

INDUSTRY PERFORMANCE AND INDIRECT ACCESS TO STRUCTURAL HOLES

April, 2008 © RONALD S. BURT
University of Chicago Graduate School of Business, Chicago, IL 60637
Tel: 773-702-0848, Fax: 773-702-9919, ron.burt@ChicagoGSB.edu

ABSTRACT

What is the scope of brokerage network to be considered in thinking strategically? Given the value of bridging structural holes, is there value to being affiliated with people or organizations that bridge structural holes? The answer is 'no' according to performance associations with manager networks, which raises a question about the consistency of network theory across micro to macro levels of analysis. The purpose here is to align manager evidence with corresponding macro evidence on the supplier and customer networks around four-digit manufacturing industries in the 1987 and 1992 benchmark input-output tables. In contrast to the manager evidence, about 24% of the industry-structure effect on industry performance can be attributed to structure beyond the industry's own buying and selling, to networks around the industry's suppliers and customers. However, the industry evidence is not qualitatively distinct from the manager evidence so much as it describes a more extreme business environment.

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There is a lively literature on the advantages associated with networks that bridge the structural holes in social networks. Given a disconnect between two groups — a gap in the flow of information between the groups — the groups can be expected to develop their own language, beliefs and business practice, such that information becomes sticky within the groups, creating potential advantage to a network that coordinates across the groups. Diverse evidence shows higher performance in networks that bridge structural holes. I will present illustrative evidence in a moment.

Given the accumulating evidence, what are the implications for strategic action intended to improve performance? Business magazines publish practical guidance on bridging structural holes (e.g., Hargadon and Sutton, 2000; Maletz and Nohria, 2001; Uzzi and Dunlap, 2005). In the natural evolution of academic work, research has matured from questions about the average value of bridging structural holes into questions about contingent value. For example, returns to networks rich in structural holes increase from negligible to substantial from junior to senior job rank, as work becomes more ambiguous and political (Burt, 1997, 2004:371, 2005:156-162). In this volume, Venkatraman et al. (2008) show that revenue growth is greater for software firms in alliance networks rich in structural holes (software firm is allied with companies not allied with one another), but particularly if the firm has a broad mix of products in a broad mix of markets. Also in this volume, van Liere et al. (2008) report on a series of inventive laboratory experiments with middle managers and M.B.A. students that show how building a network rich in structural holes is contingent on a subject's 'network horizon' (see van Liere, 2007, for more detail and corroborating evidence). Subjects able to see more of the forming and dissolving connections among others in the business simulation are more successful in building their own rewarding network of relations bridging structural holes.

This chapter too is a study of contingent returns to bridging structural holes, on a question also concerning scope: What is the scope of the brokerage network to be considered in thinking

strategically? There are my contacts, their contacts, and their contacts' contacts. How far out should strategic thinking extend? The answer with respect to manager networks turns out to be attractively simple: You only need to strategize about your immediate contacts (Burt, 2007). The answer is simple, greatly simplifies the study of strategic behavior in networks, and is surprisingly robust, but it raises a question about the consistency of network theory across micro to macro levels of analysis. My goal in this chapter is to re-establish consistency, using analogous evidence on industry networks.

I begin with illustrative evidence on manager networks, to establish a baseline and to explain why direct and indirect access to structural holes can be an advantage. Direct access refers to structural holes in the immediate network of a manager's colleagues, or an industry's suppliers and customers. Indirect access refers to structural holes between friends of friends, in the networks around colleagues, or around suppliers and customers. We know there are returns to direct access, in fact very similar returns at micro and macro levels of analysis. If there is advantage to affiliation with the well-connected, there should also be returns to indirect access. However, the returns are negligible in manager networks. Second, I describe the analogous industry network model, introducing the industry data (two years of benchmark performance and network data on detailed American manufacturing industries), and highlighting complementarities between the manager and industry evidence (consistency across levels of analysis, greater variety in manager networks, less endogeneity in the industry networks). Third, I present the evidence on industry performance and indirect access to structural holes.

MANAGER ADVANTAGE AND ACCESS TO STRUCTURAL HOLES

A cluster of related network concepts emerged in the 1970s developing the general idea that there is advantage in having connections to multiple, otherwise disconnected, groups and individuals. At the center of the concept cluster are Granovetter (1973, 1983) on weak ties as bridges between groups, Freeman (1977, 1979) on network centrality as a function of being between contacts, Cook and Emerson (1978; Cook et al., 1983) on the advantage of having

alternative exchange partners, Burt (1980, 1983) on the advantage of disconnected contacts, later discussed as access to structural holes (Burt, 1992, 2005), and Lin et al. (1981) on the advantage of distant, prestigious contacts, later elaborated in terms of having contacts in diverse status groups (Lin, 2002). Two facts — from a stream of research beginning around World War II on influence and social networks (e.g., Festinger et al., 1950; Lazarsfeld et al., 1944) — provided foundation for the network concepts: (1) People are clustered into groups by factors (later discussed as social foci, Feld, 1981) defined by the places where people meet; the neighborhoods in which they live, the organizations with which they affiliate, the offices where they work, the projects in which they are involved. (2) Communication, and thus socialization, is more frequent within than between these groups such that people in the same group develop similar views of the history that led to today, similar views of proper opinion and practice, and similar views of how to move into the future. People tire of repeating arguments and stories explaining why they believe and behave the way they do. They make up short-hand phrases to reference whole paragraphs of text with which colleagues are familiar. Jargon flourishes. What was once explicit knowledge interpretable by anyone becomes tacit knowledge meaningful only to insiders. With continued time together, the group deepens its tacit knowledge as new combinations and nuances emerge. Much of what we know is not readily understood beyond the colleagues around us. Inside the tribe, one only needs to say the punch line of a popular joke to elicit bonding recollection of the whole story. Explicit knowledge converted into local, tacit knowledge makes information sticky (von Hippel, 1994) such that holes tear open in the flow of information between groups. These holes in the social structure of communication, or more simply ‘structural holes,’ are missing relationships that inhibit information flow (“like an insulator in an electric circuit,” Burt, 1992:18).

Direct Access to Structural Holes

The network image of groups separated by structural holes, with the image’s implications for sticky information within groups and heterogeneity more likely between than within groups, is foundation for network models of competitive advantage. Structural holes are a source of

efficiency at the same time that they are a source of growth. As a source of efficiency, structural holes are boundary markers in the division of labor. By not having to attend to the interpretations of people beyond the boundary around my specialty, I can focus on deepening my knowledge of what I already know pretty well. Without structural holes, we would be overwhelmed with the diversity of knowledge out there. I expect that we would quickly establish structural holes to re-establish a sense of control over our lives. Structural holes are simultaneously a source of growth from the hardy souls among us who reach out to broker connections across the holes to create new combinations of existing opinion and practice (see Burt, 2005: Chaps. 1-2, for review). Brokerage opportunities are measured in terms of the structural holes between contacts. When contacts are all connected with one another, there are no structural holes to broker. The more disconnected a manager's contacts, the more likely her network spans holes in the surrounding organization and market. People who connect across structural holes — call them network brokers, connectors, or entrepreneurs — have a vision advantage in detecting and developing productive opportunities. As described in the previous paragraph, people disconnected from one another often employ different problem-solving and practices in their work. Because network brokers are more exposed to the diversity of these diverse opinions and practices, brokers have a vision advantage in selecting early between alternative ways to go, synthesizing new ways to go, framing a proposal to be attractive to needed supporters, and detecting likely supporters/opponents to implementing a proposed way to go. For reasons of information breadth, timing, and arbitrage, people with strong relations to otherwise disconnected groups have a competitive advantage in detecting and developing productive opportunities.

The advantage expected from manager access to structural holes is manifest in standard performance metrics. The graph in Figure 1 contains illustrative results pooled across five populations of managers listed in the graph (see Burt, 2005:56, for a similar graph based on eight study populations): human resource managers in a commercial bank (Burt, et al., 1998), investment analysts and bankers in a financial services organization (Burt, 2007), managers in the Asia-Pacific launch of a new software product (Burt, 2008), and supply-chain managers in a

large electronics company (Burt, 2004, 2007). Various performance metrics were obtained from company archives on each manager as described in the research cited in the previous sentence (job evaluations, compensation, recognition in external professional awards), then regressed across job rank, job function, education, seniority, geographic location, and other background variables obtained from company archives to remove performance variance associated with the background variables. Take the prediction residual scores, standardize them, and you have a measure of performance relative to peers — which is the vertical axis in Figure 1. A score of zero means that a manager is performing at a level expected for someone with his or her background. A score of zero in the population of supply-chain managers, for example, means that you received compensation and evaluation typical for someone at your job rank, with your seniority, in your area, and with your background. A score of one means that you are one standard deviation ahead of what is typical for people like you, and so on.

————— FIGURE 1 ABOUT HERE —————

The horizontal axis in Figure 1 measures manager access to structural holes. The measure, network constraint, is an index of the extent to which a manager's time and energy are concentrated in a single group of interconnected colleagues – which means no access to structural holes. As described in the research cited above for each of the five study populations in Figure 1, the discussion network around each manager was constructed such that the following measure of network constraint could be computed (equations are presented here for later analogy to corresponding industry measures):

$$(1) \quad C_i = \sum_j w_{ij}, \quad i \neq j$$

where C_i is network constraint on manager i , and w_{ij} is a measure of i 's dependence on colleague j :

$$(2) \quad w_{ij} = (p_{ij} + \sum_q p_{iq}p_{qj})^2, \quad i \neq q \neq j,$$

where p_{ij} is the proportion of manager i 's network time and energy spent on colleague j , so dependence weight w_{ij} varies from 0 to 1 with the extent to which i 's network time and energy is directly (p_{ij}) or indirectly ($\sum_q p_{iq}p_{qj}$) spent on colleague j . Network constraint, as the sum of

dependence weights, measures the extent to which the manager's network of colleagues is like a straightjacket around the manager, limiting his or her vision of alternative ideas and sources of support. Ideographs below the horizontal axis in Figure 1 illustrate colleague networks posing low constraint (to the left) and high constraint (to the right). The low-constraint network has the manager at the center of the network working with disconnected colleagues. Disconnections, holes, between the manager's colleagues provide opportunities to broker connections. The high-constraint network to the right has the manager working with connected colleagues. There are no opportunities for brokerage. I multiply the constraint scores by 100 to discuss points of constraint. Networks around managers in the five populations varied widely, from two points of constraint up to 100 points, around a mean of 33 points.

The graph in Figure 1 illustrates an empirical result that has become familiar over the last fifteen years: managers with access to structural holes have an advantage in detecting and developing productive opportunities. There is a strong association between performance and network constraint in each population (t-tests of -4.4 to -7.3), and the regression line in the graph shows performance decreasing as a manager's colleagues become more interconnected.

Indirect access to structural holes

Managers also vary in their indirect access to structural holes. Around each of a manager's contacts is a network of the contact's contacts. Direct contacts are the people with whom a manager has personal contact. Indirect contacts are friends of friends reached through direct contacts as intermediaries.

Given the value of direct access to structural holes through contacts in diverse groups, it is reasonable to expect that value is enhanced if those contacts themselves are connected to diverse groups. Networks are jointly owned by the people in them (not equally, but jointly), so it is not difficult to imagine that advantage spills over between adjacent networks such that it is an advantage to be affiliated with well-connected people. For one thing, well-connected colleagues can be a source of opportunity and resources. If you discover an opportunity for which you do not have the time or energy, you pass it on to a friend. In the course of working

with a colleague you learn about new gossip and ideas of interest to the colleague. Colleagues are also a signal. Well-connected colleagues signal to observers that you have standing among the right people. These commonsense expectations are nicely illustrated by a pair of quotes that Rowley and Baum (2004:122) cite from their interviews with investment bankers: “information and access to it are king . . . being close to the source is the name of the game. . . . I don’t have time to know everyone, but I need to be close to those that have the best contacts.” “The best players in the industry build reputations by getting the biggest clients and controlling information, and carefully passing it out to others. It makes you a hot commodity, like a hot concert ticket or restaurant — everybody wants some.” Common sense has a formal analogue. The imagery of advantage spilling over between adjacent networks is foundation for the idea of ‘increasing returns to networks’ and ‘Metcalf’s Law’ in which the value of a network increases with the square of the people in it. As Spence (2002:453) referenced the imagery in his lecture on the occasion of receiving a Nobel Prize for his work on information in markets: “Metcalf’s law states that the value of a network to the entities attached to it is proportional to the square of the number of connected entities. In economic terms this probably means that the value and hence the speed of connecting accelerates as the number increase. This is sometimes referred to as the network effect.”

