Recent evidence in the support of oligopolistic cooperation: a network approach

Mitchell, Green

University of Missouri-Kansas City

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A Network Approach

by

Mitch Green[1]

Abstract: This paper seeks to retest the oligopolistic cooperation hypothesis of market structure from the Centralized Private Sector Planning literature, using 2010 data on corporate board membership and recent advances in social network analysis. Centrality measures are calculated based upon the corporate governance network emerging from common board membership on Fortune 100 firms. The findings herein suggest that not only does oligopolistic cooperation continue to characterize the US economy, but directors from the finance and insurance sector occupy a significantly more central role in the planning process than those of other industries. (91 words)

Keywords: John Munkirs, Centralized Private Sector Planning, Social Network Analysis, Oligopolistic Cooperation

[1] The author is currently at UMKC pursuing an IPh.D. in Economics and Social Sciences Consortium

It has long been the province of institutional economics to address the question: what is the nature of the firm in the context of evolutionary change? One contribution towards addressing this issue remains the recognition that firms operate not as isolated producers working to meet the demands of the market, but rather operate in concert to the needs of the "machine process" (Veblen, 1904). As the machine process grows in scope and complexity it eclipses the market as a social provisioning process. Pecuniary interests vested in the integrated industrial system demand a minimal degree of certainty regarding the validation of financial interests, which necessitates an institutional framework capable of planning for such contingency. We know this institution as the modern corporation.

This paper focuses on the manner in which corporations coordinate efforts for their mutual benefit. The notion of Centralized Private Sector Planning (CPSP) emerges in the institutional economics literature to explain the "opaque fact" that the modern industrial production system constitutes a network of interlocking institutional arrangements, whereby its constituent elements play some part in the production of financial profits for the whole (Munkirs, 1985; Munkirs and Knoedler, 1987). This paper seeks to reexamine one implication of the CPSP literature: that the economy can best be described as a system of o*ligopolistic cooperation* (Munkirs and Sturgeon, 1985).

While an analysis of all categories of institutional interlocks presented in the CPSP literature is beyond the scope of this paper, it shall be argued that board of director interlocks alone provide sufficient evidence that oligopolistic cooperation constitutes the essential structure of the economy today. Moreover, the centrality of financial and insurance entities continues to exert a considerable degree of influence over the planning process amongst America's largest corporations. To establish the empirical basis for the assertions listed above, this paper employs recent methodological advances in the area of social network analysis to construct the Fortune 100 corporate governance network. The results provide some quantitative measure of power and influence vested in the corporate elite.

Methodology and Results

Social network analysis (SNA) provides a host of techniques that allow the researcher to investigate the institutional complexity involved in a variety of systems[2]. SNA rejects reductionist approaches that focus in the individual, suggesting instead the ties between individuals (nodes) serve as the fundamental unit of analysis. Furthermore, the approach recognizes that complex networks of connections give rise to emergent structures, which then become the basis for analysis. Given a set of nodes[3] N one may formalize the connections between each element of N with an *adjacency matrix* X. The resulting NxN matrix contains null values along its principal diagonal, and a binary value indicating whether a tie between the ith and jth element of N exists along its off diagonals. Once populated, the adjacency matrix allows the researcher to calculate a number of measures for *network centrality*[4]. The centrality of a given node in terms of the network may be used to make inference regarding its relative importance, influence, status or prestige (Wasserman and Faust, 1994). A more formal definition for centrality, as well as the measures employed in this study, shall be offered below. For now the task remains to introduce the manner in which this study constructs the network of interlocking corporate directorates.

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[2] For a comprehensive introduction to the literature, see Wasserman and Faust (1994)

[3] In the SNA literature, nodes refer to the element of the network such as actors, agents, etc.

