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JA CASWELL

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Dominant Forms of Corporate Control in the U.S. Agribusiness Sector

Julie A. Caswell

Two forms of control over corporate decision making are analyzed: direct control through stockholding and network control through interlocking boards of directors. A majority of the 222 large agribusiness firms studied had strong direct control by owners or cooperatives, while the largest firms lacked such control. Tests relating direct control type to level of network control exposure show that strong direct control is associated with weak network control and vice versa, with firm size being the major factor in explaining both types of control. For the largest firms, network-based rather than direct control appears to limit management discretion.

Key words: agribusiness, corporate control, management, network analysis.

The evident spread of managerial control among large U.S. corporations in the fifty years since Berle and Means' initial study has prompted extensive theoretical and empirical study of the effect of type of corporate control on firm performance and aggregate concentration. Models of firm behavior under management control have predicted that these firms may have lower profits and greater organizational slack, put sales growth before profit growth, and/or seek the quiet life of low risk, status quo operations (Williamson, Baumol, Marris). Empirical evidence on these effects is mixed. For example, while several studies show lower profit rates for managerially controlled firms, others, including the most carefully specified test, show no significant difference between control types (Scherer, p. 39). However, the reliability of these findings hinges on control data and classifications that vary widely in quality.

Corporate control patterns may affect aggregate concentration by reducing the independence of decision making in firms with strong ties to outside centers of power. This effect was recognized in the debate preceding passage of the Clayton Act in 1914, although the scope of Section 8 was ultimately limited to outlawing interlocking directors between direct competitors (Halverson). Corporate control patterns may also have a dynamic effect on aggregate concentration if they influence the internal and merger growth rates of large firms.

The potential impacts of corporate control on firm-level efficiency and quality of decision making argue for the development of accurate data on its dominant forms in the economy and its sectors.[1] In the agribusiness sector, the relevant universe for measuring dominant forms of corporate control includes the large public, private, and cooperative firms. A universe including 222 of these large firms operating in 1976 is used in this analysis. Two separate avenues of corporate control are investigated: direct control over firm decision making through stockholding and network control exercised through interlocking membership on boards of directors. In this conceptual framework, corporate control is the power to determine the broad policies, objectives, and business strategies of the firm. It is exercised through controlling the decision-making hierarchy of the firm, in particular the board of directors, which in turn controls the internal organization of the firm.

The first avenue of corporate control reflects the familiar notion that actual ownership of the firm or a significant interest in it usually confers decision-making control.

Julie A. Caswell is an assistant professor, Department of Agricultural and Resource Economics, University of Massachusetts.

[1] Most previous studies have investigated corporate control for broad cross sections of the largest firms in the economy instead of by sector as occurs here. The exceptions are U.S. Congress (Senate), Ware, and Schulman who used the Corporate Data Exchange data set.

Large, modern firms are also subject to the influence (and possible control) of other entities that have a stake in the firm's operations even if they are not significant stockholders. These include financial institutions, suppliers, buyers, regional interests, and others. Research seeking to quantify this second avenue of control has focused on seats held on the firm's board of directors by representatives of other firms. Such representation has been pervasive and stable over time in the United States (Dooley, Allen, Mizruchi). Network control indexes are used to measure the levels and patterns of this contact in order to assess its effect on corporate control.

Before proceeding, the application of network analysis to corporate control is briefly discussed. Network analysis is emerging as the primary conceptual framework and set of empirical methods in the social sciences for analyzing complex sets of relational data (Knoke and Kuklinski). Its development was motivated by the limitations of trying to understand economic and social phenomena solely by studying the attributes of individual actors apart from their relationships with other actors. This would be analogous to evaluating the profit performance of a cereal manufacturer by studying only its own size, cost structure, and other attributes while ignoring similar attributes of its competitors, their business strategies, and other market factors. As this example indicates, neither the attribute nor relational approach alone is likely to yield a satisfactory understanding of economic or social phenomena (Knoke and Kuklinski, p. 10).

The size of direct stockholdings is an attribute of the firm that explains its type of corporate control. While previous studies have stopped here in analyzing control (Schulman, Kotz, Larner, Berle and Means), such an analysis remains incomplete because the relational context of board representation is ignored. The empirical techniques of network analysis are applied here to relational data on board representation in order to qualify and clarify conclusions drawn from a simple attribute or stockholding-based analysis of corporate control.

