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Legislative cosponsorship networks in the US House and Senate

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Abstract

In the US House and Senate, each piece of legislation is sponsored by a unique legislator. In addition, legislators can publicly express support for a piece of legislation by cosponsoring it. The network of sponsors and cosponsors provides information about the underlying social networks among legislators. I use a number of statistics to describe the cosponsorship network in order to show that it behaves much differently than other large social networks that have been recently studied. In particular, the cosponsorship network is much denser than other networks and aggregate features of the network appear to be influenced by institutional arrangements and strategic incentives. I also demonstrate that a weighted closeness centrality measure that I call ‘connectedness’ can be used to identify influential legislators.

1. Introduction

Since 1967 in the US House and the mid-1930s in the US Senate, legislators have had an opportunity to express support for a piece of legislation by signing it as a cosponsor. Several scholars have studied individual motivations for cosponsorship (Campbell, 1982; Kessler and Krehbiel, 1996; Koger, 2003; Mayhew, 1974; Wilson and Young, 1997). There have also been a number of studies that seek to understand aggregate cosponsorship behavior (Panning, 1982; Pellegrini and Grant, 1999; Talbert and Potoski, 2002). This research has clearly focused on which bills individuals and groups of legislators will support. However, it does not consider which legislators receive the most and least support from their colleagues. This oversight is somewhat puzzling, since several scholars have argued that bill sponsorship is a form of leadership (Caldeira et al., 1993; Hall, 1992; Kessler and Krehbiel, 1996; Krehbiel, 1995; Schiller, 1995). Campbell (1982) notes that legislators expend considerable effort recruiting cosponsors for the bills they

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have sponsored with personal contacts and "Dear Colleague" letters. Moreover, Senators and members of the House frequently refer to the cosponsorships they have received in floor debate, public discussion, letters to constituents, and campaigns.

In this article I posit that cosponsorship networks contain important information about the social connections between legislators. In these networks, a directional link can be drawn from each cosponsor of a piece of legislation to its sponsor. Only two studies have treated the cosponsorship network as a social network. Burkett (1997) analyzes the Senate and finds that party affiliation and similar ideology increase the probability of mutual cosponsorship. She also hypothesizes that seniority will increase the number of cosponsorships received, but she does not find a significant effect. Faust and Skvoretz (2002) utilize Burkett's data to compare the Senate cosponsorship network with social networks from other species.

I extend these earlier investigations by drawing on all 280,000 pieces of legislation proposed in the US House and Senate and 2.1 million cosponsorship signatures to study the large-scale structure of these networks. Using a number of statistics, I describe these networks and show that they differ substantially from other large-scale social networks that have been recently studied. I then describe a weighted centrality measure I call 'connectedness' which uses information about the frequency of cosponsorship and the number of cosponsors on each bill to make inferences about which legislators are best connected to the network. This measure identifies a plausible list of the most connected members of the House and Senate from 1973 to 2004.

2. Methods

Why would we expect a social connection to exist between a bill's sponsor and cosponsor? Consider two different kinds of cosponsorship, active and passive. An active cosponsor actually helps write or promote legislation, but cannot be considered a sponsor since the rules in both the House and the Senate dictate that only one legislator can claim sponsorship. Thus, some cosponsorship relations will result from a joint effort between legislators to create legislation, which is clearly a sign that they have spent time together and established a working relationship. In contrast, a passive cosponsor will merely sign on to legislation she supports. Although it is possible that this can happen even when there is no personal connection between the sponsor and the cosponsor, it is likely that legislators make their cosponsorship decisions at least in part based on the personal relationships they have with the sponsoring legislators. The closer the relationship between a sponsor and a cosponsor, the more likely it is that the sponsor has directly petitioned the cosponsor for support. It is also more likely that the cosponsor will trust the sponsor or owe the sponsor a favor, both of which increase the likelihood of cosponsorship. Thus, the push and pull of the sponsor–cosponsor relationship suggest that even passive cosponsorship patterns may be a good way to measure the connections between legislators.

