Seeing Both the Trees and the Forest: An Analysis of the Indian Interorganizational Network

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Professor David Knoke (Adviser)

August 2010

Acknowledgements

My dissertation is a group, rather than an individual, accomplishment. Professor David Knoke has been the most steadfast and kind mentor I could ever have hoped for. His insights shape every aspect of this dissertation. His thoughtful and extensive reviews taught me how to write cogently and clearly. His guidance and his confidence in me allowed me to flourish and pursue grand ideas. Professor Harry Sapienza has mentored me throughout my graduate career, and his steadfast support got me through some rough patches. Professors Yanjie Bian and Erin Kelly have strengthened my dissertation with their timely and thoughtful comments. My fellow graduate students, Erika Busse, Yu Ju Chien, Megan Krausch, Isil Yavuz, Jim Saliba, Jack Lam, and Minzee Kim, have made this long process not just bearable, but fun. Thanks to them, I look forward to coming to work every day. Finally and most importantly, my husband, son, and parents; they have experienced every setback and every milestone along with me. They are my rocks, and this dissertation would not be possible without their sacrifices, and their unwavering support. I am humbled by the generosity and spirit of my mentors, friends, and family.

Dedication

This dissertation is dedicated to my husband, Gangadhar Sulkunte.

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CHAPTER 1: INTRODUCTION

Like many other Indians, I belong to a large extended family, and we keep in touch with first-cousins, second-cousins, and even, on occasion, second-cousins' spouses' parents. If I am anywhere in the state, it is expected that I will attend the weddings, births, funerals, and festival celebrations within this large extended family. If I go to a new country, there is always someone who is somehow related to us, and whom I must contact. My American friends are amazed by these ties, and although my immediate network of family ties is usually very similar to theirs (I have one sibling), it is likely that the social structure in which I am embedded differs from theirs. This intuition guides my research – Networks differ; and they differ even when the immediate network of contacts is similar.

Economic sociology and organizational theory have focused on the structural embeddedness of economic activity. Structural embeddedness is used to refer to the fact that economic actions and outcomes, like all social actions and outcomes, are affected by the overall structure of ties in which the actor resides (Granovetter 1992b). However, current interpretations of this concept are fairly narrow, and focus on the structure of the immediate network of ties. The assumption is that beyond the first-level of contacts, the structure of ties does not matter. My dissertation broadens the current conception of structural embeddedness to include the structure of second-level contacts, third-level contacts (and so on), until the structure of the overall network of ties is taken into account. This broader understanding of structural embeddedness reveals the complexity and variation in interorganizational structure. At the level of the network, the Indian interorganizational network is not a simple ideal-typical small world as current theory suggests. Instead, it is a hybrid with portions of the network displaying a small world, nested world, and atomized structure. At the level of the group, Indian business groups vary in their structural complexity and in their position in relation to the rest of the network; at one extreme are isolated clusters of firms and at the other extreme are clusters of firms embedded within multiple layers of ties. Finally, at the level of the individual firm, structural embeddedness within the overall network is consequential, and leads to performance differences among firms.

My dissertation is organized around three papers. The three papers apply the concept of *structural embeddedness in the overall network*, at different levels of analysis. The term, structural embeddedness in the overall network, refers to the structure of actors' first-level contacts, second-level contacts, and so on, ultimately taking into account the overall network of the population of actors in the field of interest. The first paper (Chapter 2) is at the network level of analysis, and focuses on the network of Indian publicly traded firms. Current network research suggests that interorganizational networks are small worlds, composed of clusters of firms with sparse ties across clusters, and dense ties connecting firms within the cluster. However, other research on phenomenon such as business groups describes dense clusters of firms embedded within dense layers of ties. These descriptions correspond better to a nested world structure. I test the extent to which the Indian interorganizational network of publicly traded firms corresponds to these alternative ideal-typical structures. I find that this network is a hybrid of atomized, small, and nested worlds, and different parts of the overall network correspond to different ideal-typical network structures. This research suggests variation in firms' social structure, and I find that these variations are systematic, and correspond to variations in firms' age, cohort, industry, and founders' community ties.

The second paper (Chapter 3) is at the group level of analysis. Research on business groups is constrained by the absence of a clear definition. I rely on structural embeddedness within the overall network to identify business groups. This perspective yields new insights, and I find wide variation in the position of groups relative to the rest of the network; on one extreme are isolated business groups, and on the other extreme are business groups nested within multiple layers of ties. Current treatments of business groups fail to take into account these differences, and tend to be biased towards larger, older, and more visible groups leading to theory that incorrectly emphasizes the power and dominance of business groups.

The third paper (Chapter 4) is at the firm level of analysis. Firms' structural embeddedness within the overall network is operationalized as *nestedness*. Nestedness indicates firms' position within the group, and also group's position in relation to the rest of the network. I find that nestedness has a positive effect on firm performance (ROA and Tobin's q) in the Indian interorganizational network of publicly traded firms.

The three papers all rely on a network of Indian publicly traded firms. Details of design and the justification for particular design choices differ slightly in the three papers. Also, the analysis and results differ. Therefore, sections on data, design, analysis, and results are presented at the end of each paper, although there is some overlap in data, design, and analysis.

CHAPTER 2: THE HYBRID WORLD OF THE INDIAN INTERORGANIZATIONAL NETWORK

Current research suggests that interorganizational networks are small worlds (Davis, Diekmann, and Tinsley 1994; Davis, Yoo, and Baker 2003; Kogut and Walker 2001; Watts 1999; Watts and Strogatz 1998). A small world consists of clusters of firms with sparse ties across clusters, and dense ties within the cluster (Watts 2004; Watts and Strogatz 1998). This network structure has several desirable properties, and remains stable even in the face of institutional shocks such as economy-wide restructuring (Kogut and Walker 2001). It enables efficient information diffusion across the network (information jumps from cluster to cluster using sparse bridging ties) without relying on central firms that might wield disproportionate influence in the economy, and without dense ties that constrain firms in making decisions. However, the similarity in overall structure across networks suggested by current research does not correspond to descriptions of cross country differences in social structure (Hamilton and Biggart 1988). For instance, research on business groups (the Japanese *Keiretsu* are a prominent example) describes clusters of firms embedded within multiple layers of ties (Gerlach 1992; Granovetter 2005; Lincoln, Gerlach, and Ahmadjian 1996). This research describes groups of firms that disproportionately influence the economy (La Porta, Lopez-de-Silanes, and Shleifer 1999). This research also describes firms constrained within dense ties (Gerlach 1992).

Latest advances in network theory suggest alternative ideal-typical network structures that correspond better to the social structure described in research on *Keiretsu* and other business groups. Moody and White (2001) describe a nested world structure, with clusters of actors embedded within increasingly multiple layers of ties. In the context of interorganizational networks, this nested world differs from a small world, and calls attention to the nested clusters of firms which could wield disproportionate influence on the economy. It also calls attention to the constraints experienced by firms embedded within multiple layers of ties.

Finally, the majority of organizational research describes isolated firms without any meaningful patterns connecting firms in the economy. Indeed, organizational research predominantly focuses on the firm and its activities independent of its ties with other firms. Similarly, most interorganizational research focuses on the dyad – bilateral relations between pairs of firms (Galaskiewicz 1985; Ring and Van de Ven 1994; Williamson 1981, 1991). By focusing exclusively on the firm or dyad, the majority of economic and organizational research assumes an atomized world consisting of isolated firms or dyads, without a meaningful overall pattern of ties connecting firms in the economy. These descriptions also do not correspond to the small world structure described by research on overall network structure.

Available studies of the overall structure of interorganizational networks tests the extent to which these networks conform to a small world (Davis, Yoo, and Baker 2003; Kogut and Walker 2001). This research does not examine the extent of conformity to alternative ideal-typical network structures such as a nested world. Hence current research provides only a partial understanding of overall network structure. My paper assesses conformity to different ideal-typical network structures, and also allows for the discovery of patterns that do not conform to any of the prevalent ideal-typical structures. Also, prior research constructs the network for only the largest firms in the economy, and hence describes only a fraction of the interorganizational network. I construct a network of all publicly traded firms, and hence my research is a fairer test of an atomized world.

The discovery of an alternative ideal-typical network structure such as nested world questions the assumption that overall network structure is equivalent across networks. It points to the presence of different dynamics within different networks, with some firms residing within largely atomized structures driven purely by transactional particulars, and others residing within nested layers of ties in which hierarchy and constraint drive behavior. In addition, the interpretation of micro-level network structural characteristics differs across different overall network structures. Hence, the presence of a variety of overall interorganizational network structures suggests the moderating role of overall network structure in the relationship between micro-level network structural characteristics and outcomes.

I test these alternative ideal-typical network structures in the context of India in 2001. Prior research on overall network structure was based in Germany (Kogut and Walker 2001) and the United States (Davis, Yoo, and Baker 2003; Mintz and Schwartz 1985). The Indian economy is dominated by business groups, and current research describes these business groups as embedded within dense layers of ties (Bertrand, Mehta, and Mullainathan 2000; Khanna and Rivkin 2001). Therefore, India provides a context where I most likely to find alternative ideal-typical network structures such as the nested world structure.

My results partly confirm my hypothesis of a nested world structure. I find that the Indian interorganizational network follows a hybrid structure with significant portions conforming to atomized (42 percent), small (24 percent), and nested worlds (14 percent). Another significant portion (20 percent) consists of isolated clusters of firms which do not conform to any of the expected ideal-typical patterns. Further analysis indicates that variation in firms' network structure (firms' position in an isolated cluster, atomized, small, or nested world) reflects variation in firms' age, cohort, industry, and community ties.

This result reveals firms' social structure as more complex and varied than currently understood. Different parts of an interorganizational network can vary in their social structure, and this meso-level variation should be taken into account to accurately understand firms' social structure. Processes of trust, isomorphism, or transaction-based behavior are likely to be moderated by the particular meso-level social structure in which the firm resides. Current network theory also predicts variation in social structure. However, current theory defines variation in social structure as variation in the structure of actors' immediate network of ties (Burt 1992, 1997, 2004). My research suggests the need to expand this definition of social structure to include the structure of second-level contacts, third-level contacts (and so on). The next section describes the dynamics of power, constraint, and connectivity associated with different ideal-typical network structures.

ATOMIZED, SMALL, AND NESTED WORLDS: A REVIEW

Atomized Worlds

Economists conceptualize organizational activity as a competition between isolated actors making rational decisions based on maximizing self-interest. Classical economists treated coordination between firms as attempts to fix prices, thwart perfect competition, and create anomalies in otherwise perfect markets (Smith 1776 [1976]). More recently, mainstream neoclassical economists have developed sophisticated analyses to explain coordination between firms as a choice based on the relative costs and benefits of organizing a transaction using markets, hierarchy, or networks (Williamson 1981). Aspects of the transaction such as asset specificity, uncertainty, and frequency determine whether a transaction should be organized using market, hierarchy, or networks. For instance, as transactional uncertainty increases, it becomes harder to create contracts that specify obligations in the case of every possible contingency. Hence a pure market contract between transacting parties is insufficient to ensure that the transaction proceeds smoothly. An alternative, a hierarchical relationship in which the buyer and supplier merge or one acquires the other, is less prone to these difficulties. Once the firm merges with or acquires the partner firm, a hierarchical relationship exists between the partners, and parties have no incentive to behave opportunistically. This theory was further extended to include interorganizational ties, which are treated as an intermediate form of organization between markets and hierarchies, incorporating features of both markets and hierarchies. Firms choose interorganizational ties such as alliances and joint ventures when the transaction requires a moderate level of asset specificity, uncertainty, and frequency. Hence this theory explains interorganizational ties as a governance mechanism chosen by transacting partners based on features of the transaction.

Organizational theorists also focus on interorganizational ties, and propose that interorganizational relations help firms acquire knowledge (Hamel, Doz, and Prahalad 1989; Kogut 1988), resources, and help manage uncertainty (Galaskiewicz 1985 has a review of this research). Organizational theorists also discuss the dynamics of coordination between firms, and propose that this relationship is affected by previous interorganizational ties with the same partner, interpersonal dynamics between the managers involved in the interorganizational ties, and considerations of equity and efficiency (Ring and Van de Ven 1994). These organizational perspectives, like the transaction cost perspective, focus on the bilateral relations between firms, and assume that factors influencing this dyadic relationship lie within the dyad. By focusing on the dyad, these theories implicitly assume the absence of effects from the overall network structure. Hence, theories of bilateral relations between firms assume an atomized world of isolate firms or dyads (pairs of connected firms) without significant and interpretable overall patterns connecting firms across the economy.