Indirect access to structural holes turns out to provide none of the advantage associated with direct access. The evidence is documented elsewhere (Burt, 2007, 2008), but illustrated in Figure 2 using the five manager populations pooled in Figure 1.

Indirect access to structural holes is measured on the horizontal axis in Figure 2. The network around each of a manager’s direct contacts poses a level of constraint and opportunity, on the contact directly and on the manager indirectly through the contact. Let IC_i be network constraint scores C_j pooled across the manager i ’s contacts j .¹ Where the network constraint index C in Eq. (1) measures the lack of structural holes in a manager’s immediate network of direct contacts, IC measures the lack of structural holes in the networks around the manager’s direct contacts. There is low indirect constraint on a manager connected to brokers (low C_j scores average to a low IC_i score). A manager subject to low indirect constraint is connected to

colleagues whose networks are rich in brokerage opportunities. Through those colleagues, the manager has indirect access to structural holes.

————— FIGURE 2 ABOUT HERE —————

There is a strong performance correlation with indirect access to structural holes. In the graph to the left in Figure 2, performance is standardized within population and year. There are no controls for job rank or background variables. Consider the population of investment bankers pooled with other populations in Figure 1. Banker performance was measured by annual salary and bonus compensation. When I regress z-score compensation (ZP) across indirect network constraint, I get the following result (standard error in parentheses):

$$ZP = .93 - .45 \ln(IC). \\ (.13)$$

The statistically significant negative association (-3.46 t-test) shows that bankers affiliated with colleagues in small, dense networks tend to receive compensation below their peers. When the bankers look around the office, they see that peers doing well are affiliated with well-connected colleagues (well-connected in the sense of having low-constraint networks rich in brokerage opportunities). The graph to the left in Figure 2 shows the result across the five manager populations. There is a strong correlation between manager performance and indirect network constraint (-7.66 t-test). In fact, the nonlinear, downward-sloping association between performance and indirect network constraint to the left in Figure 2 looks very similar to the association in Figure 1 with direct network constraint.

The performance correlation with indirect access is spurious. Well-connected colleagues have their own interests. Why should they sustain a connection with you if you are not attractive in your own right? When I hold constant manager job rank and direct network constraint — measures of manager attractiveness as a productive contact — the association between performance and indirect network constraint disappears. Again using the bankers for a specific example, compensation does not vary with the networks around a banker's colleagues so much as it varies with the banker's own network:

$$ZP = 1.30 - .47 \ln(C) - .14 \ln(IC). \\ (.13) \quad (.14)$$

Compensation is strongly associated with a banker's own network (-3.62 t-test). It is not associated with the networks around his or her colleagues (-1.00 t-test). The graph to the right in Figure 2 illustrates the point across the five manager populations. Residual performance in the graph is the same as residual performance in Figure 1 except I have also held constant the level of network constraint in the manager's immediate network (horizontal axis in Figure 1). There is no performance association with indirect access to structural holes once a manager's attractiveness is held constant (-1.26 t-test). The lack of returns led me to discuss the brokerage opportunities of indirect access as 'secondhand' brokerage (Burt, 2007), to distinguish it sharply from the performance-related brokerage opportunities of direct access.

Network Brokerage a Forcing Function for Human Capital?

These results emphasize the importance of agency in networks. People who do not build their own brokerage networks do not show the benefits of brokerage. It is not enough to affiliate with known brokers. But there should be returns to secondhand brokerage if brokerage creates advantage by providing quick, early access to distant, novel information. Consistently negligible returns to secondhand brokerage in diverse populations lead me to conclude that the advantage of network brokerage is not about quick, early access to distant, novel information so much as it is about what happens to a person who has to manage communication across a network full of structural holes. Either way, ego has a vision advantage in detecting and developing rewarding opportunities. The question is whether the vision advantage comes from better glasses or better eyes. A network that spans structural holes could provide a manager with better information access and control, which would be an advantage, or it could, by exercising one's ability to manage heterogeneous information, make the managers better able than less 'exercised' peers to see opportunities, which would amount to the same advantage. Brokerage exposes ego to diverse opinion and practice in other groups. In the course of managing contradictory relationships, ego develops cognitive skills of analogy and synthesis, and emotional skills for reading, engaging, and motivating colleagues. One is perhaps less troubled by sharp differences in opinion or practice. One becomes, perhaps, more skilled in

analogy and metaphor in order to communicate across differences. Whatever specific skills are involved, brokerage is not valuable for the information it provides so much as it is valuable as a forcing function for cognitive and emotional skills required to manage communication between colleagues with divergent belief and practice. It is the cognitive and emotional skills produced as by-product in managing brokerage networks that are the proximate source of competitive advantage. In a phrase, brokerage could be a forcing function for human capital (the theme in Coleman's, 1988, initial description of social capital). The case is made and discussed in detail elsewhere (Burt, 2008), but the above results are sufficient illustration for the purposes of this chapter.

MICRO-MACRO CONNECTION DISRUPTED

A central tenet in network theory, if not the central tenet, is that causal spark is released by the pattern in which relations intersect. Something about the pattern of relations intersecting in a network node encourages, facilitates, or inhibits. Specific models focus on the spark released by a specific pattern. Whatever the causal spark, it is expected from the relational pattern regardless of where the pattern occurs; in a person, a team, an organization, a geographic region. For example, the network status model that Podolny (1993) uses to explain why certain investment banks are able to obtain capital at more attractive rates is the same eigenvector model used by Kadushin (1995) to describe the status of individuals in the French financial elite. The network brokerage model that Burt (1992: Chap. 3) uses to explain why profit margins are high in certain markets is the same model used in the subsequent chapter of the same book to explain why certain managers are promoted more quickly to senior job rank in a large organization. The network brokerage model that Freeman (1977) uses to explain why certain people are more satisfied in a laboratory task is the same model used by Owen-Smith and Powell (2004) to explain why certain companies are more likely to file successful patent applications. The simple embedding model used to describe mutual contacts increasing the persistence of relationships and reputations (e.g., Feld, 1997; Krackhardt, 1998; Burt,

2005:chap. 4) is the same model that Gulati and Gargiulo (1999) use to describe the higher odds of repeated alliances between firms with mutual alliance partners, that Ingram and Roberts (2000) use to describe mutual friendships enhancing the survival of hotels, that Rowley et al. (2005) use to describe mutual contacts lowering the probability of exit from investment-bank cliques, and that Løvås and Sorenson (2008) in this volume use to describe mutual contacts decreasing the risk otherwise associated with sharing scarce resources between consultants.

Consistent network theory across levels of analysis is attractive because the consistency is a bridge for analogies between otherwise disparate research results, which is all the more powerful because disparate research results are likely to have complementary strengths if the results can be compared in a meaningful way. As illustrated by the examples cited in the previous paragraph, network explanations for performance differences between people can be used to draw inferences about performance differences between macro units of analysis such as organizations or industries or regions — just as network explanations for macro performance differences can be used to draw inferences about performance differences between people. I will be more specific about network brokerage models in the next section. For the moment, I can say that the integrative and cross-fertilizing potential of network theory consistent across levels of analysis has contributed in some part to the widespread use of network models in studies of competitive advantage.

Now the problem: The fact that managers do not benefit from indirect access to structural holes raises a question about consistency across levels of analysis. The role of cognition and emotion in network brokerage makes sense for sentient individuals. It is not obvious how the image of sentient individuals applies at the macro level. Organizations, and the industries and regions in which they operate, are assemblies of people who individually think and feel. To attribute thinking and feeling to macro units such as organizations, industries, or regions, requires an unattractively anthropomorphic metaphor. To continue the ‘better glasses or better eyes’ metaphor in the discussion of network brokerage as a forcing function for human capital, the ‘better glasses’ explanation generalizes readily to the macro level of organizations and markets. The ‘better eyes’ story, with its emphasis on enhanced cognitive and emotional skills,

does not. It would be useful to see macro-level evidence on performance and indirect access to structural holes. I begin with the macro advantages of direct access to illustrate what has been a consistent micro-macro connection for network models of brokerage. I then turn to performance and indirect access.

CORPORATE ADVANTAGE AND DIRECT ACCESS TO STRUCTURAL HOLES

As manager networks rich in structural holes provide an advantage in detecting and developing opportunities by exposing managers to diverse business opinion and practice, advantage comes twice at the macro level to producer organizations with hole-rich networks of suppliers and customers. (1) Within supplier and customer industries, structural holes mean more likely variation in business practice so there is something for producers to learn from the industry (groups separated by structural holes are more likely to evolve on separate paths), and competing organizations within the industry mean that producers can play them against one another to negotiate attractive prices. (2) Between supplier and customer industries, structural holes mean that large firms are unlikely to have integrated operations across the industries, so the producer advantages of within-industry holes occur between industries: more likely exposure to variation in business practice, and more likely independent competitors that can be played against one another. Using gross profit margins to measure performance, producer margins on average should increase with the structural holes in their immediate network of suppliers and customers. This was the initial intuition for returns to network brokerage at the macro level, modeled as structural autonomy, here stated in a multiplicative form (Burt, 1980, 1983, 1992:Chap. 3; Burt et al., 2002):

$$(3) \quad A = \alpha (k-O)^\beta C^\gamma,$$

where A is producer structural autonomy, an advantage provided by an industry's network position in the economy, α is an intercept term, O is a measure of producer coordination within an industry, k is a constant just above the upper limit of O so (k-O) measures the lack of

coordination between industry producers, β measures the corrosive effect of disorganized producers, C is a network constraint measure of producer dependence on well-organized suppliers and customers, and γ measures the corrosive effect of organized suppliers or customers. Network constraint at the macro level of an industry is defined by the dependence weights that define network constraint at the micro level on individual people (w_{ij} in Eq. 2), but there is now a question of whether supplier and customer establishments are organized to exploit producer dependence on them. Producer dependence on another industry is not a problem if businesses in the other industry can be played against one another. Dependence is a problem when there are few alternatives within a key supplier or customer industry. Network constraint on industry i is a weighted sum of dependence on supplier-customer industries j in which business is concentrated in a few dominant companies:

$$(4) \quad C_i = \sum_j w_{ij} O_j, \quad i \neq j$$

where O_j is the coordination of businesses in market j , measured as it is measured for the producer market in Eq. (3). The product $w_{ij} O_j$ in Eq. (4) is a network measure of the condition that Pfeffer and Salancik (1978:51) so productively explored as resource dependence:

“Dependence can then be defined as the product of the importance of a given input or output to the organization and the extent to which it is controlled by a relative few organizations.” The network constraint index in Eq. (4) is the sum of such dependencies, measuring the aggregate extent to which producers are dependent on coordinated suppliers or customers. With respect to Porter’s (1980:4) influential five-forces metaphor — grounded in the economics of industrial organization (e.g., Caves, 1992) and a close relative in time and content to Pfeffer and Salancik’s resource dependence metaphor — β measures the negative effect on industry profits from producer ‘rivalry’ within the industry and γ measures negative effects from ‘supplier power’ and ‘buyer power.’ In sum, Eq. (3) is a baseline industry network model for which estimates of β and γ should be negative. The estimates have been significantly negative in the American economy since the 1960s and in other economies where estimates are available (Burt et al., 2002). The results merely express empirically the old idea that monopolists do well exploiting disorganized partners. The optimum industry network for profits combines

coordination inside the industry with brokerage outside the industry (high O combined with low C in Eq. 3; see Burt, 2005:139-146 for a surface plot of industry data, cf. Baum et al., 2007: Figure 3a, for a similar graph describing company data within an industry).