The Study's Data Base

The sample of 222 agribusiness firms and the stockholding data base were constructed by the Corporate Data Exchange (CDE) in publishing its *Stock Ownership Directory—Agribusiness*. The sample firms represent the leading agricultural input manufacturers (machinery, feed, chemicals), cooperatives (supply and marketing), food manufacturers, restaurant chains, wholesalers, and retailers in the United States in 1976.[2] Nearly three-fourths of them are large, with operating revenues greater than $500 million, while 50% have operating revenues greater than $1 billion. The CDE directory lists all voters of at least 0.2% of a company's stock as of 31 December 1976 for the 153 widely traded firms in the sample and all major holders in the remaining 69 firms.

The directory is used in two ways in this study: (a) to classify individual firms under categories of direct control based on the size of their largest stockholdings and (b) to define the limits of the network of firms and institutions that are included in the analysis of board representation. The relevant network is the 222 agribusiness firms and any other firms or institutions that might seek to control or influence them through board representation. While this latter group might include any organization in the economy, the network is limited to all organizations that have displayed an interest in the sector through stockholdings of any size in the sample agribusiness firms. The CDE stockholding directory is used to identify 216 such organizations. Twenty-seven *Fortune* Top 50 commercial banks and life insurance companies that were not agribusiness stockholders are also included in order to comprehensively cover these types of firms. Since data on board membership for 10 of the agribusiness firms could not be found, the network studied contains 455 firms.[3]

The data set on board representation for the network analysis was constructed by coding the company, name, and position held for the officers and directors of the 455 companies. This set contained nearly 12,000 listings. Names were then matched to generate records of company contacts through individuals using

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[2] Representative firms include Deere and Ciba-Geigy (inputs); Agway and Sunkist (cooperatives); Beatrice, American Bakeries, and Gallo Winery (food manufacturers); McDonald's and Howard Johnson (restaurant chains); Super Valu and Wetterau (wholesalers); and Safeway and Lucky (retailers). A complete list of the sample firms is available from the author.

[3] Of the 10 excluded agribusiness firms, 7 were privately owned (6 domestic and 1 foreign), 2 were cooperatives, and 1 was a foreign, publicly owned firm. A complete list of the 455 network firms is available from the author.

biographical sources for confirmation when needed. The aggregation of these records is discussed in the network control section.

Direct Corporate Control

Dominant forms of corporate control through stockholding are evaluated by classifying each of the agribusiness firms under eight categories of direct control based on the identity of the leading stockholder(s) and the strength of its stockholding(s). The categories of control are as follows:

Full owner. Control is held by an individual, a family, or a group of individuals (e.g., a partnership). This category includes privately held firms.

Partial owner. Shared control is held by one or more owners.

Full financial. Control is held by a bank, insurance company, or other financial institution.

Partial financial. Shared control is held by one or more financial institutions.

Miscellaneous. Control is held by a nonfinancial firm outside the agribusiness sample. This category also includes one case of church control.

Mixed. Shared control is held by more than one of the above types of stockholders.

Cooperative. Control is jointly held by the members of the cooperative.

No-identified-center-of-control. Firm does not fall into any of the above categories. The label "no-identified-center-of-control" is more accurate than the commonly used "management control" because as a residual this category also includes firms where centers of control exist but were not discovered because of a lack of information.

The criteria for categorizing firms under one of the above types of direct control are adapted from those Kotz used in studying control over the top 200 nonfinancial corporations in the United States. They rely on a combination of the identity of the leading stockholder(s), the size of the leading stockholding(s), whether the stockholder(s) has seats on the board of directors, and the relative size and distribution of other holdings in the firm. The criteria distinguish between full and partial control. Full control presumably gives the stockholder unchallenged direction over the corporation, while partial control indicates a strong but shared voice in corporate decision

making. A firm is classified under the full or partial control of a particular stockholder if that holder meets one of these criteria:

Full Control

(*a*) Stockholder has the largest holding, this holding is ≥ 10%, and no other holding is ≥ 60% of the largest holding.

(*b*) Stockholder has the largest holding, this holding is ≥ 5%, stockholder has strong representation on the company's board, and no other holding is ≥ 5%.

Partial Control

(*a*) Stockholder has the largest holding, this holding is ≥ 10%, and another holding(s) is ≥ 60% of the largest holding.

(*b*) Stockholder has a holding ≥ 4% and no other holding is ≥ 10%.[4]

(*c*) Stockholder is not the largest holder but has a holding ≥ 60% of the largest holding over 10%.