Small Worlds

Small world theory predicts the presence of an overall network connecting firms, and proposes that these large networks display high connectivity, low constraint, and low centralization (Watts and Strogatz 1998). A network with high connectivity is one in which the average number of steps required to connect any two actors in the network is low. Constraint is the extent to which focal actors' contacts are connected to each other (form a closed triad), and dense networks tend to be highly constrained. Centralization is the extent to which a few actors in the network are highly central and play a disproportionate role in the network. Small worlds are unique because they combine the paradoxical qualities of high connectivity, and low constraint and centralization. Networks typically achieve high connectivity when the network is highly centralized with a few hub firms connecting all other firms in the network, or when the network is extremely dense (and hence highly constrained) with firms having ties to most other firms. However, centralized and dense networks are problematic because they raise issues of power and constraint. Centralized and dense networks are also inherently inefficient / unstable given the power struggles in central networks, and the time and resource commitments required for maintaining multiple interorganizational ties in dense networks (Provan and Sebastian 1998). Watts and Stogartz (1998) noticed that many different types of networks – such as biological neural networks and friendship networks – displayed the paradoxical effect of high connectivity and low constraint, and they proposed that this paradoxical effect was produced when the network is composed of clusters with sparse ties across clusters, and dense ties within clusters. The sparse ties transfer information between dense clusters, and once information reaches one member of a dense cluster, all members get access to the information. Hence information speedily diffuses across large networks, without the need for a dense network with all actors connected to all other actors, and without requiring a highly centralized network in which a few central actors connect all other actors in a network.

Current research on the overall structure of interorganizational networks provides strong support for small world theory. These studies assess conformity of an observed network to a small world pattern by comparing summary measures of connectivity and constraint in the observed network to a similar-sized random network. Using these techniques, Kogut and Walker (2001) in a study of the ownership network of the largest 550 German firms, and Davis, Yoo, and Baker (2003) in a study of interlocking directorates between the largest 500 U.S. firms find that these networks follow a small world pattern. Studies focusing on particular industries like the film actor's network (Uzzi and Spiro 2005) or bank syndicate networks (Baum, Rowley, and Shipilov 2004) also find a small world pattern. Further, Kogut and Walker (2001) use mathematical modeling to confirm the stability of the small world structure. They find that even when a massive institutional shock such as economy-wide restructuring, disrupts and reconstitutes a significant proportion of ties in the German interorganizational network, the network retains its small world structure.

Small world theory is also consistent with the predictions of several different strands of research. First, current network theory differentiates between actors who are constrained within a closed group or hold a bridge position connecting unrelated others (Burt 1992). This theory is egocentric, and focuses on the structure of actors' immediate network of contacts. Although small world theory is a theory of overall network structure, it is consistent with this egocentric theory since it draws attention to dense clusters and to the firms that form bridges between the dense clusters. Second, small world theory is consistent with calls to reject over or underembedded conceptualizations of organizational activity (Granovetter 1985). In a small world, firms across the network are connected to each other, and information and practices diffuse across the network. But the lack of significant constraint or centrality implies that these firms are not prone to overly proscribed behavior (overembeddedness) or overly rational behavior untouched by social feedback (underembeddedness).

Other strands of research also support small world theory. Research on interorganizational clusters and research on business groups describe dense clusters of legally independent firms in most countries in the world (Almeida and Wolfenzon 2006; Amsden 2001; Bertrand, Mehta, and Mullainathan 2000; Chung 2000; La Porta, Lopez-de-Silanes, and Shleifer 1999). Scholars have sometimes referred to interorganizational clusters as strategic blocks (Nohria and Garcia-Pont 1991), innovation networks (Dhanaraj and Parkhe 2006), strategic alliance networks (Knoke 2009), and whole networks (Provan and Milward 1995), and have described this phenomenon as intra-industry clusters of firms banding together in search of complementary skills.

Nested Worlds

Nested world theory also emphasizes the importance of clusters in the overall network structure (Moody 2001; Moody and White 2003). However, unlike small world theory, which predicts sparse ties between these clusters, nested world theory predicts that clusters split into sub-clusters, which themselves split into even smaller clusters (and so on). This theory is relatively new, and empirical applications are limited to a study of high school friendship networks (Paxton and Moody 2003) and a social science research collaboration network (Moody 2004). The study on high school friendship networks found that cohesive clusters of students residing within increasingly cohesive sets of ties reported greater attachment to the school compared to less nested students (Paxton and Moody 2003). A cohesive set of actors consists of a set of actors with multiple independent ties connecting the actors. For instance, a set of four high school students who are all connected to each other, have three independent paths connecting each student to the other three students; further the four students are nested within a less cohesive cluster of eight students with two independent paths connecting the eight students.

In the context of an interorganizational network, a nested world of cohesive firms embedded within less cohesive sets of ties is plausible, and corresponds to descriptions of organizational activity in countries characterized by business groups. Prominent examples of business groups include the *Keiretsu* in Japan (Gerlach 1992) and the *Chaebol* in Korea (Baek, Kang, and Lee 2006). This research describes economies dominated by dense clusters of firms embedded within multiple layers of ties. The nested structure has two important features with consequences for organizational activity. One, a nested world points to hierarchical differences between highly nested and less nested firms, and two, a nested world, by definition, is highly integrated with multiple ties connecting firms. Hence a nested world suggests dynamics of power and constraint, and prior research suggests that both are plausible in the organizational context. For instance, research on the power structure of economies describes influential firms residing within an integrated network of organizations, and controlling the flow of information to the rest of the economy (Mintz and Schwartz 1985). Similarly, Useem (1984), Mizruchi (1982), and Knoke and Rogers (1979) describe a hierarchical network with core firms (or the top managers of core firms) connecting peripheral firms in the network, and controlling the flow of information to peripheral firms. This focus on hierarchical differences and power is also reflected in research on business groups, which speaks more directly to the Indian context. Research on business groups describes these groups as highly entrenched, dominant, and murky (Morck, Wolfenzon, and Yeung 2005). Scholars focus on the extent to which these business groups dominate the economies in which they operate (La Porta, Lopez-de-Silanes, and Shleifer 1999; Morck, Wolfenzon, and Yeung 2005).

In addition to power, the nested structure raises issues of constraint. The prediction of constraint is plausible in the organizational context. Business group research emphasizes constraint, and describes a social insurance effect with group firms bailing out weaker firms, even to the detriment of individual profit maximization (Lincoln, Gerlach, and Ahmadjian 1996). Dense ties and a multiplicity of ties (for instance interorganizational ties overlaid with family and community ties) ensure conformity among legally independent profit-seeking firms (Portes and Sensenbrenner 1993). The Indian economy has some of the features described above.

THE INDIAN ECONOMY IN 2001

The major liberalization in 1991 reduced the restrictions on Indian businesses, and opened up the economy to the global market. Pre-liberalization, the Indian government assumed the role of ensuring that societal resources were put to their best uses. Expansion or entry into particular sectors of the economy required government permission. For instance, an entrepreneur starting, say, a soap manufacturing business would have to get a license from the government to make a particular quantity of soaps.

The process of obtaining licenses was difficult, and frequently perceived as arbitrary. Entrepreneurs who had successfully navigated the process to obtain licenses had an edge in obtaining new licenses to expand existing businesses or to enter new industries. The choice of entry into a new industry or expansion within the current industry was at least partly influenced by the availability of licenses in that particular industry (Manikutty 2000). Scholars suggest that such conditions lead to the formation of diversified business groups (Guillén 2000, 2001), defined as sets of legally independent firms which have high levels of group coordination, and are frequently tied together by family and community ties, and common ownership (Khanna and Rivkin 2006; Lincoln, Gerlach, and Takahashi 1992). Congruent with these theoretical expectations, the Indian private sector is characterized by family controlled, diversified, business groups (Khanna and Palepu 2000).

These families frequently belong to the Marathi, Gujarathi, and Parsi communities. These traditional entrepreneurial communities are based religious and regional ties, and play an important role in the Indian economy. Members of these communities control the largest business groups in India (Lamb 1955; Nafziger 1978; Timberg 1978). The most prominent families of industrialists in India, the Tatas, Birlas, Mittals, and Ambanis, for example, belong to these entrepreneurial communities. Community members are also prominent among startups, and small and mid-sized Indian businesses (Iyer 1999; Lamb 1955; Nafziger 1978; Saha 2003). The important role of traditional entrepreneurial communities in Indian businesses is not surprising since these communities are religious and social institutions that emphasize entrepreneurship (Iyer 1999; Lamb 1955; Timberg 1978). Scholars have noted the willingness of entrepreneurs belonging to these communities to extend capital, knowhow, and resources to each other, "even in the absence of direct incentives" and without "expecting repayment in kind" (Kalnins and Chung 2006: 234). For instance, Piramal (1998: 142-143) describes how the Birlas, established business groups, provided the capital for fellow community members and employees to set up competing businesses. Kalnins and Chung (2006: 235) quotes a Gujarathi entrepreneur: "[A Gujarati owner of a branded chain hotel] helped me a lot. In franchise, you have to replace furniture, et cetera, regularly. So, instead of selling it, he gave me all the stuff he was supposed to sell….People don't just give away such things for free. He gave me all this just because I was from the place near to his native [land]. We don't have a relation. We met for the first time….[He] helped me without any expectations. I am an ordinary person. What would he get from me?" This research emphasizes the norm of generalized reciprocity between members of traditional entrepreneurial communities.

A growing stream of research documents the positive effects of these traditional entrepreneurial communities (sometimes called traditional entrepreneurial communities) on entrepreneurship. For instance, Chung and Kalnins (2001), Aldrich, Jones, and McEvoy (1984) describe Gujarathis operating hotels in the United States and describes the Gujarathis operating corner shops in Britain. In India, community ties helped navigate the license system, and establish businesses in sectors that the entrepreneur did not have strong prior experience. They also helped ease the formation of interorganizational ties. For instance, intercorporate shareholding ties are a significant feature of the Indian economy (Douma, Pallathitta, and Kabir 2006), and the presence of community ties supports the formation of these ties. Corporate shareholders can better monitor the activities of the firm, and can serve as a strategic resource (Douma, Pallathitta, and Kabir 2006). Also, dense intercorporate shareholding ties create a certain "murkiness" since lay investors have difficulty assessing the performance prospects of firms in isolation (Morck, Wolfenzon, and Yeung 2005). This opacity decreases trading in the stock market, and increases the cost of capital on the stock market (Bhattacharya, Daouk, and Welker 2003). Hence, corporate shareholders are an attractive source of capital. However, family businesses are typically careful about maintaining control, and a significant shareholding by another firm carries the risk of loss of control. Traditional entrepreneurial communities, with their focus on reputation, help overcome these concerns, and ease the formation of intercorporate shareholding ties.

The major liberalization effort in 1991 removed many of the constraints on businesses. Gross Domestic Product (GDP) began growing at approximately 6 percent per annum, and the Indian software industry showed phenomenal growth. Even before the major liberalization in 1991, the software and technology services industry was one of the few sectors of the Indian economy that was not controlled by the government. In addition, the software and technology services industry is not capital intensive, and hence is especially attractive to entrepreneurs who do not belong to an established business group. The opening of the economy further facilitated the growth of existing software and technology firms, and encouraged the aspirations of a new generation of "technocrat" entrepreneurs who primarily identified with professional networks formed in India's many engineering colleges and business schools (Arora, Arunachalam, Asundi, and Fernandes 2001; Arora and Athreye 2002: 267). Hence, Indian scholars sometimes differentiate the post-liberalization cohort of firms from the older pre-liberalization cohort of business groups, and claim that they are more transparent, more reliant on global markets, have stronger records on corporate governance, and are not constrained by strong social structures (Arora, Arunachalam, Asundi, and Fernandes 2001; Arora and Athreye 2002; Khanna and Palepu 2004, 2005).