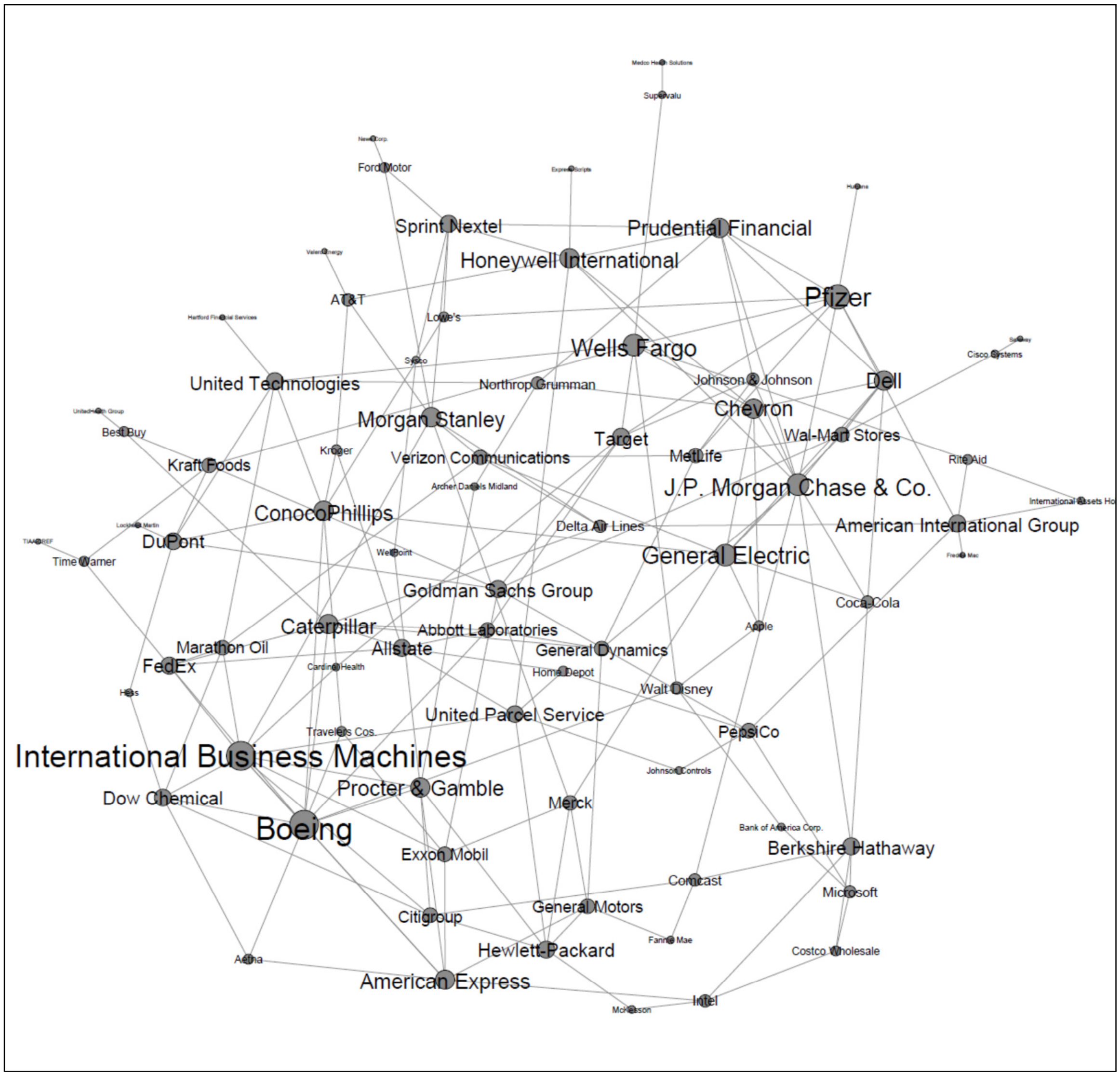
[4] All measures of centrality and graph layouts were obtained using two programs: Gephi and UCINET. Gephi is open-source and available at www.gephi.org

This paper focuses on the Fortune 100 list of American corporations for 2010 as well as each firm's respective board of directors (BOD)[5]. Taking the set of corporations and board members together as our list of nodes allows us to examine which board members provide a link between firms through common BOD membership. Three networks emerge from the data that are of interest to this paper. First, the total set of directors and corporations constitutes a network wherein the largest corporations in America are connected *indirectly* through common board members. In total, there are 1129 nodes (directors plus firms) with 1179 ties linking them together. Since the ties are greater then nodes, we observe that some directors serve on more than one board. For example, Richard Myers sits on the boards of both United Technologies and Northrup Grumman. While this network is interesting insofar as one may examine which directors serve as connections between different corporate boards, measures of centrality lose meaning since each corporation will have a degree centrality measure equal to the number of directors on its board. We are more interested in the *indirect connections* implied by interlocking directorates, which will give us some sense of the centrality of each Fortune 100 firm.