Based on the identity of the holder (e.g., family, financial institution), the firm is then placed into one of the eight categories listed above. Strong representation is defined as having two people on the board of directors or one person serving on the board's finance or executive committee. Representation is used to qualify the strength of smaller holdings rather than to measure network control as in the following section. Under these definitions, full control can be held by only one stockholder while partial control may be held by more than one. Firms that are controlled by other companies in the agribusiness sample are classified according to who exercises ultimate control over the set of connected firms.

Stockholdings of 4%–10% or even 20% may seem too small to imply corporate control. However, because of the wide dispersion of stockholding in large corporations, such levels of holdings are considered to imply a control capability (Kotz, Burch, Schulman). Recent experience with takeover attempts, particularly in the oil industry, underscores the threat to corporate management of control over holdings of these sizes. The federal government's routine reporting requirements for accumulations of stock in a company also recognize a 5% holding as a benchmark.

The pattern of direct control in the agribusiness sector in late 1976 is presented in

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[4] A 4% rather than a 5% lower limit on stockholding size is used for partial control in order to include holdings kept just under 5%. This avoids the stock-trading reporting requirements that become effective at the 5% level.

Table 1. Direct Stockholder Control over Large Agribusiness Firms, 1976

Type of Direct Control	Number of Firms	Firms	Assets[a]	Assets
		(%)	($ millions)	(%)
1. Full owner	95	42.8	77,931.2	32.7
2. Partial owner	17	7.7	14,541.0	6.1
3. Full financial	6	2.7	8,215.5	3.4
4. Partial financial	18	8.1	32,234.8	13.5
5. Agr. cooperatives	27	12.2	6,447.9	2.7
6. Miscellaneous	5	2.3	2,237.4	0.9
7. Mixed	11	5.0	3,868.7	1.6
8. No-identified-center	43	19.4	92,805.9	38.9
Total	222	100.0	238,282.4	100.0
Summary of Control				
Owner (1 + 2)	112	50.5	92,472.2	38.8
Financial (3 + 4)	24	10.8	40,450.3	17.0
Agr. cooperatives (5)	27	12.2	6,447.9	2.7
Miscellaneous or mixed (6 + 7)	16	7.2	6,106.1	2.6
No-identified-center (8)	43	19.4	92,805.9	38.9
Total	222	100.0	238,282.4	100.0

[a] Asset figures are from *Stock Ownership Directory-Agribusiness* (Corporate Data Exchange); annual reports; *Directory of the 200 Largest U.S. Food and Tobacco Firms* (Connor and Mather); and Moody's Industrial Manual. Asset figures were estimated for 19 firms, 17 of which were owner controlled, by applying the average operating revenues to total assets ratio for firms in similar lines of business to the estimated firm's operating revenues. The asset distribution without this adjustment shows owner control of 36.8% and no-identified-center-of-control of 40.3%.

table 1. The top portion categorizes the firms by type of control. The lower portion of the table summarizes these findings into five categories. Full and partial owner control account for 112 firms or 50.5% of the number of firms. The category no-identified-center-of-control is next in importance with 43 firms (19.4%). Financial and cooperative contol have similar importance accounting for 10.8% and 12.2%, respectively. Miscellaneous and mixed control account for the remaining 7.2% of firms.

Owner and no-identified-center-of-control have equal importance when percentage of assets in each category is considered. Thus owner control is less important in terms of assets held than number of firms (39% versus 51%), while firms with no-identified-center-of-control are much more important in assets held than number of firms (39% versus 19%). Financially controlled firms are also more important in assets controlled than in number of firms (17% versus 11%). Miscellaneous, mixed, and cooperatively controlled firms are less important in assets controlled than in number of firms. This evidence of size differences between firms under the various types of direct control is supported by *t*-tests. These tests (not reported here) show that the mean size of firms with no-identified-center-of-control and financially controlled firms are not significantly different, while both are signifi-

cantly larger than owner controlled firms. Cooperatives are significantly smaller than firms under the other three types of direct control. The miscellaneous and mixed category is excluded from this and subsequent tests because it includes diverse control situations for which group averages are not meaningful.