Network Data on Industry Dependencies (w_{ij})

Much of the data needed to estimate effects in Eq. (3) can be obtained at high quality in the U. S. Department of Commerce benchmark input-output tables. Each table is a network of dollar flows between sectors of economic activity: cell (i,j) is dollars of goods purchased by organizations in sector j from organizations in sector i . In theory, organizations assigned to the same input-output sector, or industry, draw supplies in similar proportions from the same supplier industries and sell product in similar proportions to the same customer industries. Thus, an input-output table is a summary network, like a density table, describing patterns of buying and selling between structurally equivalent organizations (Burt, 1988; Burt and Carleton, 1989), and an input-output industry composed of structurally equivalent organizations corresponds to a market in that the industry contains organizations competing for the same supplier and customer business (Burt, 1992:208-215). Regional markets, government regulations, business practice, and data limitations must create data deviations from theory, but the industry concept remains in theory a concept of industry organizations using similar processes, to produce similar goods, available to customers according to customer input requirements. Treating the input-output dollar flows as cells in a network density table, the dependence weight w_{ij} in Eq. (2) can be computed with p_{ij} defined as the proportion of industry i buying and selling across industries that is conducted with establishments in industry j ,²

$$(5) \quad p_{ij} = (z_{ij} + z_{ji}) / (\sum_k z_{ik} + \sum_k z_{ki} - z_{ii}),$$

where z_{ij} is dollars of sales from industry i to j in the input-output table, and k ranges across all product categories in the table (i.e., everything excluding government and final demand).

Weight w_{ij} varies from 0 to 1 with the extent to which producer buying and selling is directly (p_{ij}) or indirectly ($\sum_q p_{iq}p_{qj}$) with establishments in market j (see Burt, 1992: 54-62, for other specifications and connections with laboratory results on exchange networks).

In this chapter, I estimate effects for detailed manufacturing industries in 1987 and 1992. I use the most detailed input-output categories to preserve the highest level of structural equivalence available between producers treated as competitors in the same industry. I focus on the years 1987 and 1992 for consistent, reliable sector definitions. The U.S. Department of Commerce expanded distinctions between service sectors in the 1987 benchmark input-output table, then shifted from Standard Industrial Classification (SIC) categories to the North American Industry Classification System (NAICS) for 1997 and later benchmark input-output tables (Lawson et al., 2002). Sector definitions in the 1987 and 1992 panels are similarly expanded from earlier benchmark tables, but still based on SIC categories familiar to the operations people at the Department of Commerce before they changed over to the substantially different NAICS categories. Dollar flows between industries can be downloaded from the U.S. Department of Commerce, Bureau of Economic Analysis website (www.bea.gov/industry/io_benchmark.htm). Excluding government and final demand, the 1987 benchmark input-output table distinguishes 469 production sectors, of which 362 are manufacturing (Lawson and Teske, 1994). Respective numbers for the 1992 table are 485 and 361 (Lawson, 1997). There is almost no difference between manufacturing industries in the two tables. The one difference is that chewing gum and a portion of candy manufacturing are separate sectors in 1987, but combined in 1992 (sectors 142001 and 142003 in 1987 are combined as sector 142005 in 1992). For consistency across the tables, I combined the two 1987 candy categories to correspond to their combined category in the 1992 table. Thus, I have 361 manufacturing industries in 1987 and 1992.

Each industry is subject to some level of network constraint in its buying and selling with suppliers and customers in the other 402 industries. Producers in manufacturing industry i are dependent on industry j , w_{ij} , as defined in Eq. (2), with proportional buying and selling defined in Eq. (5). Producer dependence is combined with the data on organization within other industries to compute measures of direct and indirect network constraint. To compute the network constraint scores for an industry, I need a measure of coordination within each of the 402 potential supplier or customer industries.

Industry Concentration (O)

I follow standard practice in using market shares to measure the extent to which producers are coordinated within an industry. The four-firm concentration ratio for an industry varies from 0 to 100 as the percent of industry output that comes from the four firms producing the largest volumes of industry output. Higher concentration is presumed to indicate more coordination, less rivalry, so producers can price for higher profit margins. The four-firm concentration ratio of 91% in the 1987 ‘Tire and Cord Fabric’ industry indicates that almost all industry output came from establishments operated by one of the four leading firms in the industry. In contrast, concentration in the 1987 ‘Sheet Metal Work’ industry indicates that only 10% of industry output came from the four leading firms, so there must be numerous other competitors within the industry.

Concentration ratios for manufacturing industries in 1987 and 1992 are available from the U.S. Census Bureau website for four-digit Standard Industrial Classification (SIC) categories (www.census.gov/epcd/www/concentration.html). The input-output tables are published with a list of SIC categories that map into each input-output category. Of the 361 manufacturing industries on which I have input-output data, 320 correspond to a unique four-digit SIC category. The other 41 correspond to multiple four-digit SIC categories. For example, the input-output ‘Sugar’ industry (141900) is composed of three four-digit SIC categories (2061 ‘Cane Sugar,’ 2062 ‘Cane Sugar Refining,’ and 2063 ‘Beet Sugar’). For the 41 manufacturing industries that correspond to multiple four-digit SIC categories, concentration is averaged across component SIC categories, weighting by the volume of business in each component category: $\sum_k CR_k \cdot (S_k / [\sum_k S_k])$, where CR_k is the four-firm concentration ratio in component SIC category k , and S_k is dollars of sales by establishments in SIC category k .

Buying and selling with 42 aggregate industries beyond manufacturing is included in the network measures. The industries are taken from a network analysis of boundaries between detailed input-output categories of agriculture, mining, construction, distribution, and services. The 42 non-manufacturing industries are described in the Data Appendix and listed with

concentration scores for 1987 and 1992. There are no authoritative concentration scores in these industries. Input-output tables provide dollar-flow data beyond manufacturing, but there are no measures of producer organization comparable to the concentration data on manufacturing. Concentration in non-manufacturing can be estimated using data on the relative size of companies (e.g., Burt, 1992:89-91), but the practice is disconcerting because companies often operate in multiple industries and competition in non-manufacturing industries is often more local and regulated than competition in manufacturing industries (e.g., Burt et al., 2002). In the Data Appendix, I report tests with alternative approximations to concentration, but the approximations based on company size provide the clearest results. Effect estimates in this chapter are based on network constraint computed from size-based approximations to concentration in non-manufacturing.

I now have a measure of concentration (O) in each of the 403 manufacturing and non-manufacturing industries in 1987 and 1992. I can compute network constraint in the baseline model (C in Eq. 4) and measures to be presented of indirect constraint.

I focus on predicting performance in certain industries because the concentration scores are not equally valid across industries. Scores in the 42 non-manufacturing industries are approximations correlated with the effective level of competition in non-manufacturing (Burt et al., 2002). The scores in which I have the most confidence are those for the 320 manufacturing industries that correspond to a unique four-firm SIC category. These are the industries in which producer concentration is defined by the same industry boundaries that define producers buying and selling with suppliers and customers. Concentration scores in the other 41 manufacturing industries are an average of scores within segments of the industry so it is impossible to know the extent to which the four leading producers within industry segments account for total industry output. I compute network constraint scores for all 361 manufacturing industries and test for selection bias from my focus on the 320 that correspond to unique four-digit SIC categories. I obtain similar results for the 320 and the 361 industries. Effect estimates based on all 361 manufacturing industries differ slightly in metric, and are statistically stronger since they are based on 82 additional observations across the two panels,

however, I focus where I have the most authoritative industry-structure data: the 320 industries for which transaction data and concentration data are defined by the same industry boundaries.

Baseline Effects on Industry Performance (PCM)

The input-output data provide a measure of industry performance. Price-cost margins (PCM) are a performance measure of net income to sales introduced by Collins and Preston (1969) and widely used in market structure research: PCM as originally computed from Census of Manufactures data equals net income (dollars of value added minus labor costs) divided by sales. Computed from input-output data, PCM equals net income (dollars of 'other value added' plus indirect business taxes) divided by volume of business. The input-output data could be argued to provide a better measure of performance because more production and distribution costs such as advertising and entertainment are removed from value added, but the final result is that the two data sources provide price-cost margins similarly associated with industry structure (Burt, 1988:372-378).

The average price-cost margin is .162 across manufacturing industries in 1987 and 1992, showing a price-cost profit of 16.2¢ on the average dollar of sales. As a concrete example, the 1987 input-output table shows \$1,047.3 million in business by establishments in the 'Tire Cord and Fabric' industry. Of that sum, \$742.8 million were production and distribution costs, leaving \$304.5 million in value added, of which \$134.8 million was labor cost (input-output category 880000), \$3.5 million went to indirect business taxes (category 890000), and \$166.2 million was other value added not attributed to specific costs (category 900000). Removing labor costs from the value added, dividing by volume of business, and multiplying by 100 yields a price-cost margin of 16.2¢, the average across all manufacturing. The margin seems modest given the high 91% four-firm concentration in the industry, however, it is well known that industry margins have only a weak correlation with industry concentration (Schmalensee, 1989: 973-976; Weiss, 1989).

Relative industry performance in 1987 continued by and large into 1992, but margins were slightly higher on average in 1987, and nine industries operated at a loss in one or the

other year. No industry operated at a loss in both years. Given that the nine negative price-cost margins are year specific (each is positive in the other panel), and would have disproportionate influence on estimated effects because they are at the extreme edge of the data distributions, I put the nine aside as intrusive outliers. This turns out not to affect conclusions about the statistical significance of effects, but it does make effects stand out more clearly since the nine temporary outliers do not have to be fit into the aggregate performance associations with industry structure. Detailed discussion is in the Data Appendix. As quick illustration, here are estimates for the baseline model (Eq. 3) fit across all 722 observations of the 361 manufacturing industries, including adjustment for the slightly higher margins in 1987:³

$$\text{PCM} = 41.37 - 4.07 \ln(100-O) - 3.99 \ln(C) + 2.45 \text{D87},$$

(1.48) (.81) (.41)

where standard errors are given in parentheses (adjusted for autocorrelation across repeated observations with the ‘cluster’ option in STATA). There is a statistically significant -2.75 t-test for the negative effect of producer rivalry, and a -4.92 t-test for the negative effect of supplier-customer network constraint. Here are estimates for all 640 observations of the 320 industries that correspond to unique four-digit SIC categories:

$$\text{PCM} = 42.31 - 4.14 \ln(100-O) - 4.18 \ln(C) + 2.51 \text{D87},$$

(1.52) (.87) (.41)

which define t-tests of -2.70 and -4.81 respectively for producer rivalry and network constraint. And here are estimates for the baseline model fit across the further subset of 632 observations in which price-cost margins were nonnegative:

$$\text{PCM} = 48.41 - 5.42 \ln(100-O) - 4.39 \ln(C) + 2.38 \text{D87},$$

(1.41) (.80) (.41)

which define t-tests of -3.83 and -5.47 respectively for producer rivalry and network constraint. Three points are illustrated: First, the two industry-structure effects are, as expected, negative and statistically significant. Second, estimates do not differ much between the equation estimated across all 361 manufacturing industries and the one estimated across the 320 manufacturing industries that correspond to unique four-digit SIC categories. Third, effects are

more clear — stronger magnitudes and smaller standard errors — in the equation for which I put aside the nine negative price-cost margins as temporary outliers.

Micro-Macro Connection

The two graphs in Figure 3 illustrate micro-macro consistency for performance as a function of direct access to structural holes. The graph at the top in Figure 3 describes the industry performance-structure association. I standardized price-cost margins within years to have a measure of relative industry performance comparable to the z-score performance metrics on managers in Figure 1. The z-score performance measure, ZPCM, is then a function of the two industry-structure variables, O and C, in the baseline model (Eq. 3):

$$ZPCM = 3.41 - .56 \ln(100-O) - .46 \ln(C),$$

(.15) (.08)

where estimation is across the 632 non-negative margins in the 320 manufacturing industries that correspond to unique four-digit SIC categories, standard errors are given in parentheses, and the two network effects are clearly negative. Lines in the graph at the top in Figure 3 show how z-score price-cost margins vary with decreasing brokerage opportunities among suppliers and customers. The bold line shows the negative effect of coordinated suppliers or customers on industries in which producer rivalry is low (concentration is in the top quartile of manufacturing). The thin line shows the negative effect on industries in which producer rivalry is high (concentration is in the bottom quartile).