The second network of interest emerges as we limit our set of nodes to the list of Fortune 100 firms, then cross-tabulate each element of the set according to common board membership. Excluding firms for which no common membership exists with another corporate board results in 82 firms defining a square matrix, populated with the number of direct BOD interlocks in off-diagonal cells[6]. A graphical representation of the results in Appendix 1 is shown in Figure 1 below.

[5] Firm data were gathered from Fortune's website, while board membership was gleaned from Reuters news service and annual reports for 2010.
[6] See appendix 1 for full matrix.

Figure 1: Network of Fortune 100 firms joined by common membership on boards of directors (excluding isolates). Nodes weighted by # of direct interlocks.



Source: Boards gleaned from Reuters for public companies, while 2010 annual reports were used for private companies.

A cursory glance at this network illustrates a few interesting characteristics. First, we note the distribution of *degree centrality* – the number of direct BOD interlocks between firms – is asymmetric. That is, some firms are more connected than others. In fact, only 82% of Fortune's 2010 list of the largest American corporations are connected to at least one other corporation. The following table summarizes the distribution of degree centrality amongst firms shown in Figure 1:

Table 1: Frequency distribution of degree centrality for firms in Figure 1

Degree Range	*Frequency*	*Cumulative %*
0-2	23	28.05%
2-4	20	52.44%
4-6	24	81.71%
6-8	12	96.34%
8-10	1	97.56%
10-12	2	100.00%

Source: Based upon centrality measures calculated in Gephi

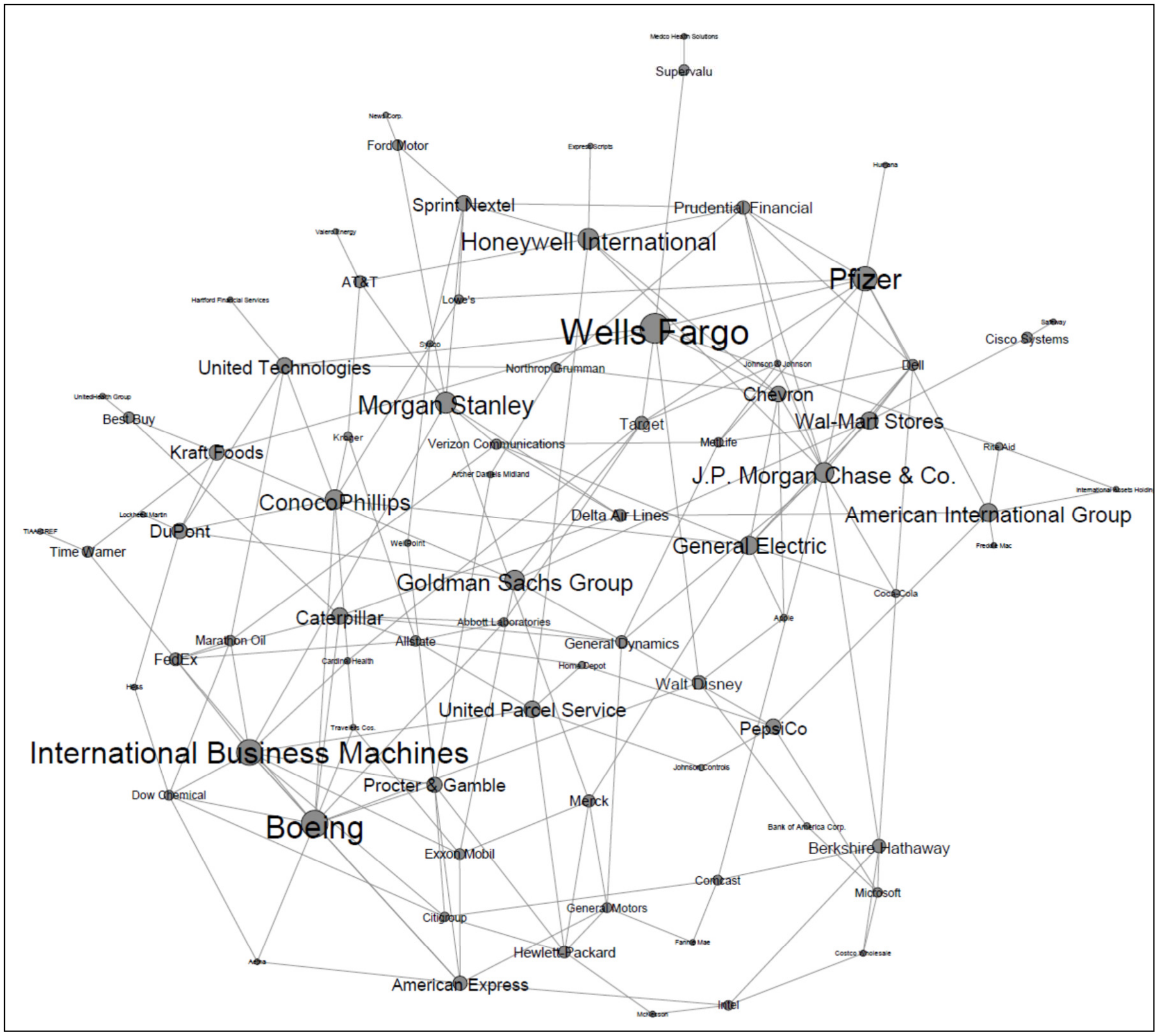
It is clear from the table shown above that most of the firms are connected to six or less other firms and only 18% have direct BOD interlocks with more than six. These highly connected companies include the likes of J.P Morgan Chase, GE, Goldman Sachs, AIG, and IBM, to name a few. In other words, the corporations that typically register in our minds as powerful or influential are central to the network when measured in terms of direct BOD interlocks. However, degree centrality alone does not provide us with enough information to determine how important or influential corporations are within the totality of the network. For instance, we may be interested in the relationship between two corporations that are indirectly connected – e.g. J.P. Morgan Chase is one degree removed from Citigroup via common directors on the board of Comcast. From the perspective of the network, interaction between these two firms depends, in part, on Comcast.