Data for the legislative cosponsorship network is available in the Library of Congress Thomas legislative database. For the purposes of this study I include cosponsorship ties from the cosponsor to the sponsor for all forms of legislation, including all 280,000 resolutions, public and private bills, and amendments (I will use the term "bills" generically to refer to any piece of legislation). Although private bills and amendments are only infrequently cosponsored, I include them because each document that has a sponsor and a cosponsor contains information about the degree to which legislators are socially connected.

Biennial elections cause the membership of the US House and Senate to change every 2 years, but between elections the membership is relatively stable. Toward the end of this article I examine the whole network, but for now I divide it by chamber and Congress to create 32 separate cosponsorship networks. This will permit analysis of changes over time and between the House and the Senate, and will expose the manner in which institutional rules or artifacts in the data may drive some of the network characteristics.

3. Number of sponsors and bills sponsored

Table 1 shows the number of sponsors identified in each Congress and the total number of bills sponsored by these individuals. The number of sponsors varies only slightly (less than 2%) from Congress to Congress due to deaths and retirements that occur between Congresses and in some cases inactivity by a particular member. However, there are two fairly large and systematic changes in the total number of bills sponsored that are worth noting. First, prior to the 96th Congress there was a 25 cosponsors limit on all legislation in the House. As a result, the number of bills sponsored in the 93rd to 95th Houses is about double the number of bills sponsored in later years. These numbers are inflated because of the incidence of identical bills during this period. However, this rule did not deter legislators who sought more support—it was not uncommon for several identical versions of the same bill to be submitted, each with a different set of 25 cosponsors. In 1978, the House voted to remove the limit. Second, the Library of Congress provides data for all bills and resolutions since the 93rd Congress, but complete data for amendments is not available until the 97th Congress. The number of amendments sometimes exceeds the number of bills and resolutions in the Senate, helping to explain the substantial jump in total bills in the 97th Senate.

4. Number of bills per legislator

For the 97th to 108th Congresses, the average number of bills per legislator ranges from 41 to 111 in the Senate and 15 to 24 in the House, suggesting that Senators tend to produce more legislation on average than members of the House. The mean is only one part of the story, however. Bibliometric studies have revealed an interesting tendency in the distribution of published scientific papers. The vast majority of scholars produce relatively few papers and a very small number of individuals are extremely productive. Moreover, the tail of the distribution tends to follow a power law $p(k)=k^{-\gamma}$, where k represents the number of papers, $p(k)$ represents the frequency of scholars who have written that many papers, and $-\gamma$ is the linear slope of the distribution when a histogram of papers per author is displayed on a log–log plot. Lotka (1926) was the first to notice this feature in scientific authorship and it has since been confirmed in a number of other studies (Newman, 2001a,b; Pao, 1986; Voos, 1974).

The distribution of bills per legislator is quite different from the distribution of articles per scholar. Fig. 1 shows histograms of the total number of bills sponsored by each legislator in each Congress for the House and Senate on a logarithmic plot. For comparability between the House and Senate the counts are converted to percent of chamber and pooled across Congresses, but the distributions for individual Congresses (not shown) tell the same story. These distributions are clearly not power law distributed. In contrast to the large number of scholars who publish five scientific papers or less, most legislators sponsor five bills or more (91% of legislators in the House and 99% of legislators in the Senate).

One possible explanation for the difference between scholars and legislators may be related to the survival function underlying the data of both processes. Scientific authorship studies typically define a fixed time period to observe published articles, just as we have defined a 2-year period (one Congress) to observe proposed legislation. In the Congress there are very few exits and new entrants between elections. In contrast, there may be a relatively high level of turnover among