The graph illustrates two characteristics of the macro performance-structure association: First, the bold and thin lines both decrease, showing how producer margins are eroded by increasing dependence on supplier and customer industries in which rivalry is low. Second, producers in concentrated industries lose more. Dependence on coordinated suppliers and customers can erase the advantage of producer coordination. The bold line lies well above the thin line in the graph, showing the higher margins enjoyed by producers in concentrated industries. Where suppliers and customers are completely disorganized (far left in the graph), the difference between the bold and thin lines is almost two standard deviations (.13 z-score

price-cost margin for the thin line, 2.01 for the bold line). The gap corresponds to 18¢ extra profit on a dollar of sales.⁴ As producers become more dependent on supplier and customer industries in which rivalry is low (far right in the graph), the bold line decreases more quickly than the corresponding thin line, narrowing the gap between the lines (-.42 for the thin line at the far right in the graph, versus -.45 for the bold line, a difference that corresponds to a mere .3¢ profit advantage to industries in which concentration is high).

Similarity between the graphs in Figure 3 illustrate network-effect consistency across levels of analysis. The network model of brokerage applied to markets is a bit more complicated than the model applied to managers, but it is the same model. The difference is that applications to managers usually assume that each manager is equally able to act in his or her own interest. Consider the implications of making that assumption about producers in markets. If it could be assumed that producers were equally coordinated within each market, then O would be a constant, so Eq. (4) would reduce to a sum of dependence weights as in Eq. (1), the producer organization term in Eq. (3) would be absorbed into the intercept and Eq. (3) would reduce to aC^γ (where a is the intercept in Eq. 3, α , plus an adjustment for constant O), which is the form of the log constraint predictions illustrated for managers in Figure 1.

In fact, managers are not equally able to act in their own interest. When the assumption of equal ability to act is relaxed, returns to manager brokerage resemble the returns to market producer brokerage. *Ceteris paribus*, managers doing a job in which they have many peers are less able to act in their own interest. Numerous peers increase competitive pressure on each manager. Jobs in which there are many peers are more subject to company processes. Individuals are less the author of their own jobs, more a reflection of company prescriptions. Returns to brokerage decrease as the number of peers increases (Burt, 2005:156-162). In the graph at the bottom of Figure 3, I use job rank as a crude surrogate for number of peers and re-estimate the prediction in Figure 1 for managers in senior job ranks separate from managers in lower job ranks. The bold line in the graph at the bottom of Figure 3 describes for senior managers the rate at which performance erodes with decreasing access to structural holes. The thin line describes the same for managers in lower ranks.

The two points made about the industry graph at the top in Figure 3 can be made equally well about the manager graph at the bottom in Figure 3. In both graphs, the regression lines decrease showing the corrosive effect on performance of increasing network constraint. The bold line is higher than the thin line, showing the advantage of being a producer in a concentrated industry or a manager in a senior rank. Second, the advantaged lose more. The bold line decreases more quickly in both graphs as suppliers, customers, or colleagues, become more coordinated with one another.

The micro and macro effects are also complements in their differences. For one thing, there is a difference in network variability. Managers are more varied in network constraint. Once a manager finds a secure niche in a large organization, he or she can work it to personal advantage. Unproductive managers are not removed from organizations with the same ruthlessness by which competition removes unproductive organizations from markets. The two graphs in Figures 1 are drawn to scale. They are the same height, but the manager graph is wider. The industry graph is less wide because surviving industries rarely exist at the upper extremes of network constraint. Only two percent of industry observations used to estimate industry effects for Figure 3 lie above 40 points of network constraint on the horizontal axis. Only one percent of the observations lie above 50 points. The managers exist in more varied circumstances. A third of the manager observations used to estimate network effects for Figure 3 lie above 40 points of network constraint. A fifth of the observations lie above 50 points, and many managers are embedded in completely closed networks, networks that pose 100 points of constraint.

The industry data have their own strength: they provide a stronger foundation for claims that network structure affects performance. The stronger foundation is due to network data that are more authoritative, and network relations that are more exogenous to performance. With respect to more authoritative, the benchmark input-output tables defining industry networks are based on a census of business establishments. Anyone who studies industry networks defined by the tables begins with the same dollar-flow relations. Results are directly comparable across research projects. Manager network data, in contrast, are always open to questions about how

networks have been sampled and measured, and whether the measured relations are real or a reflection of passing interests. With respect to more exogenous, the dollar-flow relations are not discretionary. They are defined by production technology, which makes them more exogenous to performance than is usually the case in network analysis. Car producers, for example, can purchase steel from one or another company, but they must purchase steel somewhere. Producers are dependent on another industry to the extent that existing production technology has them transacting a large portion of their business with the other industry. In contrast, relations in manager networks are typically cited and maintained at the discretion of individuals. Who I select as my 'friend' is my choice, as is naming 'frequent' or 'valued' contacts. Where I have discretion in selecting friends, I can select for reasons other than friendship, which creates an endogeneity problem: a relationship can appear, or be obscured, because the person naming contacts is reacting to performance. Whatever the performance advantage provided by access to structural holes, for example, there must be some effect in the opposite direction. People seek out successful colleagues. Successful people will attract relations from colleagues from other groups such that a network measured after a manager has achieved success is likely to span structural holes. Input-output relations are more exogenous to performance. The relations are defined by production technology and performance results from how producers execute the technology. This is not to say that industry performance and production technology do not have mutual effects over time. Both evolve and are subject to exogenous shocks (e.g., McGahan et al., 2004). However, relative to the networks around managers, industry networks are more exogenous to performance.

In short, what managers do not provide in authoritative network data as a research site, they provide in variety. What industries lack in variety, they provide in authoritative data. Industries and managers are together a more powerful platform for network studies of competitive advantage than either would be alone.

CORPORATE ADVANTAGE AND INDIRECT ACCESS TO STRUCTURAL HOLES

That is, unless something disrupts the ability to draw research inferences between manager and industry networks, which is the central issue for this chapter: Advantage does not spill over between adjacent manager networks. Is the same true of industry networks?

Expected Advantage: Maybe, Yes, and No

A priori, the performance association with indirect access could be almost anything; negligible, positive, or negative. Argument can be made for each of the three possibilities. Indirect access to structural holes in manager networks corresponds to industry networks: Organizations with which producers buy and sell define the producer industry's direct suppliers and customers. Organizations with which those suppliers and customers do business are the industry's indirect suppliers and customers. The effect on producers of structural holes among indirect suppliers and customers follows from the effect of holes among direct suppliers and customers.

A priori, my prediction would have been a negligible association in industry networks because the association in manager networks is so obviously negligible. Given the similar micro and macro performance associations with direct access to structural holes (Figure 3), and given no performance association with indirect access for managers (Figure 2), my default prediction would have been to assume similar micro and macro associations with indirect access, and so predict a negligible industry performance association with indirect access. The storyline would be that supplier and customers advantage is irrelevant to producer advantage. All that matters is whether producers are in a position to benefit from supplier or customer diversity and disunion.

A person unaware of the manager results could be expected to predict a correlation between producer margins and supplier-customer advantage — for much the same reason that correlation with manager performance was expected before the results in Figure 2 were known: Given the known advantage of direct access to structural holes, and the fact that networks are jointly owned (producers have nothing without customers and customers have nothing without suppliers), an advantage enjoyed by suppliers and customers must affect producer margins.

The performance effect could be positive. We know that direct access to structural holes is an advantage. Producers with direct access to structural holes among suppliers and customers are more exposed to variation in business practice and have more opportunities to play competing organizations against one another. Extend the immediate network one step to predict the performance association with having suppliers and customers advantaged by direct access to structural holes. Advantaged industries are more likely to have budget to experiment with new business practice so producers with advantaged industries as suppliers and customers are more likely to see new business practice and alternative ways to implement the practice. Advantaged industries in this view would be hubs in the spread of new business practice (e.g., Davis, 1991) and the abandoning of old practice (e.g., Greve, 1995). There is a precedent for this possibility in Baum et al.'s (2007) analysis of U.K. investment banks predicting the value of a bank's bond deals from bridges in the bank's network and bridges in the networks around partners in the bank's bond deals (where network ties are defined by bank participation in the same syndicates). They report positive associations with the number of a bank's own bridges and the number of bridges that its partners have. Beyond information and access, the more-likely slack resources available to advantaged suppliers and customers (illustrated in the graph at the top of Figure 3), can make them more lucrative customers and suppliers. The summary story would be that advantaged suppliers and customers offer lucrative business opportunities and an enhanced portal into new business practices, so advantaged suppliers and customers have a positive association with producer performance.

The performance effect could equally well be negative. The performance advantage of direct access to structural holes is anchored on the assumption that producers gain advantage from supplier and customer disadvantage. The corollary is that producers lose advantage when dealing with advantaged suppliers and customers. Laboratory experiments with exchange networks clearly show that people with multiple exchange opportunities exploit their partners who have few opportunities (Cook and Emerson, 1978; Cook et al, 1983). Outside the lab, Fernandez-Mateo (2007) reports disadvantage to contingency workers from continued affiliation with one placement firm that brokers access to jobs. Specifically, Bidwell and

Fernandez-Mateo (2007) show that contingency workers receive a decreasing share of their earnings the longer they stay with the same placement firm. With respect to industry networks, the story would be that advantaged suppliers and customers extract a disproportionate share of profit from their business, so advantaged suppliers and customers have a negative association with producer performance.

Tire Cord Industry

To illustrate the arguments, consider the tire cord industry network displayed in Figure 4. Figure 4 is a sociogram of the network around the tire cord industry in 1987 ('Tire Cord and Fabrics,' input-output industry 170700, SIC code 2296). Lines in Figure 4 indicate volumes of business. Dots indicate industries. The tire cord industry is indicated by the square 'dot' in the sociogram. The tire cord industry is a useful example because of its simplicity. There is one primary supplier and one primary customer. The bulk of tire cord supplies are purchased from the manmade fibers industry ('Manmade Organic Fibers,' input-output category 280400). The bulk of tire cord output is sold to tire manufacturers ('Tires and Inner Tubes,' input-output category 320100). The two primary supplier and customer relations are indicated by the two solid lines in Figure 4. Together, the two relations account for 86.7% of tire cord buying and selling with other production industries (the p_{ij} defined in Eq. 5, are given in Figure 4 as 52.8% with tire manufacturers, 33.9% with manmade fibers). I have further simplified Figure 4 by presenting only relations that constitute more than five percent of an industry's buying and selling (all p_{ij} greater than .05). I am using a broader 2% criterion to define suppliers and customers in the analysis, but a 5% criterion is better for the purposes of the example in Figure 4. The lack of a solid line in Figure 4 between tire manufacturers and manmade fibers means that each does less than 5% of its business with the other. There is little more to report on the immediate network around tire cord producers. After the 33.9% of business with manmade fibers, the next largest volume of tire cord business is 3.1% with advertising, followed by 1.7% with the local electric utility, followed by still smaller percentages spread across 44 other industries with many relations constituting less than .01 percent of tire cord business. In short,

the tire cord industry is little more than a way station in the flow of product from manmade fibers to tire manufacturers.

————— FIGURE 4 ABOUT HERE —————

The immediate network helps explain why tire cord profits are low despite the high level of industry concentration. The tire cord price-cost margin of 16.2¢ equals the average margin across all manufacturing industries, yet the concentration ratio of 91% is well above the 40% average in manufacturing (2.45 z-score). The price-cost margin should be higher in such a concentrated industry. However, the sociogram in Figure 4 shows that concentration within the industry is counterbalanced by severe network constraint from suppliers and customers. Tire cord manufacturers are dependent on one primary supplier and one primary customer. The industries on which they are dependent are highly concentrated. Concentration is color coded in Figure 4 as high (black), above average (grey), below average (light grey), and low (white) distinguished by the median and interquartile range of 1987 scores. The text box shows that concentration is high in the direct supplier and customer industries: 76% in manmade fibers and 69% in tires and inner tubes. Dependence on concentrated supplier-customer industries defines a high level of direct network constraint on the industry (C equals 37 for tire cord and fabrics, well above the average of 15 for manufacturing, 2.36 z-score). Under strong pressure from suppliers and customers, tire cord profits should be lower than would be otherwise expected from high concentration in the industry — as they are.