The SNA literature defines the sort of network role implied in the Comcast example as "betweenness centrality" (BC) (Anthonisse, 1971; Freeman, 1977; Pitts, 1979). More recently, Wasserman and Faust (1994, pp. 189-190) emphasize Shaw's (1954) recognition that nodes serving as bridges between the interaction of other nodes, assume higher degrees of "stress," thus we attribute importance to such position through an index of BC[7]. A node's "betweenness" is the sum of probabilities that it will lie on the shortest path between any two nodes in the network. These probabilities are then

[7] See Appendix 2 for a formal definition of betweenness centrality

normalized to range between 0 and 1. Calculating BC measures for each of our 82 firms allows us to scale each node and identify which firms assume more of this new measure of centrality.

Figure 2: Network identified in Figure 1where nodes are weighted by betweenness centrality.



Source: See Figure 1

BC measures range from 0 to .1180, with a mean and median of .0285 and .0236 respectively. As with degree centrality, the distribution of BC scores are skewed towards the upper-tail of the distribution, suggesting that a minority of firms are well positioned to influence the interaction between two other firms that otherwise lack common ties. An examination of Figure 2 yields the observation that membership among the elite subset of high BC firms includes many financial or insurance firms. Based upon the role suggested in the CPSP literature for the CPC (Munkirs, 1985) we would expect banks and insurance companies to be central in this regard. Of the 82 firms that comprise this network, 16 represent the finance and insurance (FI) sector[8]. On average, FI firms possess a BC measure of .0350 which is statistically different than the unrestricted set average of .0285 at all levels of significance. These results suggest that banks and insurance companies are centrally positioned, through interlocking BODs, to affect the overall corporate governance of America's largest companies.