Allowing for differences in control criteria, paired comparisons of these results to those of Schulman, Herman, Kotz, and Burch show similar distributions of control types for those agribusiness firms included in both studies.[5] Major differences appear, however, in overall distributions of control types between some of the studies. For samples of the largest 200 nonfinancial firms in 1974 and 1969, respectively, Herman and Kotz found a much higher incidence of firms with management or no-identified-center-of-control and a much lower incidence of owner control than is found here. This difference can be attributed to the smaller size of the majority of the firms in the agribusiness sample. In contrast, Burch's study of the top 500 industrials in 1965, which included a comparable range of firm sizes, found a similar overall distribution of control types.

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[5] The agribusiness sample has 38 firms in common with Herman, 41 with Kotz, and 90 with Burch. Schulman used the same sample and his overall distribution of control types is similar to that found here.

These comparisons indicate that among agribusiness firms smaller than those included in the sample owner control is likely to be the predominant form of direct control. A similar relationship between distributions of firm size and control type could be expected in other sectors of the economy. In the agribusiness sector, the dominant forms of direct stockholding control among large firms are owner and no-identified-center-of-control. The majority of these firms are under owner control, while the largest have no-identified-center-of-control. If those firms with no-identified-center are all under management control, then about 40% of the sector's economic activity takes place in firms where management is free from direct control. This decision-making freedom is tempered, however, by control exercised through board representation by outsiders with a minor or no stockholding interest in the firm. This second avenue of control is addressed in the next section.

Network Corporate Control

The practice of officers and directors of one corporation or institution sitting on the board of another establishes a network of contacts between them. The degree of outside influence or control over a firm is based on the number and stength of their contacts. In this section, centrality scores are calculated for each of the 455 firms in the network as indexes of control through board representation. This measure was developed for analyzing interlocking directorates by researchers at SUNY-Stony Brook (see, e.g., Bearden et al., Mariolis, Mizruchi, Mintz and Schwartz). In contrast to the direct control results, this application of network analysis does not link individual firms to specific centers of control; rather it measures a firm's exposure to outside influences.

Under the SUNY-Stony Brook model, the centrality scores for the firms in the network are calculated by a set of 455 simultaneous equations, one for each firm. A firm's centrality is a weighted summation of the intensity of its board interlocks with other firms where the weights are the centrality scores of the interlocking firms. The general form of the centrality measure for firm i is

$$c_i = \sum_{\substack{j=1 \\ i \neq j}}^{N} r_{ij} * c_j,$$

where r_{ij} is intensity of the link between firm i and j, c_j is centrality of firm j, and N is number of firms in network. The weights allow for links with different degrees of importance. A highly interconnected firm has a relatively high centrality score (e.g., Chase Manhattan). A link to a high scoring firm ties a firm more closely into the network than a link to a low scoring firm (e.g., First National Bank-Akron). This disproportionate effect is reflected as a higher centrality score for the firm.

The data used to measure the intensity of linkage (r_{ij}) between two firms are the records of company-to-company interlocks through common board membership described above in the data section. These records are aggregated to yield two measures of the intensity of intercompany links. Each measure in turn defines a separate network. In the first, the full network, r_{ij} is defined as

$$r_{ij} = \frac{b_{ij}}{\sqrt{d_i d_j}},$$

where b_{ij} is number of board members in common, d_i is number of members on board of firm i, and d_j is number of members on board of firm j. The number of interlocking directors between the two firms is in the numerator, while the denominator controls for the potential number of interlockers from each firm.[6] The full network centrality score of a firm based on this definition of r_{ij} is a measure of the number and intensity of all its board links to other firms.

In the strong directional network a second, more stringent definition of network influence is used for the r_{ij} measure. First, r_{ij} counts only board interlocks made by an officer of one of the interlocked corporations. These strong officer ties represent a conscious decision by the two corporations to establish a formal link. In contrast, ties made by non-officers may simply reflect the tendency of some individuals to sit on multiple boards.

Second, r_{ij} is defined so that the firm sending the interlock (the officer's home firm) gets most of the increase in centrality scores due to the link; the receiving firm gets the balance.

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[6] Theoretically, r_{ij} ranges from 0 (no interlocks) to 1 (identical boards). However, the maximum number of common board members (b_{ij}) counted between firms was 3 for the full network and 1.5 for the strong directional network that follows. This modification arises from rare cases in which an unusually high number of interlocks between a pair of companies gives them exaggerated centrality scores.