The post-liberalization cohort of software and technology firms are a growing sector of the Indian economy (Arora and Athreye 2002; Khanna and Palepu 2004), and descriptions of these firms conform to an atomized world. However, the pre-liberalization cohort of business groups continue to play an important role in the Indian economy, and in many cases are successfully transitioning into global multinationals (Pradhan 2007). Research on these business groups describes diversified business groups linked together by family ties and ownership ties (Bertrand, Mehta, and Mullainathan 2000; Khanna and Palepu 2000). This research treats Indian business groups as clearly distinguishable from other groups, which implies dense ties within the group, and few ties to the rest of the network; a structure consistent with a small world. However, the clear distinctions seen between Indian business groups could be due to internal family ties, and need not necessarily imply few ties to the rest of the network. Indeed, research on Indian business groups tends to emphasize their embeddedness in dense networks of ties (Khanna and Palepu 2000); a description most consistent with a nested world structure. In addition, research on business groups emphasizes the constraints on these groups (Gerlach 1992; Guillén 2000; Khanna and Palepu 2000; Lincoln, Gerlach, and Ahmadjian 1996), and also focuses on power differences and dominant business groups (Morck et al. 2005). For instance, studies focusing on the traditional community ties among the families controlling Indian business groups describe community norms regarding extending capital, loans, and other resources to other businessmen in the community (Timberg 1978). These descriptions of constraint and hierarchical differences are more consistent with a nested world structure compared to a small world structure.

Hypothesis. The Indian interorganizational network conforms to a nested world structure to a greater extent compared to a small world or atomized world structure.

DESIGN AND DATA

India is an appropriate site for this research for three reasons. First, prior studies on economy-wide interorganizational networks (studies which are not focused on a particular industry) were based in Germany (Kogut and Walker 2001) and the United States (Davis, Yoo, and Baker 2003). India is an emerging market, and provides a context in which the interorganizational network might differ from the ones found in the U.S. and Germany. Also, descriptions of the business groups in this economy match a nested world structure, and hence India presents an interesting case that might question the prevailing assumption that large networks are small worlds. Finally, from a practical perspective, India is one of the few countries in the world where information about shareholding ties, loan ties, and trade ties are available for publicly traded firms in easily accessible form. Therefore, India is an acceptable context for this research.

Another design choice is the boundary of the interorganizational network. Current economy-wide network studies limit themselves to the largest firms in the economy (Davis, Yoo, and Baker 2003; Kogut and Walker 2001; Mintz and Schwartz 1985). However, this choice ignores small and mid-sized firms, and is likely to overestimate the level of connectivity in the economy. A fair test of atomized versus small or nested worlds will require complete population data. Therefore, I construct the network using all publicly traded firms listed in Prowess CMIE (Centre for Monitoring Indian Economy). Prowess CMIE is a standard source of data for research on Indian firms (Khanna and Palepu 2000; Mahmood and Lee 2004). This dataset tracks annual reports of publicly traded Indian firms, and also sources data from the two major Indian stock exchanges, the National and Bombay Stock exchange.

Prior research on interorganizational network structures relies on interlocking directorates (Davis, Yoo, and Baker 2003; Mintz and Schwartz 1985) or shareholding ties (Kogut and Walker 2001) to construct the network. Scholars have criticized the use of interlocking directorates because it is difficult to interpret what, if anything, interlocking directorates indicate (Mizruchi 1996). Interlocking directorates might indicate coordination and control between firms. Instead, it might simply indicate the propensity of board members to recruit other board members, whom they have worked with before on other boards. Ownership ties are easier to interpret; a significant ownership tie can be reasonably interpreted to indicate some form of control. However, the type of tie used to establish coordination among firms varies according to the legal and normative pressures operating in particular countries. For instance, the institution of double dividend taxation largely eradicated cross-ownership ties in the United States (Morck 2004), and studies of coordination between firms in the United States relies on alliance and joint venture ties (Nohria and Garcia-Pont 1991). Research in contexts such as India suggests that ownership ties reflect coordination among firms, and is predictive of other types of ties such as interlocking directorates, trade ties, and loan ties (Khanna and Rivkin 2006; Lincoln, Gerlach, and Takahashi 1992). Prior research finds that domestic corporate shareholders are the single largest category of shareholders in India (Douma, Pallathitta, and Kabir 2006), and my conversations with Indian managers and auditors also confirmed the importance of ownership ties in establishing coordination between firms the Indian economy (transcripts of these conversations available upon request). Therefore, I choose shareholding ties to construct the Indian interorganizational network.

I construct the Indian shareholding network for the year 2001 since 2001 is the first year for which data about all shareholders of all publicly traded firms became available in easily accessible form. The year 2001 is exactly a decade away from the 1991 liberalization of the Indian economy. For the year 2001, Prowess has annual report data for 3,543 publicly traded firms (firms listed on the Bombay or National Stock Exchange). Scholars have used 1 percent, 5 percent, 10 percent, 20 percent, 30 percent, or 50 percent shareholding as cutoffs to indicate a significant ownership tie (Chang and Hong 2000; La Porta, Lopez-de-Silanes, and Shleifer 1999) (Morck, Wolfenzon, and Yeung 2005). The exact percentage of shareholdings, which translate into coordination between firms, is unclear. My conversations with Indian managers and auditors indicated that coordination among business groups firms is indirectly established through different members of a controlling family; each individual family member might own a very small percentage of shares, but in concert, the family retains control of the firm. Hence, I use the least stringent one percent shareholding as the cutoff to include or exclude shareholders. I find 2,963 Indian firms, which have at least one shareholder with a one percent or greater stake in the firm. These 2,963 firms have between 1 and 47 shareholders each.

Prowess CMIE sources shareholding data from the stock markets, and includes classifications of shareholders into different categories. I exclude shareholders who are pure investors (classified as "Indian Public") since by definition these shareholders are not involved in organizational decisions. I also bound the network within India, and hence excluded shareholders classified as "Foreign", or "nonresident Indian." Bounding the network by country is arbitrary and doesn't reflect the global ties between firms. However, the network has to be bounded, and nation states continue to be a meaningful construct reflecting particular laws and norms. This approach is consistent with prior research on overall interorganizational network structure. Finally, I exclude shareholders classified as "institutional investors." These investors, usually government bodies, behave like passive shareholders. They "basically are instructed by the government to side with the [promoter family] shareholders, and they virtually never divest their shareholdings" (Khanna and Palepu 2004: 488). In the Indian context, including institutional investors threatens to far overstate the level of coordination in the economy. The final network is constructed using shareholders classified as "private corporate bodies" (defined as public or private firms that are not government controlled), "persons acting in concert" (defined as sets of shareholders, frequently family owners, who operate as a block), and "Indian promoters" (the firms' founders and their heirs). The last two categories of shareholders were included because, as mentioned above, group firms sometimes do not have direct ties to each other, and instead ties between group firms are established through a holding firm (private or public corporate bodies) or through family members owning shares in all group firms. Including "Indian promoters" and "persons acting in concert" helps ensure that these indirectly established relationships between organizations are considered.

These exclusions leave 24,647 firm–shareholder pairs. I cleaned these data by manually going through this list. This process was essential since sometimes shareholder names were slightly different across observations – e.g., "Af-tek rolling mills enterprises ltd" also appears as "Aftek rolling mills entr. Ltd." The presence of different shareholders with the same name is even more problematic. For instance, in one extreme case, Ramesh Goyal, a common Indian name, appears six times in my dataset. I used several techniques to check whether these names referred to the same person. First, I checked the six firms in which Ramesh Goyal appears as a shareholder. I checked if these six firms had other shareholders/directors in common or if *related party* data indicated that the six firms mentioned one another as "related parties" in their annual reports. "Parties are considered to be related if at any time during the reporting period one party has the ability to control the other party or exercise significant influence over the other party in making financial and/or operating decisions" (Indian Accounting Standards 2005). If I found no indication of a link between the six firms, then I would conclude that the six different Ramesh Goyals referred to six different individuals, and marked the six Ramesh Goyals appearing in my list as Ramesh Goyal1, Ramesh Goyal2, Ramesh Goyal3, and so on. This process was important because otherwise the interorganizational network would treat these individuals as the same individual. However, ultimately this problem proved fairly minor since there were only

100 instances (out of the 24,647 firm–shareholder pairs) where the above changes were required. I also construct an interorganizational network where I do not make the above changes. This network had many obvious instances of nonsense data (“MRF ltd” and “M R F ltd”, appearing as distinct but proximate entities in the network). Therefore, I report the results of the cleaned network.

The 24,647 firm–shareholder pairs represent 12,794 unique actors (firms or shareholders) since firms and shareholders have multiple ties, and appear multiple times in the list of firm–shareholder pairs. The 12794 unique actors represent 2781 publicly traded firms, 5727 individuals, and 4286 privately held firms (firms not listed on the Bombay or National Stock Exchange). I construct a 12,794*12,794 matrix with each cell in the matrix representing the tie between each unique actor to each other actor in the network. A tie in this matrix refers to an ownership relationship, either between two firms or between a firm and an individual (individuals cannot have shareholding ties with each other). The next section analyzes the network, and describes the patterns observed.

ANALYSIS AND RESULTS

Current research on overall network structure of interorganizational relations uses small world analysis. Small world analysis relies on summary measures of connectivity and constraint, and cannot reveal the extent to which the overall network structure matches other ideal-typical overall network structures such as nested worlds and atomized worlds. Hence, I rely on a fairly new and sophisticated analytical technique, which can identify small, nested, and atomized world patterns. The analysis starts with the overall network, and then analyzes distinct fragments in this network using a combination of component and cohesive blocking methods (Moody 2001; Moody and White 2003). A component is a set of actors with at least one path connecting every pair of actors in the set. In other words, a component is like an island with a set of connected actors, but which does not have ties to any other actor in the network. A component composed of only one publicly traded firm (all other actors in the component are shareholders – privately held firms or individuals) is an isolated firm. Similarly, a component with only two publicly traded firms is a dyad with no ties to the rest of the network. Larger components can split into bicomponents. Here each bicomponent has at least two traceable paths connecting every pair of actors in the set, and by definition, the bicomponents are connected to each other with few ties. Or alternatively the component might contain a bicomponent, which in turn contains a tricomponent (three traceable paths connect each pair of actors in the tricomponent) and so on to reveal increasingly cohesive clusters. Hence this technique can reveal different ideal-typical network structures: isolates and dyads (atomized world), clusters that lie side by side and which are sparsely connected (small worlds) or increasingly cohesive clusters nested within one another (nested world).

Stage I analysis: An atomized world. Component analysis reveals that the Indian shareholding network is composed of 1294 small components (each containing 1 to 11 publicly traded firms), and one large component (composed of 1050 publicly traded firms)[1]. Out of the 1294 small components, 1,001 small components contain

[1] Here and going forward, I only report the number of publicly traded firms in each component. The number of privately held firms and individual shareholders in these components are proportional to the

only one publicly traded firm. Hence, these 1,001 components represent isolated firms, in which neither the firm nor its shareholders have any ties to the rest of the network. Next, I find that 78 small components contain 77 dyads (pairs of connected firms with no other ties to the rest of the network) and one dyad chain (Firm A owns a percentage of shares in Firm B and Firm B owns a percentage of shares in Firm C). These 78 small components (containing 170 firms) are not cohesive (they disintegrate into disconnected actors with the removal of a single actor or tie). Figure 2.1 presents examples of isolate firms and dyads. Since these firms are not bound in a larger pattern of ties, I classify these firms as belonging to an *atomized world*.

This atomized world includes isolate firms such as Infosys Technologies Ltd. and Dr. Reddy's Laboratories. Scholars claim that these companies represent a newer cohort of post-liberalization Indian firms, which rely heavily on the global market (Arora and Athreye 2002; Khanna and Palepu 2004). The perception that these firms are more transparent compared to the business group firms is perhaps related to their lack of "murky" cross-shareholding ties (Morck, Wolfenzon, and Yeung 2005). These entrepreneurs do not belong to established business groups or to the traditional entrepreneurial communities (Arora and Athreye 2002), and hence cannot rely on these social ties to ease the formation of intercorporate shareholding ties. Also, these firms are in industries that are not capital intensive. And even if they required capital, these firms are listed on the London and New York Stock Exchanges, and hence have greater access to global capital markets (Khanna and Palepu 2004: 489). However, Infosys' isolated position in the network helps explain its failure in penetrating the Indian

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number of publicly traded firms in the component, and I can provide these figures on request. I do not provide these figures here for the sake of brevity.

corporate market for software and technology services (Economic Times 2009). In contrast, Tata Consultancy Services (TCS), another prominent software consultancy firm which is affiliated to the densely connected Tata business group, has a much greater penetration into the domestic corporate services market (Singh 2009).

To conclude this section, a total of 1171 firms (1,001 isolated firms and 170 firms in dyads or dyad chains) or 42 percent of the 2781 publicly traded firms in the Indian interorganizational network, conform to the atomized world ideal-typical network structure.