Table 1
Characteristics of cosponsorship networks, 1973–2004

Congress	Years	Total "bills"	Total sponsors	Mean "bills" sponsored by each legislator	Mean "bills" cosponsored by each legislator	Mean cosponsors per "bill"	Cosponsors per legislator	Mean distance	Clustering coefficient
House									
93rd	1973–1974	20994	442	48	129	3	70	1.95	0.41
94th	1975–1976	19275	439	44	151	3	79	1.89	0.44
95th	1977–1978	18578	437	42	170	4	93	1.83	0.47
96th	1979–1980	10478	436	24	187	8	111	1.76	0.50
97th	1981–1982	10062	435	23	223	10	132	1.72	0.56
98th	1983–1984	9095	435	21	297	14	157	1.65	0.63
99th	1985–1986	8606	432	20	329	17	171	1.61	0.67
100th	1987–1988	8093	436	18	341	18	174	1.60	0.67
101st	1989–1990	8423	438	19	370	19	184	1.58	0.68
102nd	1991–1992	8551	436	19	339	17	172	1.61	0.66
103rd	1993–1994	7464	437	17	259	15	144	1.67	0.59
104th	1995–1996	6558	433	15	168	11	105	1.77	0.47
105th	1997–1998	6780	439	15	219	14	127	1.73	0.54
106th	1999–2000	7894	437	18	278	15	151	1.67	0.60
107th	2001–2002	7541	441	17	273	16	143	1.68	0.59
108th	2003–2004	7636	438	17	276	16	147	1.67	0.60
Senate									
93rd	1973–1974	5123	101	51	153	3	54	1.46	0.79
94th	1975–1976	4913	100	49	137	3	52	1.48	0.76
95th	1977–1978	4722	102	45	121	3	49	1.51	0.74
96th	1979–1980	4188	99	41	135	3	54	1.46	0.77
97th	1981–1982	9674	101	96	219	2	68	1.31	0.88
98th	1983–1984	11228	101	111	294	3	77	1.24	0.93
99th	1985–1986	7596	101	75	324	4	75	1.24	0.92
100th	1987–1988	7782	101	77	361	5	83	1.17	0.95
101st	1989–1990	7370	100	74	376	5	82	1.17	0.95
102nd	1991–1992	7686	101	75	335	4	79	1.21	0.93
103rd	1993–1994	5824	101	58	232	4	70	1.30	0.88
104th	1995–1996	8101	102	79	176	2	59	1.41	0.80
105th	1997–1998	7001	100	70	212	3	67	1.33	0.86
106th	1999–2000	8265	102	81	290	4	76	1.24	0.91
107th	2001–2002	8745	101	87	261	3	71	1.30	0.89
108th	2003–2004	7804	100	78	285	4	72	1.27	0.90

Note: "bills" include any bill, resolution, or amendment offered in the House or Senate. Complete data for amendments starts in the 97th Congress.

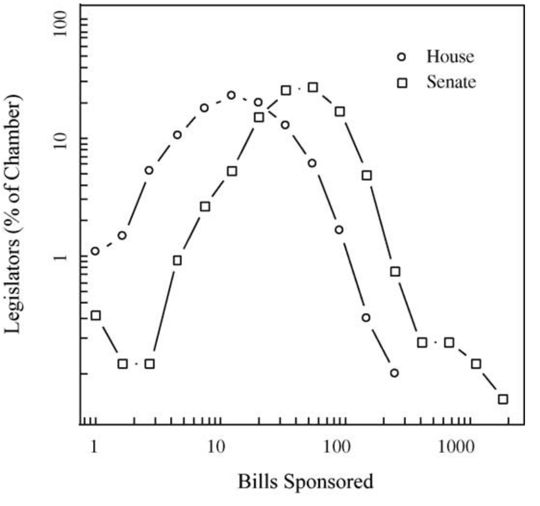

Fig. 1. Histogram of bills sponsored in the House and Senate.

scholars who enter and exit the production of scholarly research due to death, retirement, or change of careers. For example, it is not uncommon for students to coauthor a few pieces with an advisor and then enter the private sector or devote themselves to teaching once they graduate. Thus, the observed number of papers per author may really be a mixture of two distributions, the distribution of the active time spent as a scholar and the distribution of the rates at which active scholars produce papers. Since the Congress data keep the distribution of active time relatively fixed, it suggests that the distribution of entry and exit may play an overlooked role in the analysis of scientific productivity.