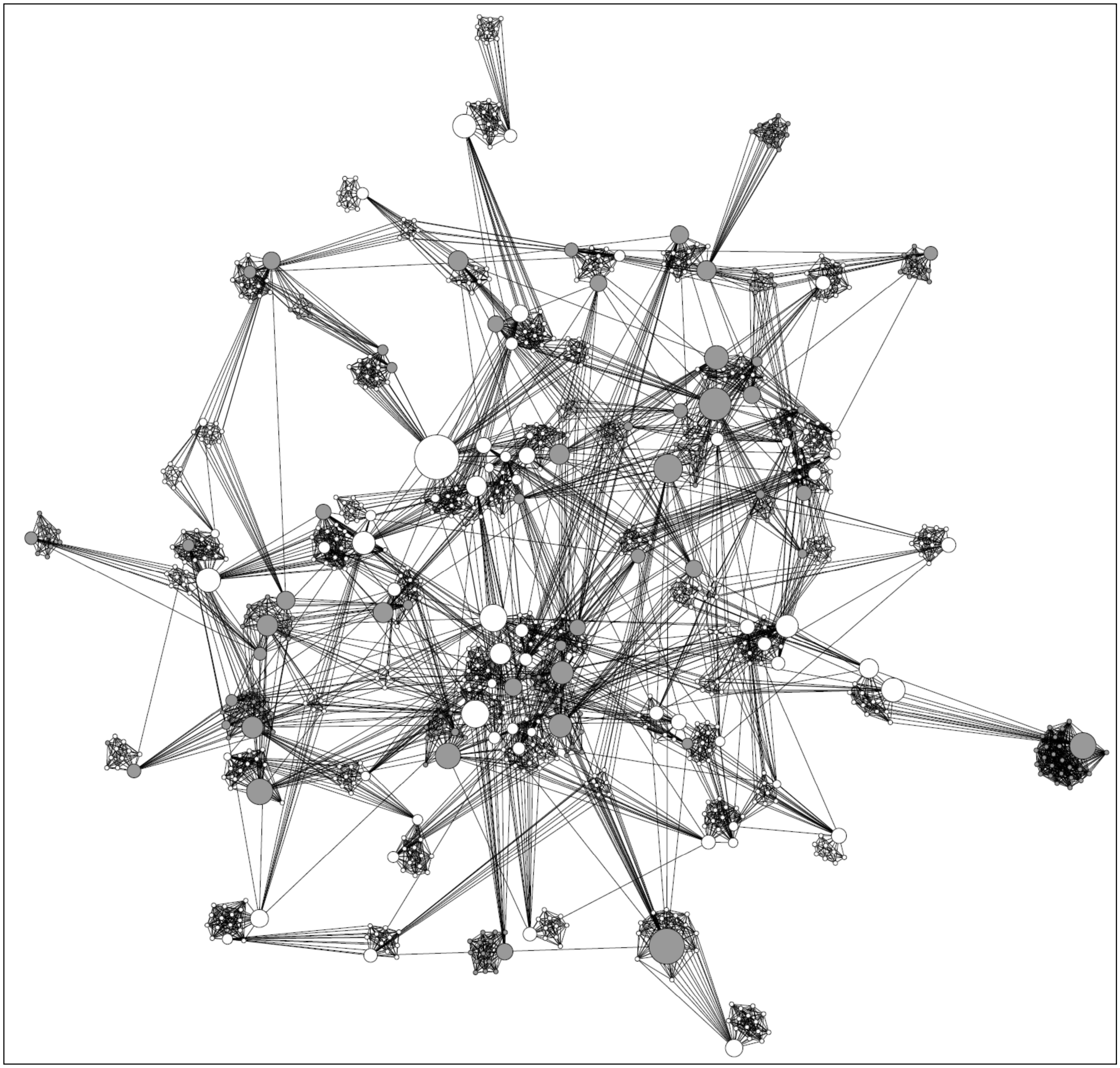
Thus far our discussion has considered networks that emerge from connections between directors and firms. A third and final network of interest arises from the implicit ties between directors that serve on common boards. In similar fashion to the approach used to develop the network of interlocking firms described above, we arrange our set of nodes to include only the 1029 directors. The corresponding adjacency matrix will also be square and contain an array of binary values indicating whether a tie exists between two directors based upon co-membership on Fortune 100 boards[9]. This approach has the advantage of allowing us to examine the structure of the corporate governance community, by drawing direct connections between those that sit face-to-face in board meetings.

Figure 3 below offers a visual overview of the implicit community of Fortune 100 corporate directors. For the sake of clarity, isolate groups of directors have been excluded. Given an average degree centrality measure of 14 as well as the relatively large number of directors, it is not surprising that all 787 directors are connected by a

[8] Excludes health insurance companies
[9] Due its size (1029x1029) the paper excludes this adjacency matrix. It is available upon request for those who wish to reproduce these results.

total of 5395 individual links. To illustrate visually the distribution of FI vs. non-FI directors, we color each node dichromatically: grey for FI directors, white otherwise.