But tire cord profits are even lower than predicted by industry concentration and direct network constraint in the baseline model. The text box in Figure 4 shows a 23.0¢ price-cost margin predicted for the tire cord industry in 1987, which is well above the observed margin of 16.2¢ (z-score difference is .72).⁵

Explanation can be found in the broader network of indirect suppliers and customers. Dashed lines in Figure 4 indicate buying and selling beyond the immediate network around tire cord producers. Network constraint computed within the immediate network around an industry — the solid lines in Figure 4 — measures the extent to which industry producers have direct access to structural holes from which they could benefit. Network constraint computed

within the broader network of suppliers and customers to the industry's direct suppliers and customers — the dashed lines in Figure 4 — measures the extent to which industry producers have indirect access through their suppliers and customers to structural holes in the network structure around their suppliers and customers. In predicting tire cord profits from the Eq. (3) baseline network model, I held constant supplier and customer concentration as a component in direct network constraint (C in Eq. 4). However, the supplier and customer industries for tire cord producers have a further advantage: they are subject to low network constraint from their own networks of suppliers and customers. Figure 4 shows that suppliers in the 'manmade organic fibers' industry do business with many supplier and customer industries, few of which are especially concentrated — so tire cord suppliers face much less direct network constraint than tire cord producers (C for manmade fibers is 13 versus 37 for tire cords, a 2.52 z-score difference). The lower direct network constraint on suppliers means that they enjoy a higher profit margin (PCM is 21.6¢ in manmade fibers versus 16.2¢ in tire cord), which could affect on tire cord producers. Tire manufactures, the primary customer industry for tire cord, are similar subject to lower network constraint (C equals 13).

In this case, having advantaged suppliers and customers seems to have a negative effect on tire cord margins. Advantaged suppliers and customers enjoy profits at a level expected from direct access to structural holes (PCM hat is about the same as PCM in the text box) while producer profits are well below expected.⁶

Returns to Indirect Access

In contrast to the tire cord example, the aggregate effect is positive: producers derive advantage from business with advantaged suppliers and customers. Results with alternative measures are presented in Table 1.⁷ Suppliers and customers in Table 1 are the industries with which producers transact two or more percent of their business.⁸ As a point of reference, Model (1) in Table 1 provides estimates for the baseline model in Eq. (3). The estimates, discussed in the text on page 20, show the negative performance effect of rivalry within the industry (reversed industry concentration in the first row of the table) and the negative effect of dependence on

supplier-customer industries in which there is little rivalry (network constraint C in second row of the table).

Zero-Order Correlation

As a further point of reference, Model (2) is the same as Model (1), but with indirect network constraint replacing direct constraint. Recall the correlation between manager performance and indirect access to structural holes (graph to the left in Figure 2). Similarly, Model (2) in Table 1 shows a strong positive association between industry margins and indirect access to structural holes. The measure of indirect network constraint is average direct network constraint on supplier and customer industries, which is an exact analogue to the measure of indirect network constraint in Figure 2 for managers.⁹ In Figure 4, for example, network constraint on suppliers in the ‘Manmade Organic Fibers’ industry ($C = 13$) would be averaged with network constraint on customers in the ‘Tires and Inner Tubes’ industry ($C = 14$), which together define 13.5 points of indirect network constraint on tire cord producers. Model (2) in Table 1 shows that producer margins increase with decreasing direct constraint on suppliers and customers (-5.21 t-test).

Returns to Average Indirect Network Constraint

Models (3) and (4) test direct and indirect network constraint as alternative effects on producer margins. The measure of indirect constraint in Model (3) is the average across suppliers and customer industries used in Model (2). No consideration is given to the relative volume of producer business with different industries. Any supplier or customer industry over the criterion volume of business is equally a source of indirect network constraint on producers. This is a crude measure, but it is sufficient to show that producer margins increase with indirect access to structural holes in the networks of suppliers and customers, above and beyond the effect of direct access within their immediate network. The -5.09 coefficient for indirect network constraint in Model (3) generates a strong -3.84 t-test (cf. Baum et al., 2007: Table 2, for association between investment bank performance and the average number of bridging ties in the networks around the bank’s syndicate partners).

———— TABLE 1 ABOUT HERE ————

Model (4) differs from (3) in weighting supplier and customer industries for volume of business.¹⁰ In Figure 4, for example, indirect network constraint on tire cord producers is more defined by the network constraint on tire manufacturers than the constraint on manmade fibers because tire cord producers do more business with tire manufacturers. Specifically, the weight for tire manufacturers is .61, which is $52.8 / (52.8 + 33.9)$, and the weight for manmade fibers is the complement, .39. The two weights together define 14 points of weighted indirect network constraint on tire cord producers: $13.61 = .61(14) + .39(13)$. Weighting in Model (4) offers no improvement over the count of indirect suppliers and customers in Model (3). The -3.32 coefficient in Model (4) for indirect network constraint generates a -3.48 t-test, which is about the same as the corresponding t-test in Model (3).

Returns to High versus Low Indirect Network Constraint

In Model (5), I disaggregate indirect network constraint into positive and negative elements to see whether either extreme makes disproportionate contribution to the spillover. Models (3) and (4) show that indirect network constraint erodes producer performance, but the effect is some mix of negative effect from indirect network constraint and positive effect from the lack of indirect network constraint. I suspected that the negative effect might be less negotiable in industry buying and selling, and so more likely to spill over between adjacent networks.

Measuring positive spillover potential in Model (5), ‘Percent Industry Business with Low-Constraint Suppliers-Customers’ is the percent of industry business transacted with suppliers or customers that are advantaged by their own networks of suppliers and customers, which could be an indirect advantage to producers. The measure is p_{ij} for producer industry i (in Eq. 2), summed across supplier-customer industries j , where industry j is under ‘low’ network constraint from its own suppliers and customers, and ‘low’ refers to the bottom quartile of network constraint scores (C less than 7.72 points). In Figure 4, tire cord producers score zero on this measure. The 13 points of network constraint on manmade fibers is above the 7.72 criterion for a low-constraint industry, and the 14 points of network constraint on tire manufactures is above the criterion.

Measuring negative potential, ‘Percent Industry Business with High-Constraint Suppliers-Customers’ is the percent of industry business transacted with suppliers and customers weakened by severe network constraint from their own suppliers or customers. The measure is p_{ij} for producer industry i summed across supplier-customer industries j where industry j is under ‘high’ network constraint from its own suppliers and customers, and ‘high’ refers to the top quartile of network constraint scores (C greater than 17.43 points). In Figure 4, tire cord producers score zero on this measure. Network constraint on supplier and customer industries falls below the 17.43 criterion for a high-constraint industry.

The results for Model (5) show that producer performance is affected by both the positive and negative effects of indirect network constraint (t-tests of 2.14 for the positive and -2.04 for the negative).

Returns to Constraint from the Whole Network of Indirect Suppliers and Customers

Model (6) in Table 1 measures indirect network constraint for the whole extended network that does business with producer suppliers and customers. The measures of indirect network constraint in Models (2), (3), (4), and (5) average network constraint in the networks around each supplier-customer industry. Business relations between networks are ignored. The measure of indirect network constraint in Model (6) defines constraint within and across the networks around an industry’s suppliers and customers.

The measure is created as follows: Define the immediate network around a focal industry by identifying every other industry where focal-industry producers do more than 2% of their business. Second, define in the same way the immediate network around each industry supplier and customer in the immediate network. The M industries identified in the second step, but not the first, are indirect suppliers or customers for the focal industry. In Figure 4, for example, M equals 19. There are 19 indirect supplier-customer industries for tire cord producers. For the lower 2% criterion used in Table 1, the number of indirect supplier-customer industries increases to 26. Third, assemble from the input-output table buying and selling among the M industries to define the extended network of indirect suppliers and customers. By definition, the focal industry has no direct buying or selling (above the criterion) with its M indirect

supplier-customer industries. I operationalized indirect relations with the strongest two-step connection through a direct supplier or customer.¹¹ Fourth, and finally, compute constraint C in Eq. (4) from the network of buying and selling among indirect supplier-customer industries, and concentration data on producer rivalry within the industries.

This measure of network constraint across indirect supplier-customer industries has a statistically significant effect on industry performance (2.03 t-test), but the effect is less clear than the corresponding effects for the more narrowly defined indirect constraint measures in Models (2), (3), (4), and (5). The implication is that what matters most for indirect network constraint is the immediate network around each supplier and customer industry, not the whole network of business relations within and between the immediate networks.

SUMMARY

I opened this chapter with a question: What is the scope of brokerage network to be considered in thinking strategically? Given the value of bridging structural holes, is there value to being affiliated with people or organizations that bridge structural holes? The answer is ‘no’ according to evidence on performance associations with manager networks. Indirect access to structural holes through colleagues, deemed ‘secondhand brokerage,’ shows no performance advantage. Advantage depends on people building their own bridge relations across structural holes. The answer ‘no’ is simple, greatly simplifies the study of strategic behavior in networks, and is surprisingly robust, but its interpretation in terms of enhanced cognitive and emotional skills raises a question about network theory generalized across levels of analysis. Cognitive and emotional skills are more obviously qualities of people than they are qualities of organizations or industries. My goal in this chapter has been to re-establish micro-macro consistency, using evidence on industry networks analogous to the evidence on manager networks.

I began with illustrative evidence on performance and manager networks, to establish a baseline and to explain why direct and indirect access to structural holes can be an advantage.

Direct access refers to structural holes in the immediate network of a manager's colleagues, or an industry's suppliers and customers. Indirect access refers to structural holes between friends of friends, in the networks around colleagues, or around suppliers and customers. We know there are returns to direct access (Figure 1), in fact very similar returns at micro and macro levels of analysis (Figure 3). If there is advantage to affiliation with the well-connected, there should be returns to indirect access. The returns are negligible in manager networks, as illustrated in Figure 2, showing no advantage to affiliation with well-connected colleagues despite the fact that a manager's own network is strongly associated with performance.

I then described the analogous industry network model (Eq. 3), introducing the industry data (two years of benchmark performance and network data on detailed American manufacturing industries), and highlighting in Figure 3 complementarities between manager and industry evidence (consistency across levels of analysis, greater variety in manager networks, less endogeneity in the industry networks).

The micro-macro consistency in industry and manager associations with direct access to structural holes breaks down with respect to indirect access. I analyzed industry performance in terms of three industry-structure effects: rivalry within the industry, direct network constraint from industry suppliers and customers, and indirect network constraint spilling over from the networks around suppliers and customers. In contrast to the manager evidence showing no performance association with indirect access, there is clear evidence of a positive association at the industry level of analysis. The bottom rows in Table 1 show that about 24% of the industry-structure effect on price-cost margins can be attributed to structure beyond the industry's own buying and selling, to networks around the industry's suppliers and customers.¹²

CONCLUSION

The industry results could be interpreted as evidence that the network theory used here is not consistent across micro and macro levels of analysis. However, there is also much that is

consistent across the levels. I conclude that the industry evidence is not qualitatively distinct from the manager evidence so much as it describes a more extreme business environment.

Consider the disaggregate evidence in Table 2. Performance is reported for six study populations — the five manager populations in Figure 1 plus the population of industries in Table 1 — broken down into four network categories distinguished by high versus low direct and indirect network constraint. Each network category is a row panel in Table 2 illustrated by a sociogram to the left. There are several industry measures of indirect network constraint in Table 1. For Table 2, I use the measure in Model (3) of Table 1 — the industry measure most similar to the manager measure.

———— TABLE 2 ABOUT HERE ————

The manager and industry results are similar for extreme networks, at the top and bottom panels in Table 2. Performance in Table 2 is a z-score residual holding constant job rank and year for the managers, concentration and year for the industries. At the top of the table are the networks around broker of brokers. These networks provide direct and indirect access to structural holes. These are managers and industries with many disconnected contacts, themselves in networks of many disconnected contacts. Performance scores at the top of Table 2 are the highest in the table. At the bottom of the table are the closed networks providing neither direct nor indirect access to structural holes. These are managers and industries with densely-interconnected contacts which are themselves in networks of densely-interconnected contacts. Performance scores at the bottom of Table 2 are the lowest in the table.