5. Number of cosponsors per bill

A very large number of bills (156,270 or 55% of the total) are not cosponsored by anyone, so these bills do not provide information about social connections between legislators. The remaining bills, however, each indicate which legislators were willing to support publicly legislation that has been introduced by each sponsor. Table 1 shows that the mean House member cosponsored 129–370 bills while the mean Senator cosponsored between 121 and 360 bills, suggesting that the decision to cosponsor bills is similar for both branches. This may seem like a lot of cosponsorship activity, but in fact the number of cosponsors on each bill is quite low. The average House bill was cosponsored by only 3–19 House members and the average Senate bill was cosponsored by only 3–5 Senators.

Fig. 2 shows the distribution of the number of cosponsors per bill on a log–log plot. To aid in comparing the House and Senate, the number of cosponsors is divided by the total number of legislators in the chamber. Notice that the distributions for the House and Senate are quite close, suggesting that the cosponsorship process in both branches is similar. In fact, for bills cosponsored by up to 49% of the chamber, these distributions look like the power law distributions of number of coauthors per article found in the scientific authorship literature. A simple log–log regression of cosponsors as a percent of chamber on frequency of bills suggests a power law exponent of $\gamma = 1.69$ (S.E. 0.03, $R^2 = 0.94$) in the House and $\gamma = 1.59$ (S.E. 0.04, $R^2 = 0.97$) in the Senate.

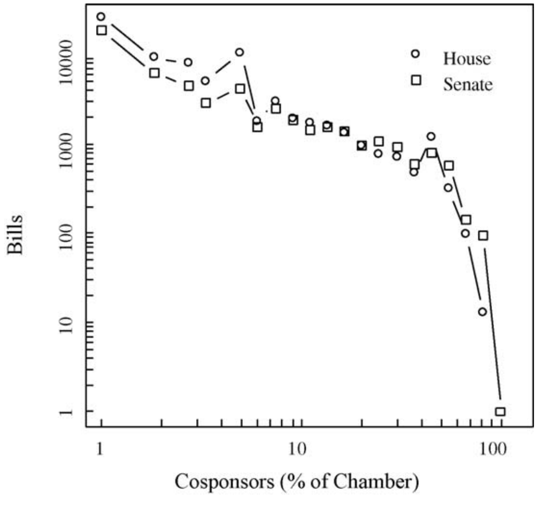

Fig. 2. Histogram of cosponsors per bill in the House and Senate.

However, unlike scientific authorship networks, there is a sizable concentration in the distribution of bills cosponsored by a majority (or near-majority) of legislators. Bills cosponsored by 49–51% of the chamber outnumber bills cosponsored by 47–49% of the chamber by 5 to 1 in the House and 3 to 1 in the Senate. This probably reflects the strategic incentive to acquire or block cosponsorship support for a bill by a majority of the chamber before it comes to a vote (e.g. see the description of the battle over the A–Z legislation in Krehbiel (1995)). When a bill approaches majority support, the marginal effect of each additional cosponsor on the probability of passage quickly increases. For example, in the House, bills with a single cosponsor pass 10.7% of the time and the probability gradually rises to 30.2% for bills that are cosponsored by 47–49% of the chamber. In the Senate, bills with a single cosponsor pass 14.0% of the time and the probability gradually increases to 39.9% for bills that are cosponsored by 47–49% of the chamber. In comparison, bills cosponsored by 49–51% of the chamber pass 43.9% of the time in the House and 54.5% of the time in the Senate. The distribution of bills cosponsored by more than a majority then drops off rapidly with an estimated power law exponent of $\gamma = 6.26$ (S.E. 0.35, $R^2 = 0.73$) in the House and $\gamma = 6.37$ (S.E. 0.62, $R^2 = 0.70$) in the Senate. Apparently, there is less interest in generating additional support for bills once they have been cosponsored by a majority of the members.