Table 2. Network Characteristics of Large Agribusiness Firms by Direct Control Type, 1976

Type of Direct Control	Total Number	Interlocked Number	Interlocked Percent[a]	Isolates Number	Isolates Percent[a]	Centrality Mean	Centrality S.D.[b]
Full Network:							
Owner	105	76	72.4	29	27.6	.035	.055
Financial	23	23	100.0	0	0.0	.107	.088
Cooperative	25	11	44.0	14	56.0	.001	.002
No-identified-center	43	40	93.0	3	7.0	.137	.186
Miscellaneous	5	5	100.0	0	0.0	.041	.032
Mixed	11	8	72.7	3	27.3	.034	.049
Total	212	163	76.9	49	23.1	.060	.107
Strong Directional Network:							
Owner	105	62	59.0	43	41.0	.029	.079
Financial	23	22	95.7	1	4.3	.101	.110
Cooperative	25	10	40.0	15	60.0	.006	.014
No-identified-center	43	38	88.4	5	11.6	.111	.205
Miscellaneous	5	5	100.0	0	0.0	.038	.064
Mixed	11	8	72.7	3	27.3	.082	.243
Total	212	145	68.4	67	31.6	.054	.131

[a] Row percentage.
[b] Standard deviation.

This definition recognizes that the direction of the interlock indicates the flow of influence between the two corporations. Thus, both the strength and direction of each tie are considered in assessing a firm's exposure to outside influence. The denominator again controls for board size.

Formally, in the strong directional network r_{ij} is defined as

$$r_{ij} = \frac{W_s * S_{ij} + W_r * T_{ij}}{\sqrt{d_i d_j}},$$

where S_{ij} is number of officers of firm i who sit on board of firm j (sending), T_{ij} is number of officers of firm j who sit on board of firm i (receiving), W_s is weight of sender, W_r is weight of receiver, and $W_s + W_r$ is 1. Following Bearden et al. and Mizruchi the W_s and W_r weights are set at .9 and .1, respectively.

The 455 centrality equations for each of the two networks comprise a set of simultaneous equations in the matrix form:

$$C = RC$$

where C is an $N \times 1$ vector of centrality scores and R is an $N \times N$ correlation matrix of the full or strong directional overlap measure r_{ij}. The system of equations $C = RC$, or $(R - I)C = 0$, has a nonzero solution only under the unlikely condition that $\det(R - I) = 0$. But Bonacich shows that multiplying the left side by a constant λ, does not violate the spirit of the model and allows a solution to the equations. The system $\lambda C = RC$ is solved by finding eigenvalues and eigenvectors. Here, λ is chosen to equal the largest eigenvalue; the elements of its related eigenvector are the centrality scores.[7] Since the system has one more unknown than equations, the actual values of the centrality scores are arbitrary. The scores are chosen so that the most central firm has a score of 1.0; therefore, the scores range from 0 to 1.0.

Data on the number of interlocked versus isolated companies among the 212 agribusiness firms in the network as well as mean centrality scores are presented in table 2 by type of direct control. For the full network, interlocking occurs among 100% of the financially controlled firms, 93% of the firms with no-identified-center-of-control, 72% of the owner-controlled firms, and 44% of the

[7] There will be as many other eigenvectors with the same sign as there are other discrete components of the network (i.e., groups of firms that are related to each other but are not related to the main cluster of firms); however, these eigenvectors are not used in the analysis. Firms in the main cluster represented by the first eigenvector will have positive centrality scores, while those firms that belong to other clusters or that are isolates (are related to no firms) will have scores of 0. Bonacich's proof of this approach is for symmetric R matrices. Following procedures developed by Bearden et al. and Mizruchi, the approach was applied to the asymmetric R matrix in the strong directional network on the basis of its acceptable accuracy in calculating centrality scores.

cooperatives.[8] The firms with no-identified-center-of-control have the highest mean centrality score (.137) followed by the financially controlled firms (.107). The owner-controlled firms have a much lower mean score (.035), while the cooperatives' mean score is near 0. Both the number of interlocked firms and mean centrality scores follow the same pattern in the strong directional network. The lower percentages of interlocked firms reflect the greater selectivity of this network.

Relationship between Network and Direct Control

These results show several marked differences in number of interlocked firms and mean centrality scores by type of direct control. How do these results clarify and qualify the findings reported above on dominant forms of direct control for agribusinesses? Recall that the majority of large agribusiness firms are under direct owner control, while the largest have no-identified-center-of-control. Earlier studies have concluded from similar evidence that an important segment of large firms are independent of outside control and are, in fact, management controlled (Burch, Larner, Berle and Means). In this section, the extent of that independence is explored.