Stage II analysis: Isolated clusters. The remaining 215 small components (out of the 1294 total small components) have cohesive structures – the removal of a single actor or tie does not disconnect any other actors in the component. These 215 small components (containing 560 firms), do not conform to any of the ideal-typical network structures. They are isolated clusters of firms (ranging in size between 2 to 10 firms), which do not have ties to any actor outside the small component. Figure 2.2 presents the network structure of three isolated clusters. Figure 2.2 shows that these cohesive clusters are characterized by a set of shareholders owning direct shares in ***all*** group firms. In Figure 2.2, group C, the shareholders not only own shares in all group firms but also own the same proportion of shares in all group firms – for example one shareholder owns 3.94 percent in all group firms, while another owns 2.32 percent shares in all group firms, and so on. In addition, Figure 2.2, group A and group C, have shareholders with the same last name, and hence most likely belong to the same family. The common last names and equal shareholdings suggest that these isolated clusters represent business groups, sets of legally independent firms that coordinate activities.

FIGURE 2.1: Isolated Firm and Dyad

Dots represent firms and shareholders (individuals or firms). Numbers represent percentage shareholding. A represents an isolated firm, AC Infocom Ltd. and shareholders, and B represents a dyad of the two publicly traded firms Essay Synthetics Ltd. and Alpha Hi-Tech Fuel Ltd. The latter also has three other shareholders (Individuals or Private companies).

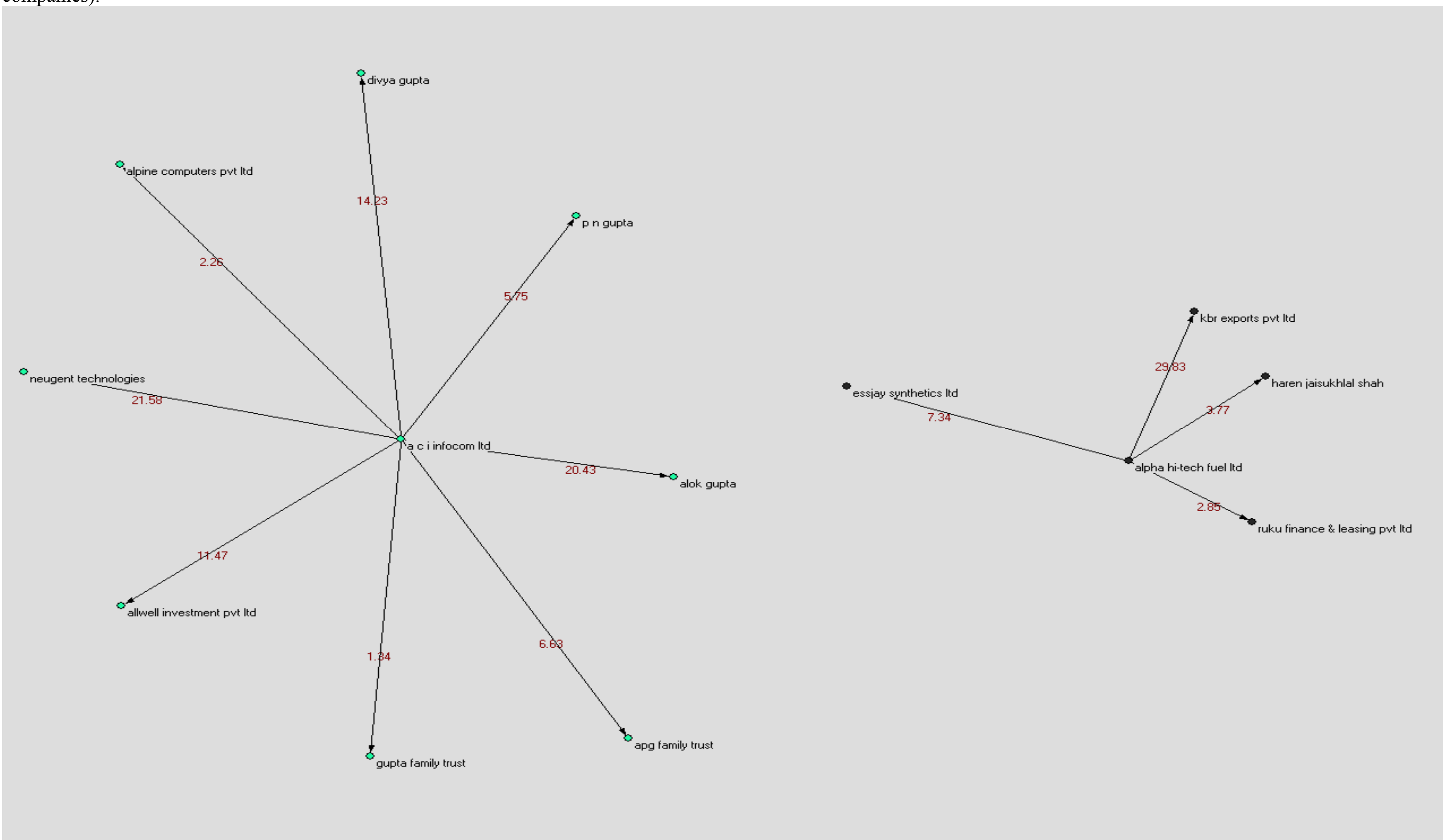
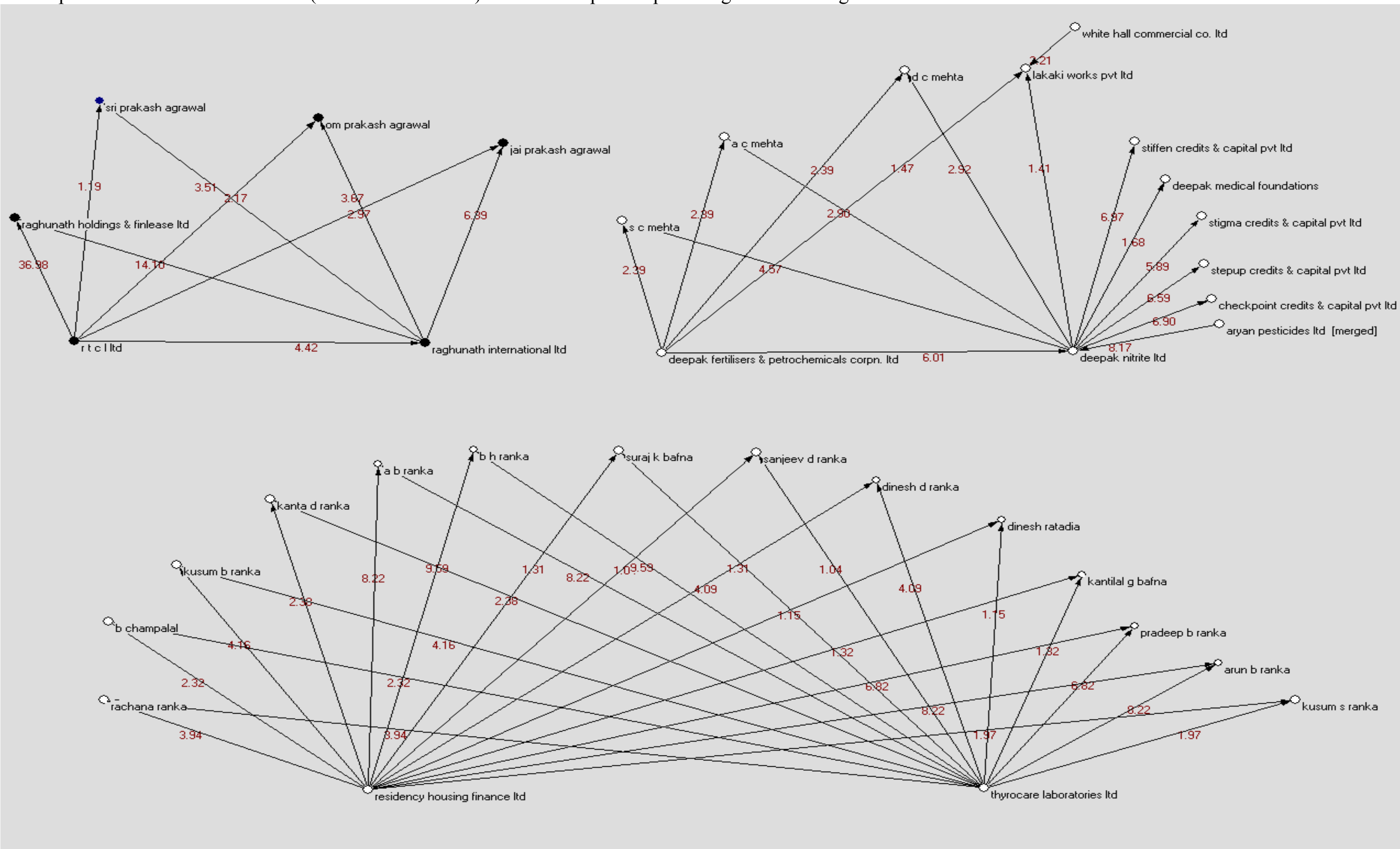


FIGURE 2.2: Internal Structure of Three Isolated Clusters

Dots represent firms and shareholders (individuals or firms). Numbers represent percentage shareholding.