6. Connections between legislators

There are many ways to measure how connected legislators are to one another in the cosponsorship network. Perhaps the simplest is to identify the total number of bills sponsored by a given legislator and then count all the legislators who have cosponsored at least one of these bills. Table 1 shows that the average number of unique cosponsors per legislator varies from 70 to 184 in the House and from 52 to 83 in the Senate. Notice that although the absolute numbers of cosponsors per legislator tend to be higher in the House, Senators tend to receive support from a much larger fraction of the total members in their chamber. There are also some important changes over time. The average number of cosponsors per legislator reflects in part the degree to which

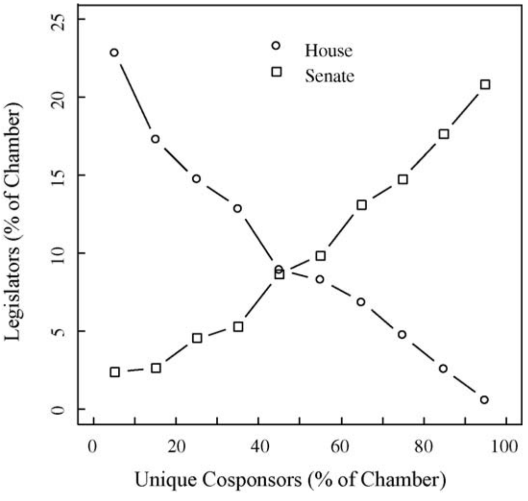

Fig. 3. Histogram of unique legislator cosponsors in the House and Senate.

the average member is integrated into the network—when legislators have more cosponsors it may indicate they are operating in an environment in which it is easier to obtain broad support. Thus, it is particularly interesting that this value falls sharply for the 104th Congress when the "Republican Revolution" caused a dramatic change in the partisan and seniority compositions of both chambers.

Once again, the mean provides only partial information. Fig. 3 shows the full distribution of cosponsors per legislator in the House in the Senate. Note that this figure is not a log–log graph—the distributions are approximately linear and they differ dramatically for the two chambers. In the House, a majority of the legislators only received cosponsorships from 25% of the chamber or less. In contrast, a majority of the Senators received cosponsorships from 75% of the other Senators. These results show that the Senate cosponsorship network is much more densely interconnected than the House. This is probably due in part to its smaller size, but it may also result from different norms or the tendency for Senators to be more skilled at making connections with their fellow legislators. These results also stand in stark contrast to the literature on scientific citations and coauthorship, which suggests that there should be a power law tail in the distribution instead of a linear distribution (Lehmann et al., 2003; Newman, 2001a; Redner, 1998).

Counting unique cosponsors is an important first step in understanding how connected a given legislator is to the network. However, this method neglects information about the legislators who are offering their support. Are the cosponsors themselves well-connected? If so, this might indicate that the sponsor is more closely connected to the network than she would be if she was receiving cosponsorships from less connected individuals. One way to incorporate this information is to calculate the shortest social distance, or geodesic, between each pair of legislators. A given sponsor has a distance of one between herself and all her cosponsors. She has a distance of two between herself and the set of all legislators who cosponsored a bill that was sponsored by one of her cosponsors. One can repeat this process until the shortest paths are drawn for all legislators in the network. The average distance from one legislator to all others (also called closeness centrality) gives us an idea of not only how much direct support she receives, but how much support her supporters receive.

The distribution of all pairwise distances in the 108th House demonstrates that the network is very densely connected. About one-third (33.98%) of the relationships are direct and nearly two-thirds (64.83%) can be connected through a single intermediary. Only a handful (1.13%) of peripheral legislators have a distance of three to the rest of the network and four is the maximum. The distribution for the 108th Senate is even denser—the maximum distance there is two. The penultimate column of Table 1 shows that the average distances for each chamber and Congress are quite short. In the House it ranges from 1.58 to 1.95, while in the Senate it ranges from 1.17 to 1.51. Other social networks typically have much longer average distances reflecting their larger size and more sparse connections. In fact, the shortest average distance reported for scientific collaboration networks is 4.0 (Newman, 2001a).