Figure 3: Network of directors affiliated by common board members. Nodes weighted by degree centrality (n=787, edges = 5395). To zoom in at high resolution this image may be viewed at: http://zoom.it/mTYR



Source: See Figure 1

The distribution of centrality measures for the affiliation network of corporate directors is summarized below:

Table 2: Summary statistics for affiliation network of Fortune 100 board members. * indicates that F/I directors are significantly different than all directors in terms of mean centrality.

Nodes	Stats	Degree	BC
All Directors	Mean	13.71029	0.004216
	Median	12	0
	Skewness	2.051343	3.654606
	SD	5.791978	0.012239
Finance / Insurance Directors	Mean	16.61353*	0.008632*
	Median	13	0
	Skewness	1.115481	2.152599

Overall the centrality of directors follows an asymmetric distribution, with a minority of directors possessing high degrees of centrality with respect to the rest of the group. Similar to the network of firms shown in Figure 1, a large proportion of these central directors sit on the nation's largest financial / insurance firms. As shown in Table 2 directors from the FI sector are more central –both in terms of degree and BC- on average. While the FI sector represents only 26% of all directors in the network, their directors are 15% more likely to have a higher than average degree of connectedness when compared to the group as a whole. Similarly, these data suggests that FI directors are 11% more likely to have a higher than average BC measure.

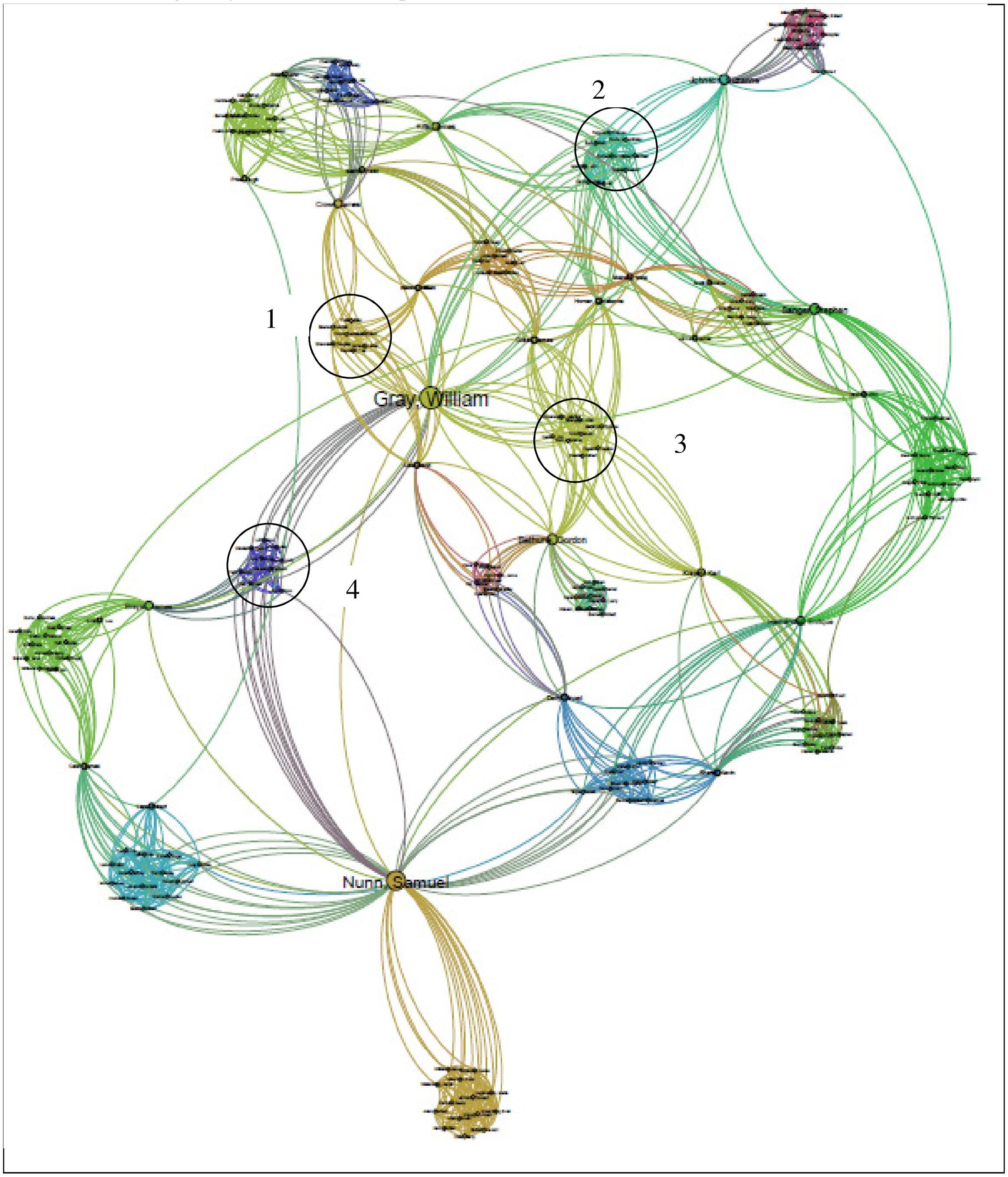
To further emphasize the importance of the banking and insurance industry with regard to the overall structure of the network let us consider the *ego network* of one director in particular: William H. Gray, III. Briefly defined, an ego network captures the connection any one individual may have as a subset of the entire network. For networks as large and as connected as that depicted in Figure 3 it quickly becomes difficult to tease out which nodes serves as indirect connections for any one subject. An ego network allows us to specify the degree of separation – say two – and create a new network with only those links that satisfy the condition. This allows us to quickly identify the characteristics of any particular element. Figure 4 shows the ego network for Mr. Gray to the extent that we capture not only his direct ties – those that sit on common boards with him –but also the indirect ties that result from Gray's board colleagues' other governing obligations.