The critical results for this chapter are in the middle of the table, describing networks that provide direct or indirect access to structural holes, but not both. In the second panel of Table 2, managers and industries are similarly advantaged by ‘only direct access’ to structural holes. These are producers relatively free from the constraint of dependence on concentrated supplier or customer industries, but beyond those suppliers and customers are concentrated industries that pose severe indirect network constraint. The $-.04$ average residual price-cost margin reported for industries in the second panel of Table 2 is lower than the $.34$ residual margin enjoyed by producers free from direct and indirect network constraint, but significantly higher

than the $-.30$ residual margin observed in industries oppressed by high direct and indirect network constraint (2.17 t-test). Test statistics in the second panel are sufficient to reject the null hypothesis — a magnitude of two or three — but are for managers and industries similarly weaker than the test statistics for the broker-of-brokers networks in the first panel of the table.

The manager and industry results disagree in the third panel of Table 2, for networks that provide ‘only indirect access’ to structural holes. Average manager performance in the third panel is no better than the low performance observed in closed networks (t-tests of $.12$ to 1.38). In contrast, price-cost margins for industries in the third panel of Table 2 are significantly higher than the margins in closed-network industries (2.22 t-test). The panel-three industries contain producers dependent on concentrated supplier-customer industries that are themselves relatively free from constraint. The network in Figure 4 is illustrative. Tire cord producers face severe direct network constraint. They are dependent on a concentrated supplier industry and a concentrated customer industry. Both the supplier industry, and customer industry, do business in a wide variety of their own supplier-customer industries (dotted lines in Figure 4), which would put tire cord producers in the third panel of Table 4. However, the indirect supplier and customer industries are sufficiently concentrated to put tire cord producers in the ‘closed network’ panel at the bottom of Table 2 (indirect network constraint score of 13.32 is higher than the median score of 8.53). In other words, industries in the third panel of Table 2 are less constrained than the example in Figure 4 in the sense that their indirect supplier-customer industries are more numerous, more disconnected, or more riddled with internal rivalry. That relative freedom from indirect network constraint is an advantage manifest in higher margins despite severe direct network constraint. In fact, margins in the third panel are about as high as the margins observed in the industries just above them with more attractive network structures (mean residual price-cost margins of $-.04$ and $-.05$ for industries in the second and third panels of Table 2, versus $-.30$ for ‘closed networks’ at the bottom of the table).¹³

The disagreement between manager and industry results in the third panel of Table 2 is not a qualitative jump from managers to industries so much as it is a matter of degree. The

manager effects are not equally negligible. There is an order to effects in the panel: statistically significant for industries (2.22 t-test; $P < .05$), not significant for the bankers and analysts (respective t-tests of 1.37 and 1.38, $P < .10$), zero for the product-launch, supply-chain, and HR managers (t-tests of .62, .12, and .66 respectively, $P > .50$).

What do analysts and bankers have in common with industries that distinguish all three populations from the other, more bureaucratic, populations in Table 2? Of the many dimensions of competition that would put industry markets at one extreme of a continuum with bureaucratic organizations at the other extreme, two dimensions stand out as likely candidates for productive network research in future: information and inhibition.

The information dimension I have in mind is the familiar contrast between Austrian and neoclassical markets (for example, with respect to network models, Birner, 1996; Burt, 2005:227-244; 2007). At the Austrian end of the continuum lie networks in which information is tacit and complex so it moves between groups slowly and inaccurately, if it moves at all. Here, the product-launch and supply-chain managers work in networks balkanized by geography, technology, and legacy culture. Indirect connections beyond the immediate network have limited value, or, judging from Table 2, no value. At the neoclassical end of the continuum lie networks in which information moves rapidly and accurately. Here are the mature capital markets in which I would have thought the investment bankers and analysts work. There must always be an element of local interpretation, but capital markets are mature in the sense that news about investments and company developments in distant locations routinely flashes around the globe to affect plans and share price in London, New York, and Tokyo. The more easily that meaningful information moves quickly between distant places, the more advantage there is to the diverse information provided by indirect access to structural holes. There is a severe scope condition to this advantage. Indirect access shows negligible advantage for the investment bankers and analysts in Table 2. Advantage is only visible at the extreme of industry buying and selling, where information can be codified into routines and apparently moved with impact through indirect connections.

The inhibition dimension I have in mind is social norms of proper behavior. The more personal and local the business, the more likely that people feel obligation to support friends and return favors. Among the six populations discussed in this chapter, HR, product-launch, and supply-chain managers show no returns to brokerage beyond their immediate network. In confidential talk with these managers, I would expect to hear stories about actions justified by personal loyalty and favors that people owe one another. In contrast, no one ‘owes’ their industry. No one counts their industry among their friends. You can drive a business into bankruptcy, but it would be poor form to hammer a friend insensible. There must always be some element of inhibition to corporate behavior. If you think corporations are wild based on what you know about their behavior, imagine what was ruled out as improper. The analysts and bankers in Table 2 show a negligible but nonzero advantage from indirect access to structural holes, so I put them somewhere between the extremes, distinct from the impersonal market behavior of industry buying and selling, but not quite the personal work environments of the HR, product-launch, or supply-chain managers. Protection from market forces can be discussed in terms of human decency or corrupt bureaucracy. Either way, it is an intriguing question for the next round of empirical research. One thing is clear: a wide range of business environments — from corporate bureaucracies up through the mature capital markets in which investment bankers and analysts work — show no performance advantage to brokerage beyond the immediate network of direct contacts. There is a detectable performance advantage at the extreme of industry market relations; but short of that extreme, advantage is limited to the immediate network of direct contacts.

NOTES

¹Alternative aggregations yield similar results. Indirect network constraint on manager i is measured by aggregating the networks around each of the manager's contacts, $IC_i = \sum_j \delta_{ij} C_j$, $i \neq j$, where C_j is network constraint on contact j within his or her own network, and δ_{ij} is a weight for pooling contact networks. I tried measuring indirect network constraint as the arithmetic average across a manager's contacts ($\delta_{ij} = 1/N$, where N is the number of the manager's contacts). This is the measure on the horizontal axis of Figure 2. I also tried the constraint on the manager's boss, under the assumption that the chain of command is the primary source for opportunities ($\delta_{ij} = 1$ for manager's boss, 0 for all other contacts), and constraint on the manager's best-connected colleague, under the assumption that every contact need not be a source of opportunity, but you need at least one ($\delta_{ij} = 1$ for the contact with the lowest network constraint, which means the largest, least redundant, network; 0 for all other contacts). These three aggregations yield the same result: strong zero-order association with performance and negligible partial association.

²After suppliers and customers in an industry's immediate network are identified, proportions are normalized within the immediate network to compute network constraint. The raw proportions defined by Eq. (5) are normalized to sum to one across all production industries in the economy. As reported in Table A3 in the Data Appendix, I get stronger network constraint effects if I compute constraint from p_{ij} normalized within the immediate network around an industry: $p_{ij} = p_{ij} / \sum_k p_{ik}$, $i \neq j$, where the sum is across all industries k in the immediate network excluding industry i itself. This assumes that the connections most relevant to the focal industry are the connections within its immediate network, not connections across the economy. Normalizing within the immediate network is what is done with manager networks when relations beyond the immediate network are unknown (as is often the case in survey network data), so I am comfortable using the same operationalization with industry networks to obtain stronger network effects.

³Throughout this chapter, I use the structural autonomy score defined by industry structure (A in the baseline model, Eq. 3) to predict exponential industry performance (e^{PCM}), rather than raw performance (PCM), where PCM is the industry price-cost margin. The exponential of performance yielded clearer results in Burt et al. (2002), and I find the same for the more narrowly-defined industries analyzed here. Thus, natural logs of industry-structure variables predict price-cost margins in the text.

⁴The statement is based on regressing observed price-cost margins across z-score margins, holding constant the slightly higher margins in 1987, which shows a 9.6¢ average increase in price-cost margin for a unit increase in z-score margin.

⁵The expected price cost margin is predicted using the estimates presented below for Model (1) in Table 1.

⁶The performance link with industry structure is all the more impressive because buying and selling this constrained is rarely left exposed to the vicissitudes of market price. Such buying and selling is typically embedded in a corporate hierarchy to manage the risk (e.g., Pfeffer and Salancik, 1978; Burt, 1983). The typical pattern is borne out here. For example, one of the leading firms in the tire cord industry is Firestone Fibers and Textiles. Firestone is

owned by BFS Diversified Products, which also runs establishments in Firestone's primary supplier industry, manmade fibers. BFS Diversified Products is owned by the Japanese tire company, Bridgestone, the American operations of which are a major tire supplier for automobiles produced in the United States. In other words, Bridgestone has embedded its American tire production in a corporate hierarchy. Bridgestone tire production can draw on Firestone tire cord, which can draw on BFS fiber output. Nevertheless, market advantage emerges in the transfer prices negotiated between business units. Tire cord production is anchored on three industries: itself, a supplier industry, and a customer industry. All three are highly concentrated. However, the supplier and customer industries are less subject to network constraint from their own suppliers and customers, which is manifest in them enjoying their expected level of profits while tire cord producers report margins well below expected.

⁷The five effect estimates in Table 1 for measures of indirect network constraint are statistically significant if I include observations on the manufacturing industries that correspond to multiple SIC categories, increasing the number of observations from 632 to 713. Here are the coefficients in Table 1 and their corresponding t-tests (in parentheses): -5.09 (-3.84), -3.32 (-3.48), 1.48 (2.14), -.74 (-2.04), and -3.92 (2.03). When estimated across all manufacturing industries with nonnegative price-cost margins, the results are similar, but stronger because of the additional observations: -5.33 (-4.41), -3.49 (-4.09), 1.38 (2.43), -.76 (-2.33), and -4.22 (-2.52).

⁸The 2% criterion is based on tests of higher and lower criteria reported in Table A3 in the Data Appendix. The 2% criterion keeps the immediate network to a minimum size without losing predictive power in the baseline model, and leaves more of the economy available as potential indirect suppliers and customers. I estimated the models adding as a predictor the percentage of industry business that was over the 2% criterion (74% on average, see Table A2 in the Data Appendix). There is no zero-order association with performance (1.37 t-test) and no partial associations in the five models in Table 1 (t-tests of .81, -.63, -.42, -.95, and .66 respectively for the five models in Table 1).

⁹See measure IC in footnote 1, where δ_{ij} is here equal to $1/N$ if producers in industry i do a criterion volume of business with industry j , and N is the number of industries with which producers do more than the criterion amount of business. For example, 5% is the criterion in Figure 4, and N equals 2, so the δ_{ij} for each is $1/2$.

¹⁰Weight w_{ij} in the preceding footnote equals $p_{ij} / \sum_k p_{ik}$ for Model (4), volume of producer business with industry j divided by the sum of business relations that exceed the criterion for inclusion in the network.

¹¹The relation p_{ij} from focal-industry i to indirect supplier-customer industry j is set equal to the square-root of the maximum $p_{ik}p_{kj}$ across industries k in the immediate network around industry i , where p_{ik} is the proportion of industry i business conducted with industry k and p_{kj} is the proportion of industry k business conducted with industry j (where industry j is not in the immediate network around focal industry i).

¹²The 24% figure in this sentence is the average across the four percentages for indirect network constraint in Table 1. The specific averages across Models (3) through (6) are 50.5% for rivalry within the industry, 26.0% for direct network constraint, and 23.5% for indirect network constraint.