Another way to measure the density of the cosponsorship network is to examine the relationships between the cosponsors for a given sponsor. In most social networks connections are highly clustered. That is, people tend to form ties in tightly-nit cliques in which everyone is tied to everyone else. The clustering coefficient is a measure of this property, giving the probability that any two individuals to which a person is tied also have a tie between them. In other words, how likely is it that there is a direct cosponsoring relationship between two legislators given that they both cosponsor bills by the same legislator? The last column of Table 1 shows these values for each chamber and Congress. The House ranges from 0.41 to 0.66 while the Senate ranges from 0.74 to 0.95. Compared to the range of clustering observed in social networks studied by Newman (Newman, 2001a,b) and others (Albert and Barabási, 2002), the values in the House cosponsorship network are normal to high, while the values for the Senate are higher than any others observed in the literature.

7. Which legislators are most connected?

In a related study (Fowler, 2005) I show that a weighted closeness centrality measure I call "connectedness" is closely related to commonly-used proxies for legislative influence. In particular, legislators with high connectedness scores tend to pass more of their own amendments on the floor, and are more effective at convincing their peers to vote for final passage of legislation they have sponsored during roll calls. This connectedness measure takes advantage of two pieces of information that are helpful for determining the strength of social relationships that exist in the network. First, we have information about the total number of cosponsors c_l on each bill l. Legislators probably recruit first those legislators to whom they are most closely connected. As the total number of cosponsors increases, it becomes more likely that a cosponsor is recruited by an intermediary other than the sponsor, increasing the possibility that there is no direct connection at all. Thus bills with fewer total cosponsors probably provide more reliable information about the real social connections between two legislators than bills with many cosponsors (Burkett, 1997). This relationship might take several different functional forms, but I assume a simple one: the strength of the connection between i and j on a given bill l is posited to be $1/c_l$. Second, we have information about the total number of bills sponsored by j that are cosponsored by i. Legislators who frequently cosponsor bills by the same sponsor are more likely to have a real social relationship with that sponsor than those that cosponsor only a few times. To incorporate this information with the assumption about the effect of the number of cosponsors into a measure of connectedness, let a_{lij} be a binary indicator that is 1 if legislator i cosponsors a given bill l that is sponsored by legislator j, and 0 otherwise. Then the weighted quantity of bills cosponsored w_{ij} will be the sum $w_{ij} = \sum_l a_{ijl}/c_l$.

I assume that the direct distance from legislator j to legislator i is the simple inverse of the cosponsorship weights: $d_{ij} = 1/w_{ij}$. Dijkstra's algorithm (Cormen et al., 2001) then allows us to find the shortest distance between each pair of legislators using the following steps: (1) Starting with legislator j, identify from a list of all other legislators the closest legislator i. (2) Replace each of the distances d_{kj} with min (d_{kj}, d_{ki}, d_{ij}).[1] (3) Remove legislator i from the list and repeat until there are no more legislators on the list. Connectedness is the inverse of the average of these distances from all other legislators to legislator j: $(n-1)/(d_{1j} + d_{2j} + \cdots + d_{nij})$. This measure is closely related to the weighted centrality measure used by Newman (2001b) to find the best connected scientist in the scientific coauthorship network, which assumes that tie strength is proportional to the number of papers two scholars coauthor together and inversely proportional to the number of other coauthors on each paper. However, ties in the cosponsorship network are directed. This means that unlike the scientific coauthorship network which has symmetric weights $w_{ij} = w_{ji}$, the weights in the cosponsorship network are not symmetric: $w_{ij} \neq w_{ji}$. In principle, there could be two kinds of connectedness—one based on the support j receives from others (the one developed here) and one based on the support j gives to others. When we think of people who are well-connected, we usually think of those who are able to get things done because of their social relationships. I focus on support received because it indicates how well a particular legislator can persuade her peers to behave in a way that will help her to achieve her goals.

We can use the connectedness measure to identify the most connected legislators in the House and Senate using all data available from 1973 to 2004. Substantial overlap in the membership from Congress to Congress ensures the cosponsorship network will remain connected so we can find distances and paths to and from each legislator in the expanded network. In fact, the significant number of legislators who have served in both the House and Senate during this time period permits us to analyze the full network containing legislators in both branches.