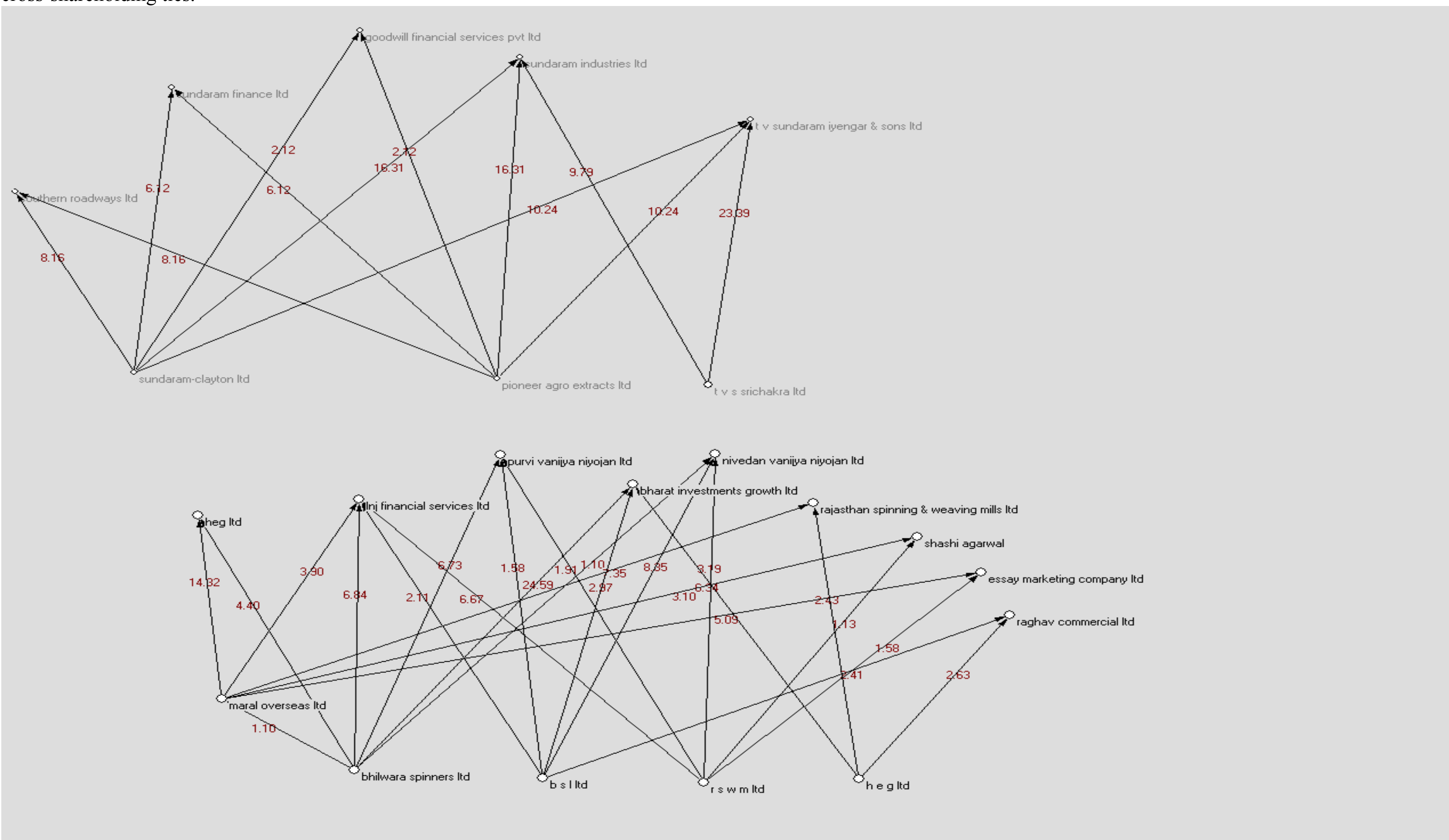


Examples of isolated clusters include sets of firms which correspond to sets of firms identified by Prowess CMIE as belonging to the Eicher business group, L&T business group, and Godrej business group. The Prowess classification of firms into business groups is a standard source for research on Indian business groups (Khanna and Palepu 1999, 2000). The Godrej group is a diversified family business group, formed in 1897, and primarily focusing on consumer goods (Godrej 2007). The family last name, Godrej, indicates that this family belongs to the Parsi community. However, family business groups tend to be diligent about maintaining their control over group firms, and a shareholding tie with another corporation which is not part of the business group carries a certain risk. In contrast, Eicher and L&T represent a pre-liberalization cohort of firms, which originated as foreign firms. For instance, Eicher Inc. originated in 1948 to import and sell GoodEarth tractors to the Indian market (Eicher 2004). Similarly L&T, another diversified business group was founded in 1946 by two Danish engineers (Larson & Toubro 2007). A senior manager at L&T explained the effect of this founding imprint on the group companies, "L&T has been a purely professionally managed company with no person or group having controlling interest in the shareholding. Since there are no owners [involved], the employees are far more empowered and decision-making more decentralized." Implicit in his statement is the assumption that the "professionals" managing the business group identify with professional communities rather than with the traditional entrepreneurial communities. The lack of ties with traditional communities might make it harder for these business groups to establish intercorporate shareholdings ties. Hence, the Eicher, Godrej, and L&T cluster of firms represent an older cohort of business groups which do not have shareholding ties with other Indian corporations. To conclude this section, 20 percent of the 2781 publicly traded firms in the Indian interorganizational network conform to an isolated cluster pattern.

Stage III analysis: A small world. Next I analyze the large component (composed of 1050 firms) using cohesive blocking analysis. Cohesive blocking starts by splitting the component into bicomponents. Bicomponents are sets of connected nodes that have at least two traceable paths connecting every pair of actors in the set. Cohesive blocking reveals that the large component is composed of 127 small bicomponents (having between 2 and 14 firms, for a total of 318 firms); 347 firms connected to the rest of the component with sparse ties (and which do not form a bicomponent with other firms); and one large bicomponent with 385 firms. The large bicomponent requires further analysis, and I describe the results of further analysis of this large bicomponent in the following paragraph. The 127 small bicomponents are connected to the rest of the network with sparse ties. The removal of one or two ties would split each one from the rest of the network. Hence, these 127 bicomponents conform to a small world structure of dense clusters linked by sparse ties. These small bicomponents have internal structures fairly similar to the isolated clusters described above. Like the isolated clusters, firms in the bicomponent have group shareholders owning shares in all or most of the group firms, and sometimes hold equal shares in all group firms and have a common last name. These features make it likely that these bicomponents represent business groups connected to the rest of the network with sparse ties (Figure 2.3 presents examples).

FIGURE 2.3: Internal Structure of Two Bicomponents

Dots represent firms and shareholders (individuals or firms). Numbers represent percentage shareholding. The figure does not display the ties connecting these bicomponents to the rest of the network. In all three of the cases shown, a single tie connects the bicomponent to the rest of the network. The bicomponent at the bottom of this visual displays cross-shareholding ties.



The Pantaloon group and S.Kumar’s group are examples of business groups which appear as small bicomponents in the interorganizational network. Prior research indicates that membership in traditional communities can be reliably determined using last names (Iyer 1999). I follow this prior research, and find that the promoter shareholders and block shareholders in these two business groups have the same last names (Biyani in the Pantaloon group and Kasliwal in the S Kumar’s group), and these last names indicate that this family belongs to a traditional entrepreneurial community. Hence the Pantaloon and S Kumar cluster of firms represent family business groups which belong to a traditional entrepreneurial community, and have shareholding ties with firms outside the group.

In addition to the 127 small bicomponents, cohesive blocking also reveals 347 independent firms (firms that have ties to the rest of the network but do not form a cohesive cluster with other firms). Scholars studying Indian business groups have sometimes referred to these firms as “nongroup firms” (Khanna and Palepu 2000) to distinguish them from business group firms. These firms are connected to the rest of the network with sparse ties, and in some cases, help connect the bicomponents to each other. These sparsely connected firms, which sometimes help connect the bicomponents to each other, are consistent with small world theory, and hence I classify them as conforming to a small world pattern. In sum, 665 firms (318 firms in the small bicomponents and 347 independent firms) or 24 percent of the 2781 publicly traded firms in the Indian interorganizational network conform to a small world pattern.

Stage IV analysis: A nested world. Finally, I use cohesive blocking to further analyze the structure of the large bicomponent (composed of 385 firms). Cohesive blocking operates by progressively cutting ties that, if removed, would split the component into subcomponents. It progressively continues this procedure until the network disintegrates into disconnected nodes if further cutting were performed. Cohesive blocking analysis shows that the large bicomponent is a highly nested structure (25 levels of nesting to get to the deepest cluster), which bifurcates repeatedly into subcomponents, which in turn bifurcate again. Figure 2.4 displays the structure of this large bicomponent. The numbers in Figure 2.4 are cutnumbers, and refer to sets of nodes that remain at particular points in the cutting procedure. For instance, cutnumber 1 refers to the all the nodes in the large bicomponent, and cutnumbers 2 to 142 refer to smaller subsets of nodes that remain after subsequent levels of cutting. The cutnumbers, at the point where the lowest undifferentiated branches in this skeletal structure begin, represent cohesive clusters that do not further split into separate sub-clusters. The largest bicomponent contains 42 such cohesive clusters, each nested within less cohesive sets of firms. These less cohesive sets of firms surrounding the cohesive clusters are highly nested independent firms (firms that have multiple ties to the rest of the network but which do not form a cohesive cluster).

Figure 2.5 contains a network visual of one of these 42 cohesive clusters, and closely matches the firms identified as belonging to the Tata business group, one of the most prominent Indian business groups. Other prominent business groups such as Reliance business group also appear as highly nested cohesive clusters. Tata and Reliance are both diversified business groups, operating in a wide variety of industries from automobiles to information technology. Both business groups represent an older cohort of firms; the Tata group began in 1968 (Tata 2009), and the Reliance group began in 1932 (Reliance 2009). The families associated with these groups belong to the Parsi (in the case of the Tatas) and the Marwari (in the case of the Reliance group) entrepreneurial communities. These groups reflect the opportunities and constraints inherent in the nested structure. Dense interorganizational ties to the rest of the network give these groups access to resources necessary for risky but potentially highly rewarding efforts such as Tata's recent bid to create the world's cheapest car for under $2000. However, their complex shareholding structures and the multiple ties to firms outside the group create significant constraints. For instance, Wu, Khanna, and Palepu (2006) recount the ultimately unsuccessful attempts of the Tata group chair, Ratan Tata, in ensuring that Tata group firms pay for the use of the Tata brand. The deeply integrated position of these groups in the network also raises issues of influence. For instance, the Reliance group is repeatedly accused of using its position to influence legislation beneficial to itself, and thus inhibit competitors (Warner 2007). Therefore, predictions of constraint and influence in the nested world find some support in these two instances of highly nested business groups.

The large bicomponent, including nested cohesive clusters and independent firms represents 14 percent of the Indian interorganizational network (385 firms out of the 2781 firms in the network).

FIGURE 2.4: Skeletal Structure of the Largest Bicomponent (385 Firms)
Numbers in the figure are cutnumbers and point to the set of nodes that remain at each points in the cutting procedure. Cutnumber 1 refers to all the nodes in the bicomponent, and lower levels of the skeletal structure contain increasingly cohesive clusters.

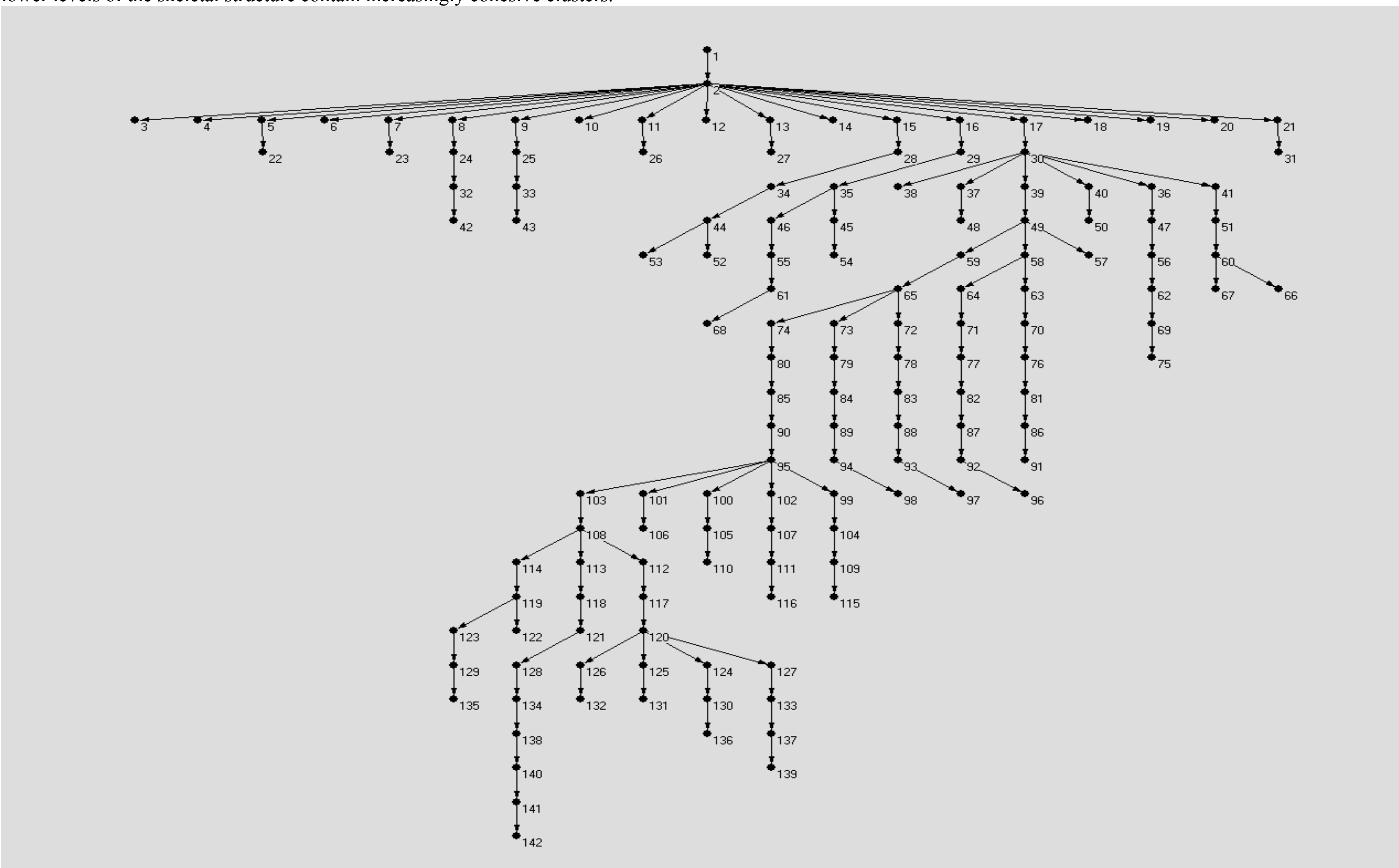
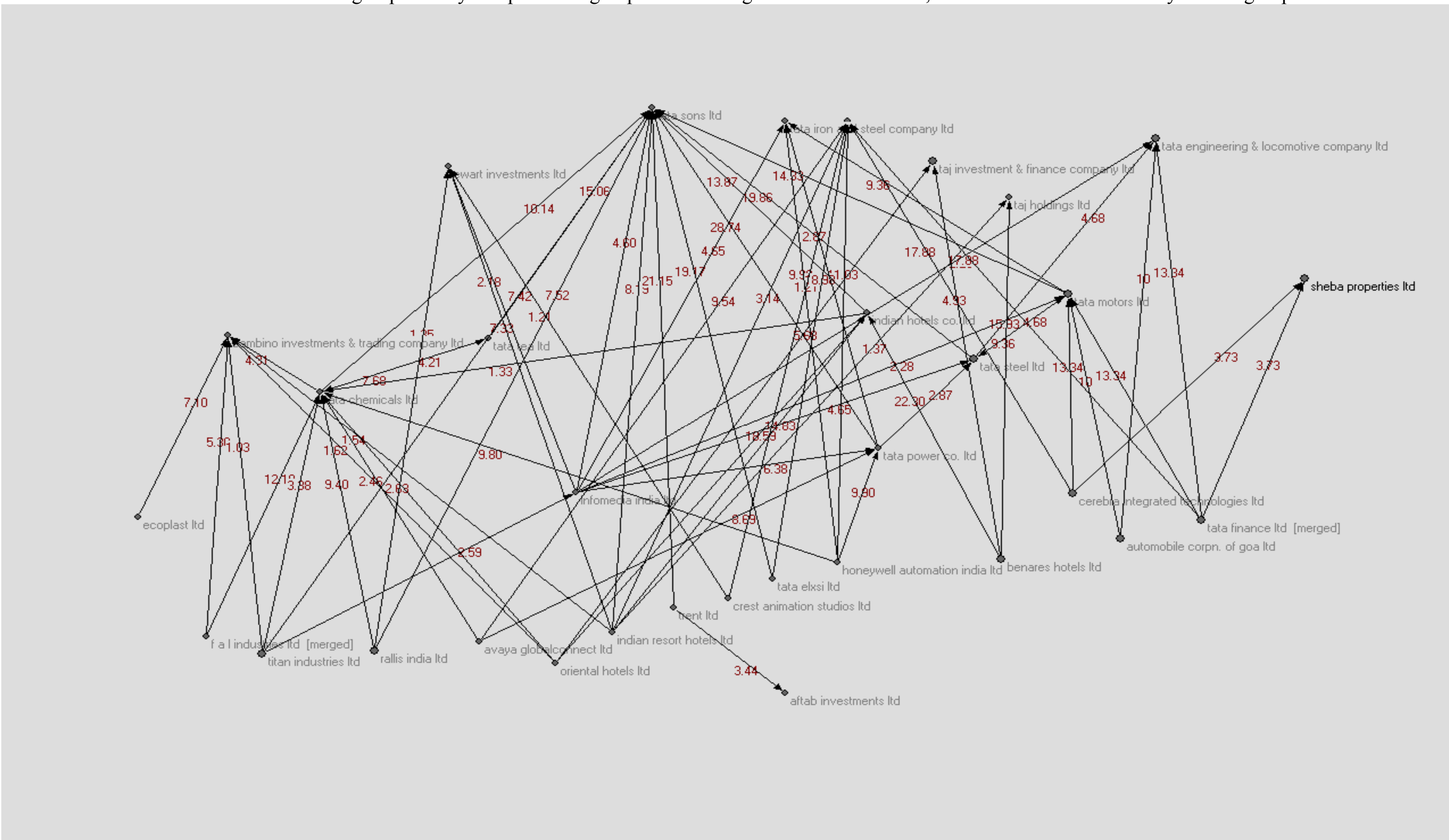