¹³The network cross-classification in Table 2 almost always elicits a workshop question about interaction effects. Do direct and indirect network constraint affect one another's effect on performance? They do not. To determine this, I multiplied log direct network constraint times log indirect constraint, and entered the interaction term to the performance prediction in each study population. The interaction term is a negligible addition: .45 t-test for compensation in the product launch, .36 for supply-chain manager salary, 1.71 for HR salary, .40 for investment banker compensation, -.12 for analyst election to the All-America Research Team, and .26 for industry price-cost margins (Model (3) in Table 1). The concentration of effect in panel three of Table 2 is a heuristic. It is true that the disagreement between manager and industry results is most apparent in panel three of Table 2, but the industry performance association with indirect access to structural holes exists in the other three panels as well. If I delete the 139 industry observations in panel three of Table 2 from the estimation of Model (3) in Table 1, there is still a -3.36 t-test for the performance association with indirect network constraint. Binary distinctions in Table 2 are a useful heuristic. They do not fully capture the continuous-variable results in Table 1.

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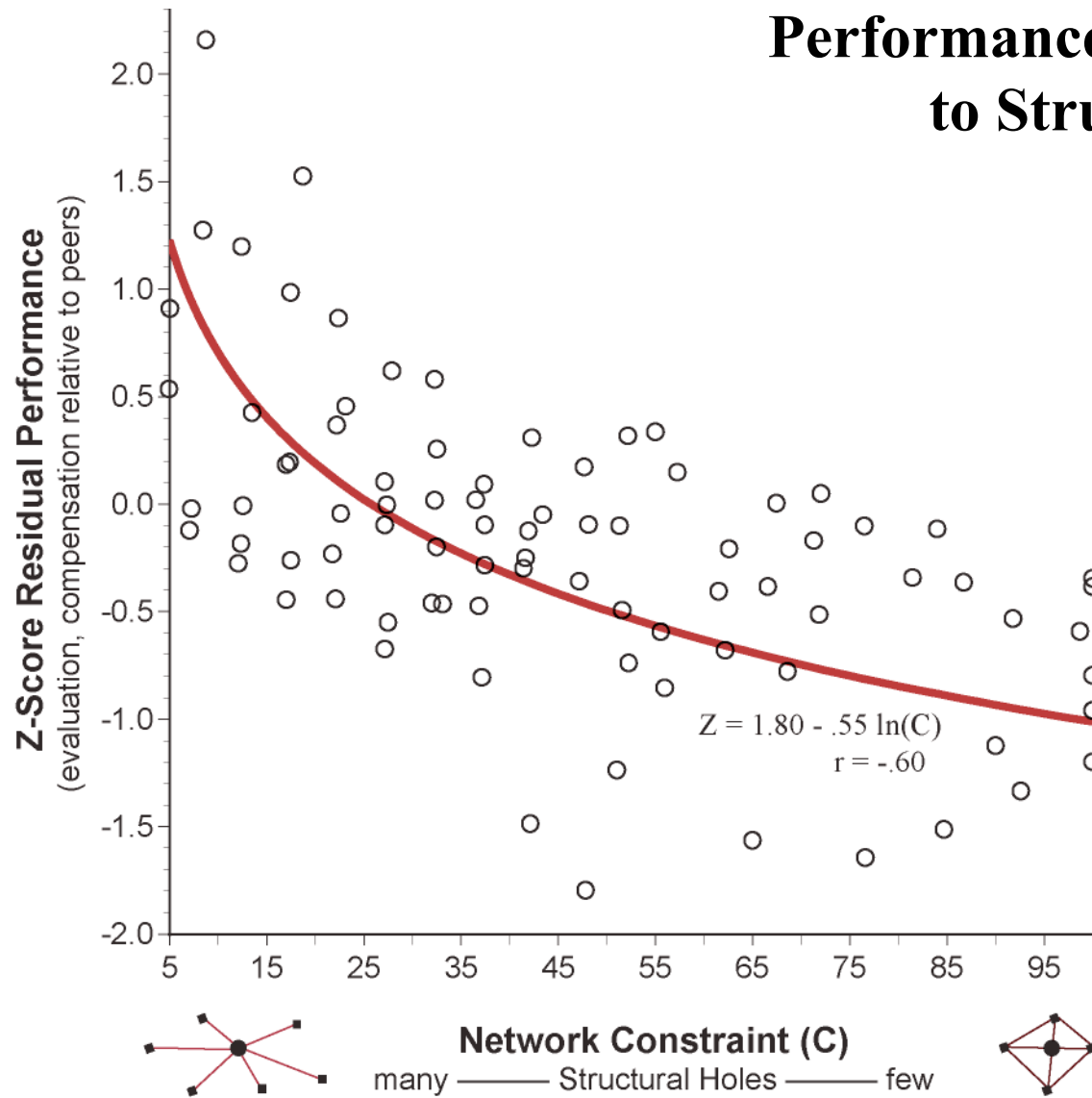
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Figure 1.

Performance and Direct Access to Structural Holes

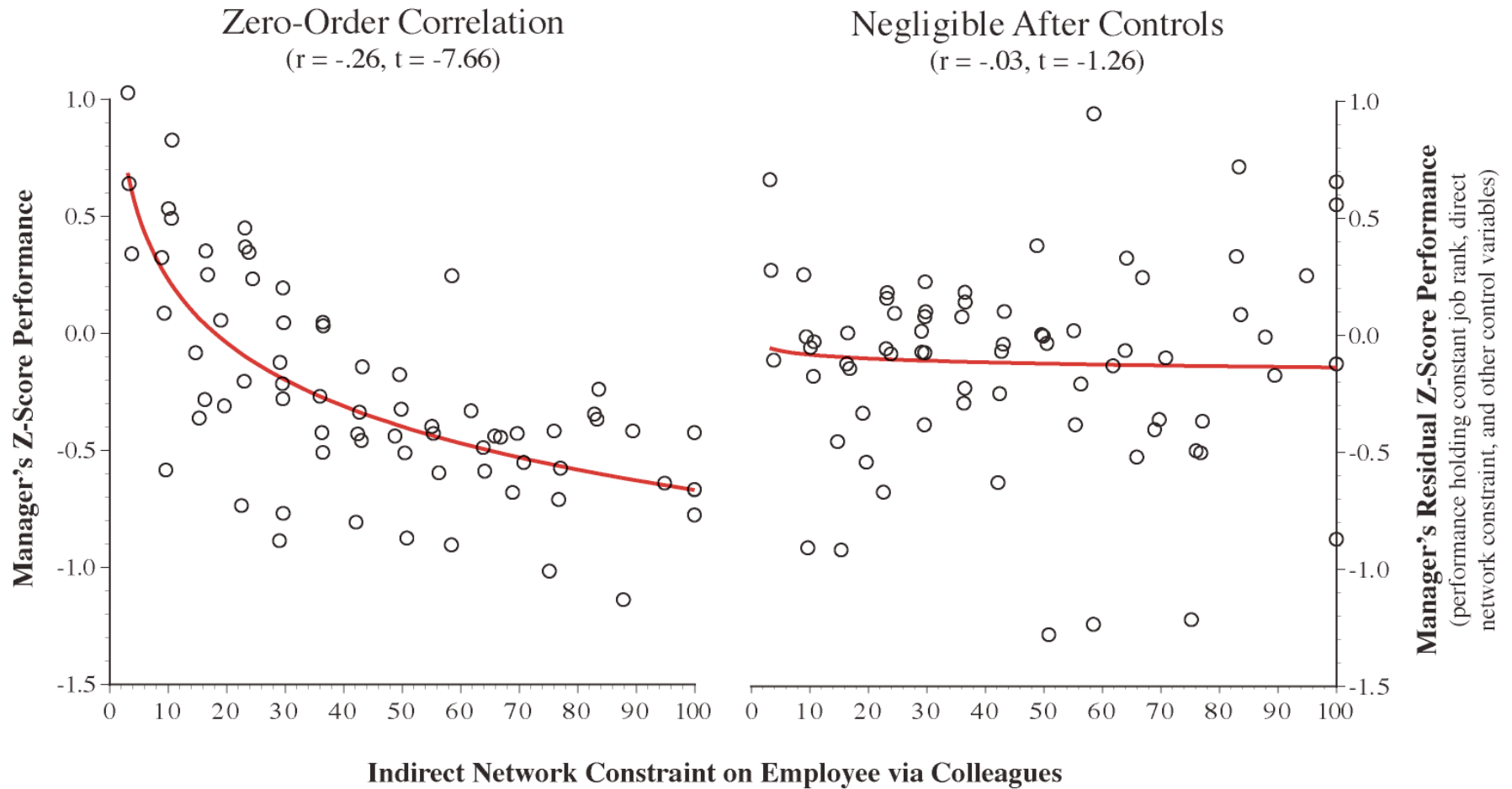


t-test	Population
-6.2	Human Resource Managers
-4.4	Investment Analysts
-7.3	Investment Bankers
-4.5	Product Launch Managers
-7.4	Supply Chain Managers

Dots in the graph are average z-score residual performance (Z) for a five-point interval of network constraint (C) within each of the populations listed above (with a t-test for the performance association with log network constraint within the population). Bold line in the graph is residual performance predicted by the log of network constraint across the 85 averages plotted in the graph.

Figure 2.

Performance and Indirect Access to Structural Holes



Each dot is a population average on the Y axis and X axis for a 5-point interval on the X axis (for the analysts, bankers, HR officers, product-launch employees, and supply-chain managers). Test statistics are estimated across individual observations with correction for repeated annual observations of the analysts and bankers.

Figure 3. Baseline: Micro-Macro Connection for Direct Access to Structural Holes

Vertical axis indicates relative performance and horizontal indicates network constraint. Graph to left shows how price-cost margins in American manufacturing industries change with increasing network constraint on producers from coordinated suppliers and customers. Graph below shows how performance metrics for managers in Figure 1 change with increasing connections among a manager's key contacts. Thin lines describe returns when peer competition is intense (low concentration, many peer managers). Bold lines describe returns when peer competition is less intense (high concentration, few peer managers).