There are some caveats. We do not observe the activity of legislators who served prior to 1973 or after 2004. Thus, these legislators may have lower scores than they would have if we could observe them for the whole period they hold office. Also, we have already seen that there are systematic differences in the density of the cosponsorship networks between the House and Senate. Thus, Senators may have an advantage in the full network, though we will not be able to tell if this advantage is due to differences in the idiosyncratic tendencies of the members (are Senators more skilled at getting connected than members of the House?), differences in the legislative rules (such as the brief 25 cosponsor cap in the House), or differences in the structure of the networks in the two branches (primarily, the smaller number of members in the Senate).

With these caveats in mind, Table 2 shows the 20 legislators with highest connectedness scores for the period 1973–2004 in the House network, the Senate network, and the full network for both chambers. A visual representation of the Senate network is also presented in Fig. 4. This figure shows that the top 20 legislators in the Senate network cluster tightly in the center of the network with many strong connections to other legislators and amongst themselves. Congressional scholars may have differing opinions about the degree to which the legislators who appear in Table 2 are influential or important. However, several of these individuals would eventually be candidates for President, party leaders, cabinet officials, mayors of large cities, UN ambassadors, and other household names in American politics. Interestingly, six members of the House make it into the top 20 for the network that combines both branches. However, all but one of these individuals

[1] The minimum is selected because the direct distance from j to k may actually be greater than the indirect distance from j to k thru i given by the sum.

Table 2
Best connected legislators across the 93rd to 108th Congresses

Rank	Best connected Representatives	Best connected Senators	Best connected (both chambers)
1	Pepper, Claude [D-FL-14]	Kennedy, Edward M. [D-MA]	Pepper, Claude [D-FL-14]
2	Koch, Ed [D-NY-18]	Hatch, Orrin G. [R-UT]	Mitchell, George J. [D-ME]
3	Biaggi, Mario [D-NY-19]	Dole, Robert J. [R-KS]	Dole, Robert J. [R-KS]
4	Oakar, Mary Rose [D-OH-20]	Mitchell, George J. [D-ME]	Thurmond, Strom [R-SC]
5	Crane, Phil [R-IL-8]	Thurmond, Strom [R-SC]	Cohen, William [R-ME-2][a]
6	Young, Andrew [D-GA-5]	Byrd, Robert [D-WV]	Hollings, Fritz [D-SC]
7	Studds, Gerry [D-MA-10]	McCain, John [R-AZ]	Byrd, Robert [D-WV]
8	Waxman, Henry [D-CA-24]	Kerry, John [D-MA]	McCain, John [R-AZ-1][a]
9	Breaux, John [D-LA-7]	Hollings, Fritz [D-SC]	Hatch, Orrin G. [R-UT]
10	Gibbons, Jim [R-NV-2]	Deconcini, Dennis [D-AZ]	Kennedy, Edward M. [D-MA]
11	Oberstar, James L. [D-MN-8]	Baker, Howard [R-TN]	Levin, Carl [D-MI]
12	Stark, Fortney Pete [D-CA-9]	Garn, Jake [R-UT]	Riegle, Donald [D-MI-7][a]
13	Dingell, John [D-MI-16]	Dodd, Christopher [D-CT]	Moynihan, Daniel Patrick [D-NY]
14	Rosenthal, Benjamin [D-NY-8]	Cranston, Alan [D-CA]	Baker, Howard [R-TN]
15	Rostenkowski, Dan [D-IL-8]	Harkin, Tom [D-IA]	Deconcini, Dennis [D-AZ]
16	Rangel, Charlie [D-NY-15]	Moynihan, D. Patrick [D-NY]	Breaux, John D-[LA-7][a]
17	Cohen, William [R-ME-2]	Helms, Jesse [R-NC]	D'Amato, Alfonse [R-NY]
18	Murphy, John [D-NY-17]	Leahy, Patrick [D-VT]	Kerry, John [D-MA]
19	Goldwater, Barry Jr. [R-CA-20]	D'Amato, Alfonse [R-NY]	Snowe, Olympia [R-ME-2][a]
20	Jones, Walter, Sr. [D-NC-1]	Bennett, Robert F. [R-UT]	Cranston, Alan [D-CA]

Note: Symbols in brackets indicate party, state, and district.
[a] Also served in the Senate during the period.