FIGURE 2.5: Internal Structure of a Highly Nested Cohesive Group: The Tata Business Group

Dots represent firms and shareholders (individuals or firms). Numbers represent percentage shareholding. The figure does not display the ties connecting this group to the rest of the network. The internal structure of this group is fairly complex with group firms owning shares in other firms, which in turn own shares in yet other group firms.



In summary, network analysis indicates that the Indian shareholding network has a hybrid structure with significant portions conforming to atomized (42 percent), small (24 percent), and nested (14 percent) worlds. In addition, 20 percent of the network does not conform to any of the above ideal-typical network structures, and appear as isolated clusters. Figure 2.6 is a compressed image of the Indian interorganizational network. A is included as a single example of an isolated firm (the other 1000 similar isolated firms are not represented in order to make the visualization understandable). Similarly, B is included as a single example of an isolated cluster, C and D represent an example of a bicomponent and an independent firm, which are connected to the rest of the network with sparse ties (these firms conform to the small world pattern), and E and F reflect nested clusters and nested independent firms, which conform to the nested world pattern. Further, Figure 2.7 provides a bird's eye view of the Indian interorganizational network.

FIGURE 2.6: The Indian Shareholding Network 2001

This visual is the actual image of the large component (composed of 1050 firms). It also includes a representative isolate firm (A), a representative isolate cluster (B). The visual also points to a sparsely connected independent firm (C) and a small bicomponent (D): Small World. Finally the visual points to a highly nested independent firm (E) and highly nested k-components (F): Nested World. The nodes in blue represent independent firms and the other colors represent particular clusters.

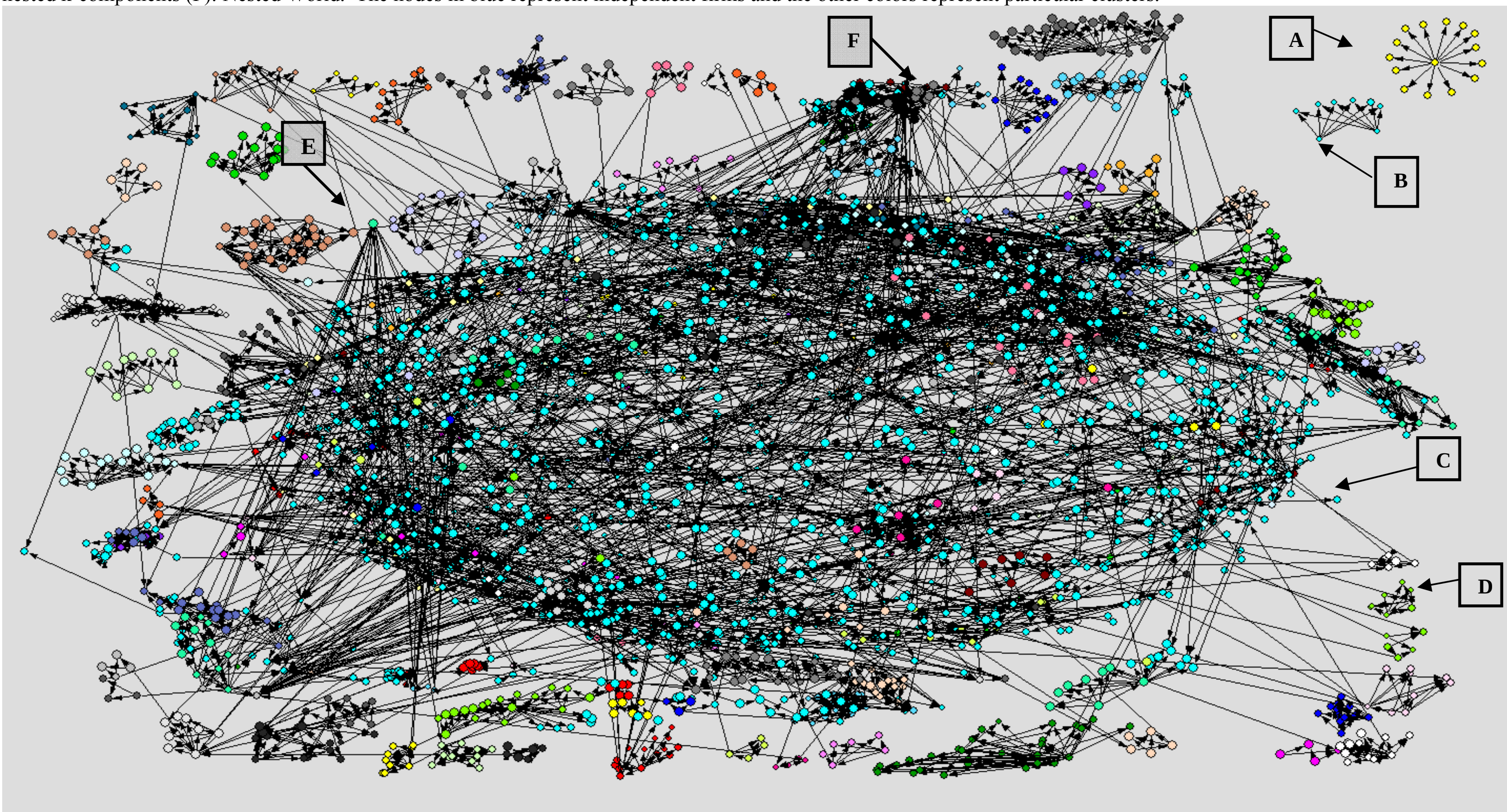
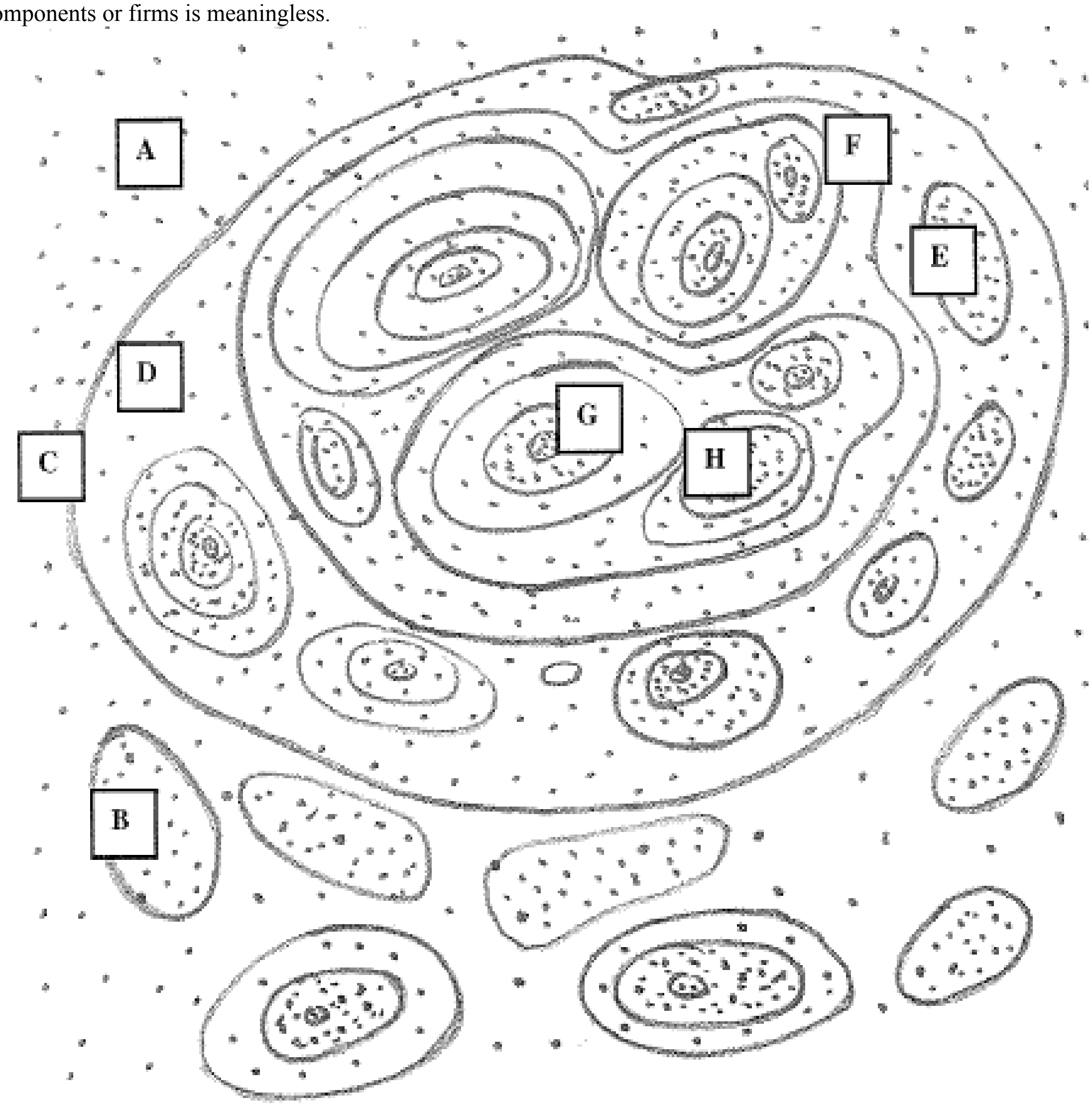


FIGURE 2.7: A Bird's Eye View of the Indian Shareholding Network in 2001
The Indian interorganizational network is composed of an atomized world (isolate firms), isolate clusters, a small world (independent firms and cohesive clusters sparsely connected to the rest of the network) and a nested world (independent firms and cohesive clusters nested within multiple layers of ties). This visual does not accurately represent the exact numbers of each of these categories of firms. However, it reflects the distribution of these categories in the overall network structure, with many isolate firms (e.g. A), many isolate clusters (e.g. B), and a single large component (C). Within the large component, the visual shows many independent firms (e.g. D) and cohesive clusters (e.g. E) sparsely connected to the rest of the network. The large bicomponent (F) contains many independent firms (e.g. G) and cohesive clusters (e.g. H) nested within multiple layers of ties. Dots represent firms. Contours represent boundaries of components, bicomponents, and k-components. The specific position on the visual of components or firms is meaningless.