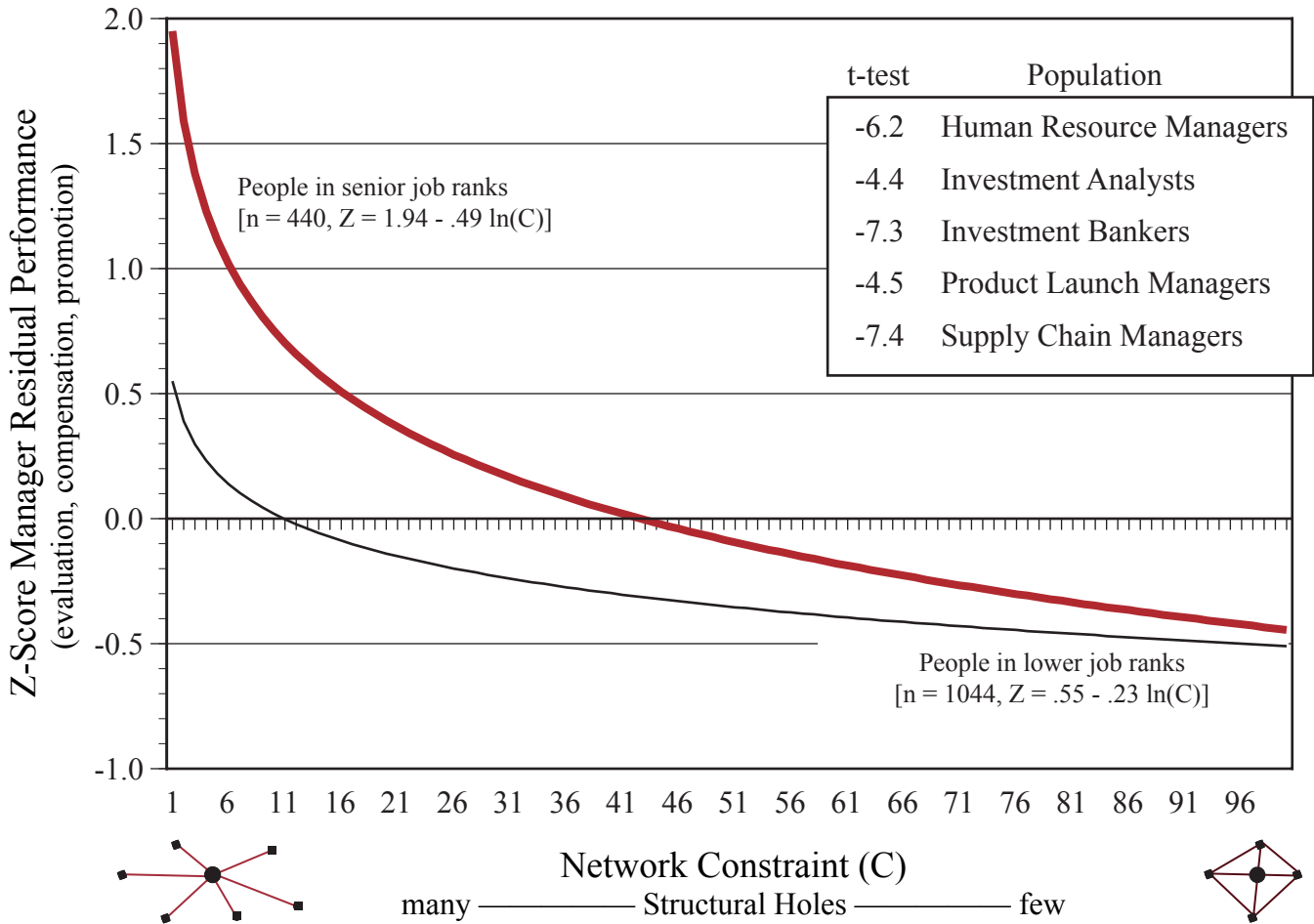
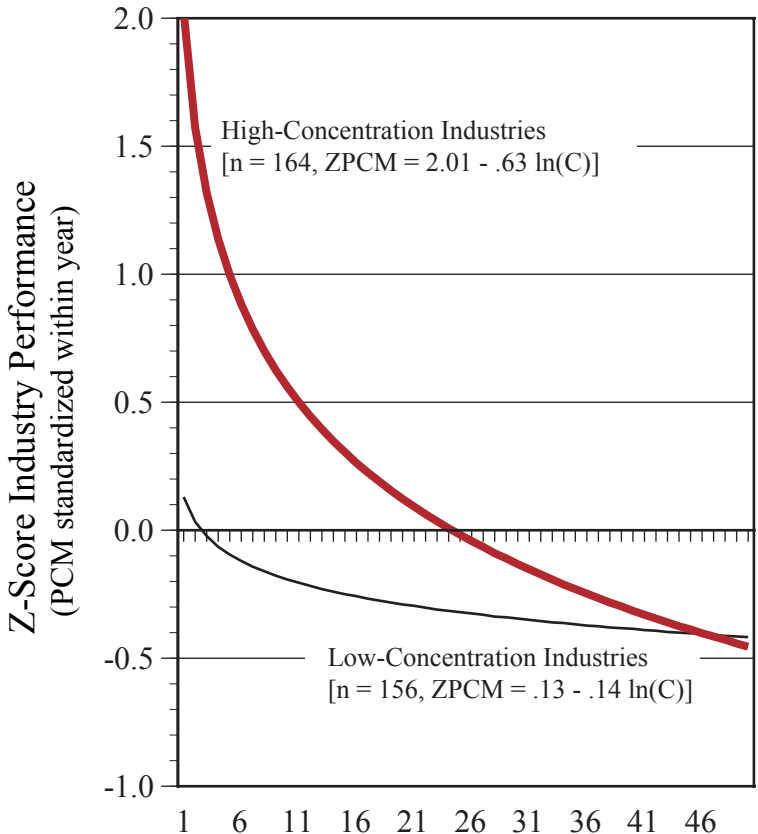
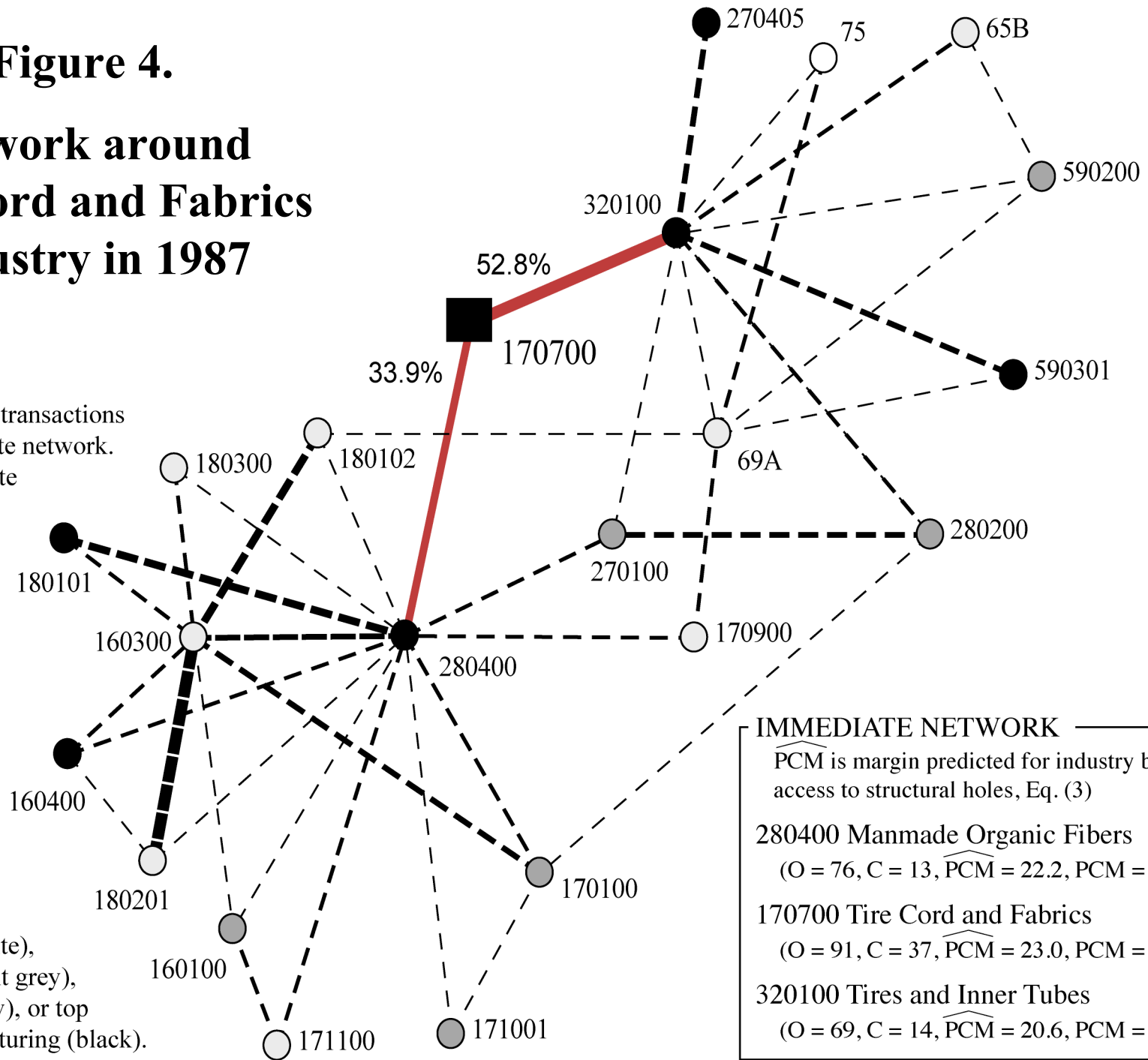


Figure 4.
Network around
Tire Cord and Fabrics
Industry in 1987

Solid lines indicate transactions within the immediate network.
 Dashed lines indicate transactions in the extended network.

Line thickness indicates volume of business (5% criterion for line).

Shading indicates industry concentration: lowest quartile of manufacturing (white), below average (light grey), above average (grey), or top quartile of manufacturing (black).



IMMEDIATE NETWORK	
\widehat{PCM} is margin predicted for industry by direct access to structural holes, Eq. (3)	
280400 Manmade Organic Fibers	(O = 76, C = 13, \widehat{PCM} = 22.2, PCM = 21.6)
170700 Tire Cord and Fabrics	(O = 91, C = 37, \widehat{PCM} = 23.0, PCM = 16.2)
320100 Tires and Inner Tubes	(O = 69, C = 14, \widehat{PCM} = 20.6, PCM = 18.9)

Table 1: Price-Cost Margins and Industry Network Structure

	(1)	(2)	(3)	(4)	(5)	(6)
Rivalry within Industry (100 - industry four-firm concentration ratio)	-5.42** (1.41)	-5.71** (1.37)	-5.77** (1.37)	-5.95** (1.40)	-5.94** (1.37)	-5.41** (1.38)
Direct Network Constraint from Suppliers-Customers (C in Eq. 4)	-4.39** (.80)		-3.11** (.82)	-3.28** (.80)	-2.63* (.80)	-3.11* (1.02)
Indirect Network Constraint from Their Suppliers-Customers						
Unweighted Average Constraint on Industry Suppliers-Customers		-6.81** (1.30)	-5.09** (1.32)			
Weighted Average Constraint on Industry Suppliers-Customers				-3.32** (.95)		
Percent Industry Business with Low-Constraint Suppliers-Customers					1.48* (.69)	
Percent Industry Business with High-Constraint Suppliers-Customers					-.74* (.37)	
Total Constraint across Indirect Supplier-Customers						-3.92* (1.93)
1987	2.38** (.41)	2.06** (.40)	2.16** (.41)	2.26** (.41)	2.20** (.41)	2.28** (.41)
Intercept	48.41	53.98	58.14	54.96	41.86	49.19
R ²	.15	.16	.19	.18	.19	.16
Percent Industry-Structure Effect from:						
Rivalry within Industry	56%	40%	48%	53%	49%	52%
Direct Network Constraint from Suppliers-Customers	44%	—	25%	29%	21%	29%
Indirect Network Constraint from their Suppliers-Customers	—	60%	27%	18%	30%	19%

Note — These are ordinary least-square regression equations predicting nonnegative price-cost margins in manufacturing industries corresponding to unique four-digit SIC categories in 1987 and 1992 (N = 632). Criterion to be a supplier-customer is 2% of industry business. All predictors are measured as log scores except the dummy variable for 1987. Means, standard deviations, and correlations are given in the Data Appendix (see acknowledgement note). Standard errors (in parentheses) are corrected for autocorrelation across repeated observations of same industry using ‘cluster’ option in STATA. * P < .05 ** P < .001

Table 2.





Manager and Industry Returns to Direct and Indirect Access to Structural Holes

Notes — (a) Focal manager or industry is dot in the center. Dashed lines are relations beyond immediate network.

(b) Constraint is dichotomized at its median in each population, except in the HR organization, where it is split to distinguish lowest 33% of scores.

(c) This is performance holding constant year and job rank for individuals, year and concentration for industries.

(d) These are test statistics for effects when z-score residual performance is regressed across the rows in each study population (analyst, banker, and industry results are adjusted for autocorrelation using ‘cluster’ option in STATA). ‘Closed Network’ is reference category. * P < .05 ** P < .001

Network Category ^a	Network Constraint ^b Direct, Indirect	Study Population (N)	Residual Z-Score Performance ^c	Test Statistic ^d
 Direct & Indirect Access	Low, Low	Product Launch (68)	.35	3.78 **
		Supply Chain (134)	.44	6.33 **
		HR (46)	.54	3.79 **
		Bankers (134)	.46	5.09 **
		Analysts (122)	.39	3.76 **
		Industries (200)	.34	4.69 **
 Only Direct Access	Low, High	Product Launch (78)	.07	2.27 *
		Supply Chain (97)	.10	3.18 *
		HR (49)	.26	2.43 *
		Bankers (88)	.26	4.44 **
		Analysts (55)	.01	2.53 *
		Industries (115)	-.04	2.17 *
 Only Indirect Access	High, Low	Product Launch (55)	-.20	.62
		Supply Chain (95)	-.29	.12
		HR (55)	-.09	.66
		Bankers (102)	-.28	1.37
		Analysts (123)	-.21	1.38
		Industries (129)	-.05	2.22 *
 Closed Network (no access)	High, High	Product Launch (57)	-.32	-2.45 *
		Supply Chain (129)	-.31	-3.68 **
		HR (133)	-.21	-2.10 *
		Bankers (145)	-.39	-6.25 **
		Analysts (54)	-.40	-3.35 *
		Industries (188)	-.30	-3.26 **