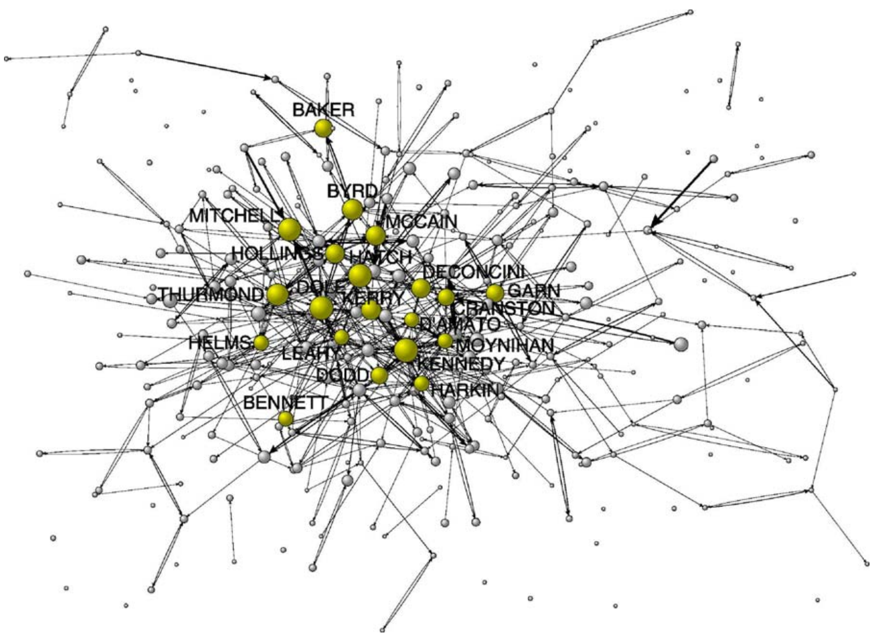

Fig. 4. Strongest weighted cosponsorship ties in the full Senate network, 1973–2004. Note: Size of each vertex is proportional to the Senator's connectedness score, the width of each arrow is proportional to the weighted quantity of bills cosponsored w_{ij} (values of $w_{ij} < 10$ not shown) and vertices that represent the top 20 Senators are identified by name. Figure drawn using Kamada–Kawai algorithm in Pajek (de Nooy et al., 2005).

also served as a Senator some time during the period 1973–2004. The one who did not – Claude Pepper – also served as a Senator, but he did so prior to 1973.

8. Conclusion

In this article I use legislative cosponsorship networks to study the social connections between legislators. Comparison of these networks with other large-scale social networks reveals several interesting features. The distribution of bills per legislator does not conform to the same power law that has been observed in studies of scientific papers per scholar. Since the 2-year networks studied here are static, one possibility is that entry and exit play an important role in the scientific productivity literature that has been overlooked. Part of the distribution of cosponsors per bill conforms to a power law in both the House and Senate, but there is a significant increase in the number of bills receiving support from a near or bare majority. This demonstrates that institutional arrangements and strategic incentives may influence the shape of social networks. The distribution of cosponsors per legislator is linear and differs by chamber—most House members are connected to less than a quarter of the members of their chamber while most Senators are connected to more than three-quarters. An analysis of the distance (geodesic) between legislators and their tendency to cluster shows that the House is more densely connected than other large networks that have been studied, and the Senate is even more densely connected than the House, conforming to recent findings on the committee assignment network (Porter et al., 2005). Finally, I demonstrate how cosponsorship networks can be used to identify influential legislators.

This work poses several challenges to formal theorists in both the physical and social sciences. Although a number of scholars have modeled cosponsorship, none of these models yields the empirical regularities in the networks studied here. For example, it is remarkable that in spite of important institutional differences in the House and Senate, the distribution of cosponsors per bill is so similar. Also, the cosponsorship network fails to generate power law tails on a number of distributions that have been observed in other large-scale networks. Now that we have a better picture of the real world, this work should promote theoretical efforts to understand the structure of legislative and other social networks.

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