In general, it is hypothesized that strong forms of direct control are associated with weak network control and vice versa. To illustrate: owner control, which is strong direct control, likely is associated with weak network control for two reasons. First, the owners who control the board selection process will tend to appoint outside directors who represent the owners' interests. Second, these firms are less vulnerable to pressure for board representation from outsiders who control important resources, especially capital. This lower vulnerability is due to the owners' ability to control the firm's policies, including the internal generation of equity capital. Thus, the outside directors of owner-controlled firms are less likely to be associated with the large financial firms and others that make up the network within which interlocking is measured. As a result, low levels of interlocking and centrality scores are expected.

The cooperative form also implies strong direct control and likely is associated with weak

network influence. Cooperative board membership is generally limited to the farmers who own the cooperative, provide its capital, and use its services, and to cooperative managers and advisors. This limitation suggests low levels of interlocking and centrality scores.

Firms with no-identified-center-of-control represent the reverse of this hypothesis. In these firms, weak direct control likely is associated with strong network control. These firms lack the protection from interference provided by a large controlling stockholder. They are likely to depend more on the opinion of the investment community for the maintenance of their stock prices and on large financial firms for the provision of their debt capital. The price of such support is often board representation and a voice in decision making. Thus, agribusiness companies with no-identified-center-of-control are expected to have higher levels of interlocking with firms in the network and higher centrality scores.

Financially controlled firms are under the strong direct control of financial institutions that are members of the network of firms studied. Any board representation resulting from this direct control is reflected at the network level in interlock counts and centrality scores. Because of this effect, financially controlled firms are expected to have higher centrality scores than companies under the other types of strong direct control. In addition, financial firms themselves tend to have relatively high scores. Given the weighted computation of centrality scores, links to these firms will tend to contribute proportionately more to the scores of firms subject to financial control. Thus, these firms are expected to be an intermediate case with strong direct and network control.

Two approaches are used to test the general hypothesis. The first employs a series of t-tests to compare mean centrality scores between pairs of direct control types in each of the two networks. From the above discussion, firms with no-identified-center-of-control are expected to have higher mean centrality (and thus greater network control) than the other three types. Financially controlled firms are expected to have higher centrality scores than owner and cooperatively controlled companies. No hypothesis is made about the relative centrality scores of owner and cooperatively controlled firms.

The results of these tests are presented in table 3. Four out of the five comparisons are

[8] Mixed and miscellaneous controlled firms are again excluded from the analysis.

Table 3. T-Ratios for Comparison of Mean Centrality Scores between Direct Control Types for Large Agribusiness Firms, 1976

Pair of Control Types Compared	Full Network	Strong Directional Network
No-identified-center/financial	.89	.25
No-identified-center/owner	3.52***[a]	2.54*
No-identified-center/cooperative	4.80**	3.33**
Financial/owner	3.74**	3.66**
Financial/cooperative	5.78**	4.11**
Owner/cooperative	6.39**	2.77*

Note: All tests are one tail.
[a] Double asterisk indicates significant at the 0.17% level. Using the Bonferroni procedure, this yields a 1% overall significance level for the family of six *t*-tests for each network; single asterisk indicates significant at the 0.83% level. Using the Bonferroni procedure, this yields a 5% overall significance level for the family of six *t*-tests for each network.

as expected in both networks. While firms with no-identified-center-of-control do not have significantly higher scores than financially controlled firms in either network, their scores are significantly higher than those of owner- and cooperatively controlled firms. Financially controlled firms, in turn, have significantly higher scores than owner- and cooperatively controlled firms in both networks. A final test indicates that owner-controlled firms have significantly higher centrality scores than cooperatives. These tests provide broad support for the hypothesis that weak direct control is associated with strong network control. This overall relationship holds for both the full and strong directional networks indicating that the results are not sensitive to network definition.

The above approach does not control for differences in sizes of agribusiness firms under the various types of direct control. Recall that firms with no-identified-center-of-control and financially controlled firms are larger than owner- and cooperatively controlled firms. Size may be important in explaining differing centrality scores because previous studies have shown a positive relationship between firm size and degree of interlocking (Warner and Unwalla, Dooley, Allen). To assess the importance of this effect, a second approach to testing the general hypothesis is based on regressions relating centrality scores to type of direct control and size of firm. Size is expected to have a positive effect on centrality scores, but the effect of direct control type on

these scores should be independent of the size factor.