Effect of Particular Design Choices on Conclusions

Particular research design choices such as type of tie, strength of tie, and excluding/including particular categories of actors affect the interorganizational network constructed. However, my conclusion that this network displays a hybrid structure is unlikely to change with alternative specifications. For instance, a higher cutoff for shareholding ties (say 10 percent or 20 percent shareholding) will make the network sparser (which will not change the conclusion that this network is a hybrid structure which cannot be explained by small world theory alone). Another design choice is excluding institutional investors. Including institutional investors will probably increase the level of integration in the large bicomponent, and hence increase the nested world portion of the network (which, again, will not change the conclusion). Including institutional investors could also reduce the number of isolated firms and isolated clusters since these institutional investor ties might help connect these firms to the large component. I examine this possibility by including domestic institutional shareholders in my network. Including institutional investors decreases the percentage of isolated firms in the network to 30 percent of the network, and decreases the percentage of isolated cluster firms in the network to 14 percent of the network. Hence the isolated portion of the network decreases from 62 percent to 44 percent (when domestic institutional investors are included in the network). This decrease is substantial but it does not change the conclusion of a hybrid structure. Also, my original network in which domestic institutional investors were excluded is a more accurate representation of the extent of connectivity in the network since domestic institutional investors tend to be passive shareholders (Khanna and Palepu 2004: 488).

Another possible concern is that my network includes both firms and individuals, but does not reflect ties between individuals (since I track only shareholding ties which cannot exist between individuals). The lack of ties between "promoter" and "block shareholders" of a firm is problematic, especially given the number of cases where these shareholders share the same last name, and are likely to belong to the same family. I can correct this problem by including ties between the "promoter" and "block shareholders" of each firm. However, including ties between these shareholders will not change the conclusions. For instance, in a component with one publicly traded firm (which I identify as an isolated firm), including ties between shareholders will not connect the firm to the rest of the network, and hence this firm will continue to be isolated. Therefore, although alternative design choices will change the network, the conclusion of a hybrid structure does not change. A final design choice is the choice of analytic technique, and in the following subsection I examine the effect of using a small world analysis on my conclusion.

The Indian interorganizational network using small world analysis. Watts and Strogatz (1998) identify a network as a small world if the network exhibits clustering greater than in a random network, and path length equal or lesser than in a random network. A random network is constructed to match the observed network in size (number of actors in the network) and average degree (the average number of ties each actor in the network has to other actors). Clustering refers to the extent to which focal actors' contacts are connected to each other (form a closed triad), and path distance is a measure of connectivity, and refers to the average number of steps between any pair of connected nodes. These measures of path length and clustering are uninterpretable if the network contains isolates or multiple components. Hence prior research using small world analysis ignores isolates and small components, and focuses only on the largest component within the network. In the Indian interorganizational network excluding isolates and small components ignores 62 percent of the firms in the network (1171 firms in the atomized world and 560 firms in isolated clusters). Hence small world analysis of the Indian economy is problematic, and requires ignoring the majority of the publicly traded firms.

However, in order to conform to the small world methodology, I ignore isolates and isolated clusters, and proceed by focusing only on the largest component. I find that, in the large component, the coefficients of path length and clustering are comparable to those found in other small world interorganizational networks (Uzzi and Spiro 2005), Davis et al.'s (2003) and Kogut and Walker's (2001). Table 2.1 presents these results. Hence, small world analysis indicates that the Indian interorganizational network is a small world with high connectivity and low constraint. However, this conclusion is problematic since it relies on ignoring isolated firms and isolated clusters of firms, and averaging out the differences between firms connected to the rest of the network with sparse ties, dense clusters of firms connected to the rest of the network with sparse ties, and dense clusters of firms nested within multiple layers of ties. Prior research on interorganizational networks justifies ignoring isolates and small components since (a) prior research focuses on the largest firms in the economy, and in the network of large firms, the number of isolate firms is small, and (b) prior research assumes that isolated firms represent missing data about ties between firms. Both the above assertions are extremely problematic in the Indian interorganizational network which (a) contains a large percentage of isolated firms and isolated clusters of firms, and (b) uses complete shareholding data, meaning that isolates cannot be reasonably argued to reflect missing data.

TABLE 2.1: Comparison of Observed Networks on Small World Measures.

	Path Length		**Clustering**		**Actual to Random ratio for:**		
Network	**Observed**	**Random**	**Observed**	**Random**	**Path Length**	**Clustering**	**Clustering/Path Length**
Film actor's network*	3.65	2.99	0.79	0.00	1.22	2925.93	**2396.90**
German firm ownership network**	5.87	4.09	0.84	0.02	1.53	78.38	**61.47**
U.S. firm interlocking directorate network***	3.43	2.86	0.23	0.02	1.20	14.00	**11.65**
Indian ownership network	1.52	2.69	2.13E-07	1.831E-09	0.56	116.33	**206.13**

*Uzzi and Spiro (2005); **Average of firm and owner network (Kogut and Walker 2001:325); ***Average of U.S. board and director network (Davis, Yoo and Baker 2003: 217)

Finally, the cross-sectional design of the study can raise concerns that the hybrid structure observed is a temporal anomaly, perhaps caused by the major institutional shock in 1991. However, my study is based in 2001, a decade away from the 1991 liberalization. Hence, even if the hybrid structure were an effect of the institutional shock in 1991, it cannot be considered a temporary phenomenon. In the next section, I further examine why particular firms are isolated or reside within isolated clusters, small, or nested worlds. I find a relationship between firms' position in the hybrid structure (isolated, small, and nested worlds, and atomized clusters) and founders' social ties and the economic context in which the firm was founded. These links between the hybrid network structure and firms' age, cohort, industry, and community ties make it unlikely that the hybrid structure is a temporary anomaly.

The Hybrid Structure and Firms' Social and Economic Context

Above I analyze a few examples of firms in the atomized, small, and nested worlds, and these examples suggest firms in the atomized world represent a newer, post-liberalization cohort of firms, which are more likely to be focused on the computer and technology services industry, and which do not belong to traditional entrepreneurial community networks. These firms' isolation from the rest of the Indian interorganizational network is related to the post-liberalization environment in which these firms were founded, which allowed easier access to global markets and capital, and reduced these firms' reliance on domestic corporate shareholders. In contrast firms in the small and nested worlds represent an older cohort of firms, which are more likely to serve older, capital intensive industries such as the manufacturing, chemical, basic materials, consumer and industrial goods, construction, agricultural, and textile industries. Also, this cohort of firms was founded in a pre-liberalization era with tight controls over exports and access to global capital, and was more reliant on domestic corporate capital. I also suggest that founders' social ties affect the formation of intercorporate ties, and hence are related to firms' network structure. For instance, firms whose founders' belong to a traditional entrepreneurial community also tend to reside in the small and nested worlds.

I further examine these relationships between firms' social structure (atomized, small, and nested worlds, and isolated clusters) and age, cohort, industry, and ties to traditional entrepreneurial communities. Table 2.2 shows support for these relationships. Column 1 shows that firms become progressively older as we move from firms in the atomized to nested worlds. Column 2 further clarifies the liberalization effect, and shows that 35 percent of the atomized world firms were born post-liberalization compared to 21 percent of small world firms, and 26 percent of nested world firms. Column 3 indicates that a larger percentage of the firms in the atomized worlds (14 percent) are in the computer and technology services sector compared to 10 percent of small world firms and 11 percent of nested world firms. I've coded the following set of industry classifications in Prowess CMIE as representative of the computer and technology services sector: business services, call centers, computer peripherals, computer software, semiconductor services, business process outsourcing, and software services.

Finally, I suggest that, when compared with the atomized worlds, founders (and their families) in the small and nested worlds are more likely to identify themselves with a traditional entrepreneurial community. I follow past research (Iyer 1999; Kalnins and Chung 2006), and use individuals' last names to identify membership in a traditional entrepreneurial community. Typical last names of people belonging to the entrepreneurial communities are identified using prior research (Kalnins and Chung 2006; Russell 1916; Timberg 1978), and using directories of last names of members belonging to these communities (Directory of Parsi Surnames, 2009). These typical last names are compared to the last names of shareholders classified as "Indian promoters" (founders and their heirs) and "block shareholders" (shareholders who vote as a block, and are typically family members). Table 2.2 Column 4 shows that a smaller percentage of these shareholders in the atomized world (40 percent) belong to traditional entrepreneurial communities compared to the small (45 percent) and nested worlds (49 percent). Finally, I test the differences between the population means of these four worlds using the Kruskal Wallis test (when the dependent variable is continuous, for example the age of the firm since founding) and the Pearson χ^2 test (when the dependent variable is categorical, for example, whether a firm was founded pre- or post-liberalization). These tests support the claim that firms in isolated clusters, atomized, small, and nested worlds differ in age, cohort, industry, and membership in traditional communities (Table 2.2).

These regularities in the founding age and social affiliations of firms residing in different network structural worlds suggest that the hybrid network structure observed is closely linked with firms' social context and the economic context when the firms were founded. This finding is broadly consistent with theories of organizational founding, which predict that organizations are imprinted with the elements in the local external environments at the time of founding (Stinchcombe 1965; Hannan, Burton, and Baron 1996), and also by the founder's pre-founding experiences (Simmons 2008). My evidence suggests that firms' social structure is also imprinted at the time of founding, and is shaped by founders' social ties.

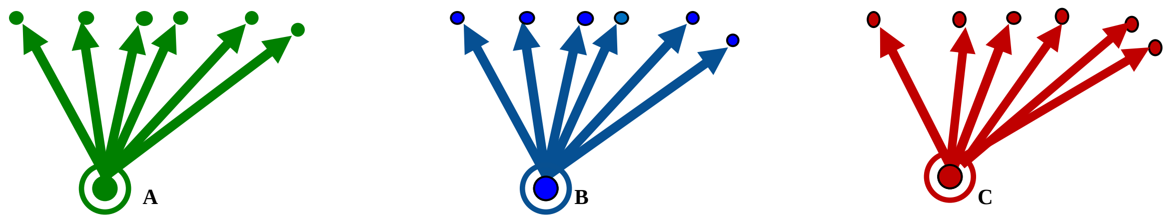
TABLE 2.2: Age, Cohort, Industry, and Membership in the Gujarathi, Parsi, Chettiar, and Marathi Traditional Entrepreneurial Communities.