Gray serves on four Fortune 100 boards: JP Morgan Chase, Pfizer, Prudential Financial, and Dell. The members of these boards are circled and enumerated in Figure 4 as they are listed above. Given the direct ties of the members on these four boards, Gray extends his professional network to a total of 186 corporate directors. In other words, Gray is either directly or indirectly connected to 24% of all other corporate elites governing America's 100 largest corporations. If it were the case that Gray is not unique in this regard, one may observe that a very small minority could potentially have a rather large impact on the administration of the commanding heights of our economy.

Whither Oligopolistic Cooperation?

While this study excludes most of the institutional arrangements – e.g. stocks, bonds, trustees and transfer agents, etc. – employed in the CPSP literature, the high level of BOD interconnectedness offers substantial evidence that oligopolistic cooperation continues to describe the structure of the modern economy. Extending this analysis to include such institutional ties as stock control, bond issues, balance sheet obligations between firms, and political contributions, only increases the complexity and structural interdependence of today's machine process. Moreover, the decision to exclude 18 of the Fortune 100 firms from the analysis above did not result from the recognition that they represent some bastion of free-market independence. Rather, their ties to the network

Figure 4: Ego network for William H. Gray, III extended to 2 degrees of separation. To zoom in at high resolution this image may be viewed at: http://zoom.it/sFdL



are not realized at the depth of Fortune 100 directors. Isolate periphery Fortune 50 firms find their links as directors from the Fortune 100 firms are added, and so with the relationship between Fortune 100 and Fortune 200 directors. In essence, establishing the true nature of industrial concatenation is a recursive problem beyond the scope of this paper.

Fortunately, it is unnecessary to perform such a task to simply retest the notion that corporations operating in an oligopolistically cooperative environment exhibit a high degree of administrative interdependence. The structural reality of the corporate governance community in 2010, demands that William H. Gray, Samuel Nunn, and Richard Myers cooperate. "For these members to act as if these intradependencies did not exist would be both logically and practically indicative of irrational tendencies" (Munkirs and Sturgeon, 1985)[10].

The methods employed in the preceding analysis are not new to institutional economics. Hayden's application of graph theory to the social fabric matrix approach makes explicit the promise of network analysis in illustrating the key structural aspects of the social provisioning process (Hayden, 1982a; Hayden, 1982b; Hayden, 1986; Hayden and Stephenson, 1995). More recently, Hayden et al (2002) employs recent advances in the SNA literature that takes centrality as a measure of power to identify networks of corporate dominance. Yet as Hayden (2002, pg. 695) argues, there remains much work in the area of network analysis on corporate power blocs, given its ability to illuminate vested interests at work and the necessity for democratic, institutional adjustment.