A subsample of 154 of the 212 agribusiness firms included in the network analysis is used in the regressions. Of the 58 excluded firms, 16 are under mixed or miscellaneous control, 25 are cooperatives, and 17 are privately held firms under owner control. Among the latter two groups, centrality scores are uniformly low regardless of size. The total assets of private firms, for example, range from $33 million to $2,900 million, while their full network centrality scores range from 0.0 to 0.07 (on a scale of 0-1). Since there is little variability in scores among these firms, they are omitted from the analysis in order to provide a clearer test of the effect of size on level of centrality scores. The 154 firms in the subsample are all public including 88 that are owner controlled, 23 financially controlled, and 43 with no identified center of control.

The dependent variable in the regressions is the firm's centrality score in either the full or strong directional network. This score ranges from 0 to 1. The results indicated that the variance of centrality scores was unequal between firms under the three types of direct control. To stabilize the variance and correct for this problem, a logarithm to the base 10 transformation was applied to the centrality scores (Mizruchi, pp. 109–37). The resulting scores for the transformed full (*FCENTL*) and strong directional (*SDCENTL*) networks range from 0 to 4.[9]

The independent variables are firm size and type of direct control. Size (*RLOGAST*) is measured as the reciprocal of the logarithm to the base 10 of total assets in 1976 measured in millions of dollars (Hall and Weiss).[10] Since centrality scores are expected to be positively associated with firm size and assets appear in the denominator, *RLOGAST* is hypothesized to have a negative coefficient.

As discussed earlier, financially controlled firms and firms with no-identified-center-of-control are hypothesized to have higher centrality scores than owner-controlled firms. Four variables were formed to test this hypothesis. A financial control dummy (*FIN-*

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[9] The transformation is

$$FCENTL, SDCENTL = \log_{10}((10{,}000 * CENTRALITY) + 1).$$

See also Neter and Wasserman (p. 507).

[10] The results for regressions using operating revenues as the size variable were virtually identical to those reported here for assets.

DUM) and a dummy (NOIDDUM) for no-identified-center-of-control were created to assess whether the intercept term differs between the direct control types. Positive coefficients on both these variables are hypothesized reflecting the higher levels of centrality scores expected for these control types compared to owner control. To assess whether the size coefficient differed among the control types, variables for financial control/size (FINDUM * RLOGAST) and no identified center of control/size (NOIDDUM * RLOGAST) were created. No hypothesis is made on the signs of these two variables.

Three models were tested for each network:

(1) FCENTL, SDCENTL
$$= a + b_1 \; RLOGAST$$

(2) FCENTL, SDCENTL
$$= a + b_1 \; RLOGAST + b_2 \; FINDUM$$
$$+ \; b_3 \; NOIDDUM$$

(3) FCENTL, SDCENTL
$$= a + b_1 \; RLOGAST + b_2 \; FINDUM$$
$$+ \; b_3 \; NOIDDUM$$
$$+ \; b_4 \; (FINDUM * RLOGAST)$$
$$+ \; b_5 \; (NOIDDUM * RLOGAST).$$

The results are reported in table 4.

Size is highly significant in explaining differences in centrality scores for public firms in all six regressions. For the full network, regression (1) shows that the size variable alone explains a substantial amount of variance. When the control dummies are added in regression, (2), both variables are positive and significant

at the 5% level. Thus, differences remain in full network centrality scores by type of control even after controlling for size. The results are mixed when the size coefficient is allowed to differ between control types in regression (3). The coefficient on FINDUM is positive but insignificant, while the coefficient on FINDUM * RLOGAST is negative and insignificant. The negative coefficient on NOIDDUM is contrary to the hypothesis. The NOIDDUM * RLOGAST coefficient is positive and significant, indicating a lower slope for firms with no identified center of control versus those with owner control. Taken together, the three regressions for the full network suggest that size is very important in explaining differences in centrality scores between public firms; type of direct control is also significant.

