure how similar each year of a parliament term is to the next one.

We look at the database of initiatives as a bipartite network in which there are two sets of nodes—MPs on the one side, and initiatives on the other—where an MP is linked to an initiative if she/he signed it. According to that description, two MPs would show a "similar" profile if they had signed "several" initiatives together. To provide a quantitative meaning to the expressions "similar" and "several", recently, a method for filtering out statistically significant links in bipartite networks has been proposed [12]. This approach has already been used to investigate the structure of several systems, including stock returns [13] and investors' activity [14] in a financial market, the specializations of criminal activity [15], the interbank market [16,17], a mobile communication network [18], and a large survey on aging [19].

Our results indicate that the methodologies we employ are able to single out both local and global characteristics of a social system such as a parliament, which appear consistent with pre-existent theories in political science. Although our conclusions pertain to the Finnish legislature, the techniques we used are exportable to any similar systems, paying due attention to any necessary adjustments when carrying them over to a different political context.

2. Results and discussion

2.1. Data

The database consists of Finnish initiatives, submitted between 1999 and 2014 by members of the parliament. The parliament has 200 members. Complementary information stored in the database comprises who submitted each initiative, who signed it and the year it was submitted, along with the following general attributes regarding members: their gender, party and electoral district of origin.

Since a parliament term lasts four years, our data encompasses four different parliaments: Dataset I corresponds to the 1999–2002 parliament, Dataset II to 2003–2006, Dataset III to 2007–2010 and Dataset IV to 2011–2014. Summary statistics for each dataset are shown in Table 1. See Appendix for Table A.1 of political parties with their abbreviations, number of seats and political position, Table A.2 for the electoral districts and Table A.3 for government/opposition coalitions.

According to Ref. [20], MPs have the right to introduce a legislative initiative containing a proposal for the enactment of an Act. As the final decision in the State's annual budget lies in the hands of the parliament, MPs can also propose a budget amendment containing a proposal for an appropriation to be included in the budget or for other budgetary decision. In addition, MPs can propose a petitionary motion containing a proposal for the government for drafting a law or for taking other governmental measures. Finally, an MP may ask the Speaker's Council that a topical debate be held in a plenary session. All the initiatives have to be in writing and must be signed together with possible co-signatures before the introduction.