Conclusion

This paper has presented recent evidence in support of the oligopolistic cooperation view of market structure. Recent advances in social network analysis methods were employed to construct the network of Fortune 100 interlocking boards of directors and develop two indices for network centrality: degree and betweenness. These

[10] Gray, Nunn and Myers are at most indirectly related through the boards of: Prudential Financial, Chevron, Northrup-Grumman and Dell.

results illustrate the extent of administrative interdependence that characterizes the so called commanding heights of the economy. It has been demonstrated that the pecuniary employments remain central to planning process of the modern production system, and hint towards further evolution in the same direction.

Appendix 1: Adjacency Matrix for 82 Overlapping BOD of Fortune 100

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
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Appendix 1 Continued (adjacency matrix key)

Id	Firm Name	Id	Firm Name
1	Abbott Laboratories	49	Kroger
2	Aetna	50	Lockheed Martin
3	Allstate	51	Lowe's
4	American Express	52	Marathon Oil
5	AIG	53	McKesson
6	Apple	54	Medco Health Solutions
7	ADM	55	Merck
8	AT&T	56	MetLife
9	Bank of America Corp.	57	Microsoft
10	Berkshire Hathaway	58	Morgan Stanley
11	Best Buy	59	News Corp.
12	Boeing	60	Northrop Grumman
13	Cardinal Health	61	PepsiCo
14	Caterpillar	62	Pfizer
15	Chevron	63	Procter & Gamble
16	Cisco Systems	64	Prudential Financial
17	Citigroup	65	Rite Aid
18	Coca-Cola	66	Safeway
19	Comcast	67	Sprint Nextel
20	ConocoPhillips	68	Supervalu
21	Costco Wholesale	69	Sysco
22	Dell	70	Target
23	Delta Air Lines	71	TIAA-CREF
24	Dow Chemical	72	Time Warner
25	DuPont	73	Travelers Cos.
26	Express Scripts	74	United Parcel Service
27	Exxon Mobil	75	UnitedHealth Group
28	Fannie Mae	76	United Technologies
29	FedEx	77	Valero Energy
30	Ford Motor	78	Verizon Communications
31	Freddie Mac	79	Wal-Mart Stores
32	General Dynamics	80	Walt Disney
33	General Electric	81	WellPoint
34	General Motors	82	Wells Fargo
35	Goldman Sachs Group		
36	Hartford Financial Services		
37	Hess		
38	Hewlett-Packard		
39	Home Depot		
40	Honeywell International		
41	Humana		
42	Intel		
43	International Assets Holding		
44	IBM		
45	J.P. Morgan Chase & Co.		
46	Johnson & Johnson		
47	Johnson Controls		
48	Kraft Foods		

Appendix 2: Centrality Measures

Wasserman and Faust (1994) define the centrality measures used in the preceding analysis as follows:

Degree Centrality:

Let $C_D(n_i)$ define an index of actor-level degree centrality, $\forall n \in N$; where $N = \{n_1, n_2, n_3, \ldots, n_g\}$.

Further define X as the sociomatrix (or adjacency matrix) for the relation between g nodes in N, such that each element of X expresses the value of the tie between the ith and jth element of *N* as x_{ij}. Then, $C_D(n_i) = \sum_j x_{ij}$

Betweenness Centrality:

Let $C_B(n_i)$ define an index of actor-level betweenness centrality, $\forall n \in N$; where $N = \{n_1, n_2, n_3, \ldots, n_g\}$.

Let g_{jk} be the number of ties between the jth and kth actor. If all ties are equally likely to be chosen as the path between the jth and kth actor, then the probability that any given path will be chosen is simply $1/g_{jk}$. Further, let $g_{jk}(n_i)$ define the number of paths on which a given ith element of *N* serves as intermediary between the jth and kth actor. Then, $C_B(n_i) = \sum_{j<k} g_{jk}(n_i)/g_{jk}$. Alternatively to normalize the index between 0 and 1 we express:

$$C'_B(n_i) = C_B(n_i)/[(g-1)(g-2)/2]$$

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