The results for the strong directional network reported in regressions (4)–(6) are similar. Size is again a highly significant explanatory variable in all three equations. The two control dummies are positive and significant when introduced alone but negative and insignificant when interaction terms between control type and size are included. Neither of the interaction terms is significant. Thus, allowing for differences in slope and intercept leads to an overall finding of no difference in centrality scores between firms with different types of direct control in both networks. However, the regressions that include only dummies for control show a modest difference by control type. These results indicate that size is the important factor in explaining differences

Table 4. Regression Relationship Between Centrality, Direct Control Type, and Asset Size for Public Firms, 1976

Dependent Variable	Independent Variables							
	CONSTANT	RLOGAST	FINDUM	NOIDDUM	FINDUM* RLOGAST	NOIDDUM* RLOGAST	$\bar{R}^2$	F-value
1) FCENTL	4.76***[a] (.36)[b]	−6.96** (.94)					.26	55.11**
2) FCENTL	4.29** (.41)	−6.18** (.98)	.52* (.23)	.35* (.19)			.28	21.10**
3) FCENTL	4.77** (.52)	−7.38** (1.28)	.55 (1.00)	−1.40 (.85)	−.26 (2.69)	4.94* (2.32)	.30	13.91**
4) SDCENTL	4.38** (.41)	−7.22** (1.08)					.22	44.85**
5) SDCENTL	3.68** (.45)	−6.08** (1.09)	1.07** (.26)	.41* (.21)			.30	22.51**
6) SDCENTL	4.18** (.58)	−7.34** (1.43)	−.40 (1.12)	−.45 (.95)	4.00 (3.01)	2.32 (2.60)	.30	13.93**

[a] Double asterisk indicates significant at 1% level; single asterisk indicates significant at 5% level.
[b] Standard errors are reported in parentheses below regression coefficients.

in centrality scores among public firms, although significant differences by type of control appear to exist as well. The similarity in the regression results between the two networks indicates that the network definition does not have an important impact for this sample of firms.

The two approaches taken together provide broad support for the general hypothesis that weak direct control is associated with strong network control and vice versa, with size being an important underlying factor. These results clarify and qualify the earlier findings on dominant forms of direct control among large firms in the agribusiness sector. Over 60% of the firms in this study have strong direct control without any substantial network ties. The owner- and cooperatively controlled firms that make up this group appear to be relatively independent decision makers. Corporate control is largely internal to the firm, and management's policy parameters are set by the controlling stockholders.

The nearly 20% of the agribusiness firms that lack any center of direct control have the highest levels of exposure to network control. These include the larger firms in the sector. In these firms, the ability of management to set its own course appears to be limited by the strength of outside interests represented on the board. Depending on the relative power of management and outside interests, the locus of control in these corporations may be internal, external, or shared. Leaving aside the 10% that are mixed or miscellaneously controlled, the final 10% of the agribusiness companies are under strong direct control by financial firms coupled with high levels of network involvement. In these special cases, both forms of control are externally centered in a financial firm. For all the direct control types considered, data on network control is most important in clarifying and qualifying the nature of corporate control in firms that have no-identified-center of direct control.

Conclusions

A mixed picture of the dominant forms of corporate control for large agribusinesses is drawn by this research. Over half of these firms are under strong direct owner control with decision making under stockholders' internal control. Cooperative control is an important secondary class of strong direct

control with cooperatives showing little connection through board membership to other centers of power in the national economy. This lack of connection is much greater than that of owner-controlled firms. The largest firms in the sector lack direct control but show much higher levels of exposure to network control. For these top firms network-based control appears to take the place of direct control by owners.[11] Financially controlled firms form a unique secondary class of control with both strong direct and network control.

Two points emerge from this article to guide research on the effects on firm performance and aggregate concentration of patterns of corporate control over large firms in the agribusiness and other sectors. First, considering patterns of direct control through stockholding will not offer a comprehensive picture of who controls firm decision making. Evidence presented here, for example, indicates that by 1976 management control rather than strong direct stockholder control was predominant among the largest firms in the agribusiness sector. However, this weak direct control was accompanied by strong outside network control. Thus, managerial control appears to encourage overall coordination in the sector rather than being a decentralizing factor. Alternatively, both public- and private owner-controlled firms along with cooperatives are more independent decision-making centers. Research emphasizing the quality of firm-level decision making must address the structure of both direct and network control.

Second, the structure of corporate control, in the agribusiness sector at least, is dependent on firm size. Size was the major factor in explaining the type of direct control and the level of network involvement. Larger firm size is related to looser forms of direct control but more extensive network influence. This implies greater centralization of decision making as firms grow to larger sizes.

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[11] Time-series data to test whether network based control replaced direct control in large agribusiness firms have not yet been developed.

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