	Average Years Since Founding (Column 1)	Percentage of Firms Founded Post-1991 (Column 2)	Percentage of Firms in the Computer and Technology Service Industry (Column 3)	Percentage of Firms whose Promoter Shareholders' have Traditional Entrepreneurial Community Last Names (Column 4)	Average Total Assets i1n 2001 in Crores of Rupees for Firms born Post-1991 (Column 5)	Number of Publicly Traded Firms (Column 6)	Number of Promoter Shareholders' with Traditional Entrepreneurial Community Last Names (Column 7)	Average Total Assets in 2001 in Crores of Rupees (Column 8)
Atomized World	23.96	35%	14%	40%	183	1171	4766	183
Isolated Cluster	25.93	31%	13%	50%	531	560	473	531
Small World	28.46	21%	10%	45%	336	665	406	336
Nested World	32.03	26%	11%	49%	1913	385	82	1913
Total	2775 Firms	2781 Firms	2781 Firms	5727 Individuals	649 Firms	2781 Firms	5727 Individuals	2330 Firms
Test	Kruskal Wallis Chi2=71.84	Pearson Chi2=38.38	Pearson Chi2=7.021	Pearson Chi2=23.01	Kruskal Wallis Chi2=39.42			

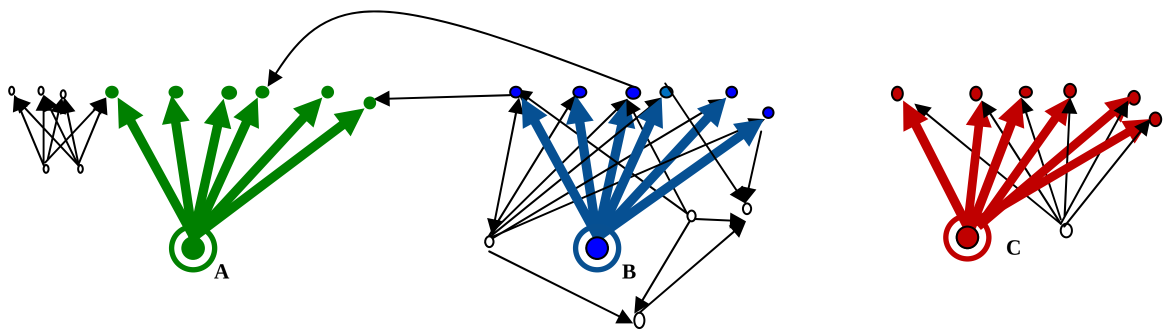
Meso-Level Variation in Social Structure. Current theory argues for the importance of variation in social structure. However, current theory defines social structure as firms' immediate network of ties. For instance, Granovetter (1992b:33) describes the differences in firms' social structure as involving "the extent to which a dyad's mutual contacts are connected to one another." Hence current theory assumes that variation in social structure is at the level of the first-level contacts, and that at the level of overall network structure, variation in social structure disappears. In contrast, my research argues that variation in social structure cannot be fully reduced to variation in the structure of first-level contacts. A graphical example helps illustrate this point. Figure 2-8, Panel A shows an egocentric focus on the immediate networks of three firms A, B, and C in the Indian interorganizational network. Figure 2-8, Panel B and Panel C, take into consideration firms' immediate contacts, second-level contacts, third-level contacts, and so on, until the overall pattern of ties in which firms are embedded is taken into account. When the structure of first-level contacts, second-level contacts (and so on) is taken into account, meso-level variation in the social structure of the three firms becomes apparent. Firm C resides within an isolated cluster, Firm B is a cohesive cluster connected to the rest of the network with sparse ties, whereas Firm A is nested within multiple layers of ties. An exclusive focus on the immediate network fails to reveal these differences – for example degree centrality and structural constraint, two commonly used egocentric measures of network structural activity show that the three firms are equivalent. Hence, my research suggests that social structures vary, even within the same economy, and that this meso-level variation cannot be reduced to variation in firms' immediate network of contacts.

FIGURE 2-8: Structural Differences Revealed when the Structure of Contacts' Contacts, and so on, is Considered

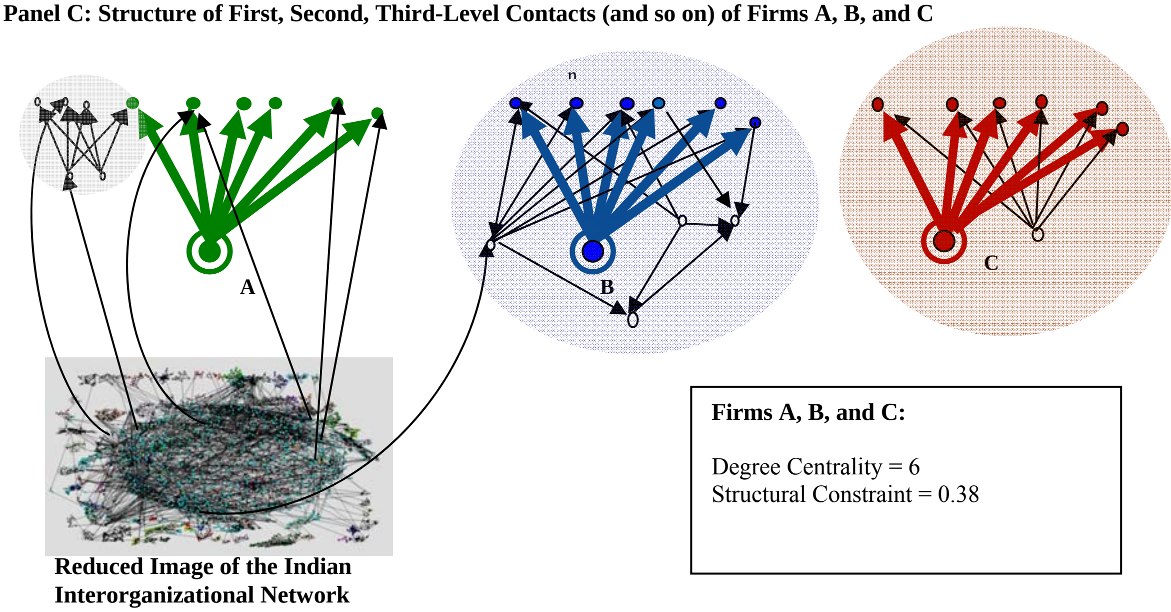
Panel A: Egocentric Focus on the Immediate Network of Firms A, B, and C



Panel B: Structure of First, Second, and Third-Level Contacts of Firms A, B, and C



Panel C: Structure of First, Second, Third-Level Contacts (and so on) of Firms A, B, and C



DISCUSSION

The case study design is a powerful tool for revealing examples that do not fit current theoretical predictions, and for helping to extend theory (Eisenhardt 1989). Current theory predicts that overall interorganizational networks across countries are similar, and predicts that information diffuses relatively easily within large interorganizational networks without raising issues of constraint and power. Instead I find a social structure more complex and varied than current theory suggests. The Indian interorganizational network in 2001 is a hybrid structure: a significant portion of the network conforms to the small world pattern (24 percent), but other significant portions conform to isolated clusters (20 percent), atomized worlds (42 percent) of firms disconnected from the rest of the network, and nested worlds of highly integrated firms (14 percent). Therefore, my research supports current theory in emphasizing the importance of variation in firms' social structure. In addition, my research extends current theory in new directions, arguing that, to fully understand variation in social structure, an egocentric focus on the immediate network of ties must be complemented with a focus on meso-level variation in social structure.

Several implications and directions for future research follow from the results of the study as well as its limitations. First, future research must explore the moderating effect of meso-level variation in social structure on micro-level processes. Second, current theory suggests that interorganizational network structure cannot be reduced to rational choice or social context (Granovetter 1985). Consistent with this theory, I find a correspondence between network structure and social context, but this correspondence is far from perfect; not all entrepreneurs in the nested and small worlds belong to traditional entrepreneurial communities and similarly many of the entrepreneurs in the atomized world belong to traditional entrepreneurial communities. However, beyond this finding, my study does not clarify the direction of the relationship between network structure and social context, and future research must clarify this relationship. Third, my research suggests a link between the economic context at the time of founding and firms' social structure. Future research into this question promises to link network theory to cohort effects and theories of organizational imprinting. Fourth, the hybrid network structure is closely intertwined with the specifics of the Indian context. However, the single-country design does not allow investigation into the links between cross-national differences and overall network structure. An exciting area of future research is cross-country research into the structure of interorganizational networks.

Finally, small world theory predicts that institutional shocks might change the composition of the actors in the network, but will not affect the small world structure. In contrast I find a hybrid structure which reflects the effects of the major liberalization in India in 1991. The nested and small worlds are disproportionately composed of an older pre-liberalization cohort of firms and business groups, operating in traditional capital-intensive industries, and which rely on domestic corporate shareholders. In contrast the atomized world is disproportionately composed of a newer post-liberalization cohort of firms which have lower capital requirements and are more reliant on the global market. However, my research design does not allow me to clearly tease out the effect of the 1991 institutional shock on the hybrid structure. Future research with a dynamic network structural design should investigate the link between institutional shocks and overall network structural patterns more systematically. In the

Indian case, it will be interesting to observe how the Indian interorganizational network evolves, and whether the atomized and nested worlds increase or reduce in size over time.

The practical significance of this study is that it suggests the importance and feasibility of economy-wide interorganizational network research. In India, the presence of business groups and community and family ties lends a certain "murkiness" to the Indian organizational environment. It is hard if not impossible for an outside investor to understand the many ties that independently traded firms have, and this "murkiness" reduces confidence in the stock market, and limits trading to a few well known firms (Bhattacharya, Daouk, and Welker 2003). Foreign investors considering investing in emerging markets are sometimes stymied by the inability to understand the dense networks of ties in local environments. My research reveals the position of individual organizations in the Indian interorganizational network. Indian managers are particularly interested in this descriptive aspect of the study, and are curious not only of their own position in the network, but their competitor's position in the network.

CHAPTER 3: PUTTING THE GROUP BACK IN BUSINESS GROUPS

Two growing streams of research, *business group* research (Guillén 2002; Khanna and Palepu 2000) and research on *interorganizational clusters* (Dhanaraj and Parkhe 2006; Nohria and Garcia-Pont 1991) focus on sets of legally independent firms that are connected by multiple ties and which coordinate activities. Business groups are defined as "a set of firms, which though legally independent, are bound together by a constellation of formal and informal ties and are accustomed to taking coordinated action" (Khanna and Rivkin 2001:46-48). Interoganizational clusters are defined as "a group of three or more organizations connected in ways that facilitate achievement of a common goal" (Provan, Fish, and Sydow 2007:482). Taken together, the evidence from the research on interorganizational clusters and business groups suggests that this phenomenon is widespread and plays a significant role in economic activity across the world (La Porta, Lopez-de-Silanes, and Shleifer 1999). Country specific studies corroborate this finding and scholars describe these phenomena in China (Keister 1998, 2001), Japan (Lincoln, Gerlach, and Ahmadjian 1996; Lincoln, Gerlach, and Takahashi 1992), Korea (Bae, Kang, and Kim 2002), Germany (Boehmer 2000), Belgium (Dewaelheyns and Van Hulle 2004), Italy (Iacobucci 2002), Israel (Maman 2006), India (Khanna and Palepu 2000), Nicaragua (Strachan 1976), Chile (Silva, Majluf, and Paredes 2006), Turkey (Gonenc, Kan, and Karadagli 2004), Indonesia (Mursitama 2006), Russia (Perotti and Gelfer 2001), Mexico (Sargent 2001), United States (Knoke 2009; Nohria and Garcia-Pont 1991), and Canada (Baum, Rowley, and Shipilov 2004).

Definitions of business groups and interorganizational clusters are strikingly similar. Equally striking is the difference in theoretical treatment of these phenomena. Business group research describes business groups as characteristic of developing countries, and describes them as “murky” (Morck, Wolfenzon, and Yeung 2005) and corrupt (Bertrand, Mehta, and Mullainathan 2000). Business groups are sometimes described as large, highly diversified, conglomerate-like organizational forms, and theories rely on some facet of the developing country context to explain the presence and performance of these organizational forms. For instance, business group theories relying on transaction cost economics claim that business groups reside (and have higher performance) in developing countries because they substitute weak external institutions by internalizing supply, labor, and capital markets. However, developing countries, somewhat by definition, have weak external institutions, and a simple substitution results in the following tautology: business groups reside (and have higher performance) in developing countries because they are developing countries. Similarly, other theorists propose that business groups thrive in developing countries with inward and outward trade imbalances by acting as bridges connecting internal labor and supply markets with external capital and technology. These theories are rightly criticized as functionalist tautologies (Granovetter 1992a: 8). Also, by conceptualizing business groups as phenomenon characteristic of developing countries, these theories fail to investigate the presence (and performance consequences) of business groups in developed countries. For instance, (La Porta, Lopez-de-Silanes, and Shleifer 1999) use shareholding ties between firms to identify business groups, and find that business groups dominate the economies of 25 of 27 western developed countries.

In contrast, research into interorganizational clusters is primarily located in the United States (exceptions are based in Canada (Baum, Calabrese, and Silverman 2000; Baum, Rowley, and Shipilov 2004)). Scholars describing this phenomenon have referred to them as strategic blocks (Nohria and Garcia-Pont 1991), whole networks (Provan, Fish, and Sydow 2007), alliance constellations (Gomes-Casseres 2003), strategic alliance networks (Knoke 2001:128), cliques (Baum et al. 2004), interorganizational clusters (Van de Ven, Walker, and Liston 1979), and innovation networks (Dhanaraj and Parkhe 2006). As the names suggest, these phenomena are conceptualized as network forms of organization, and as rational, strategic responses to competitive pressures. I follow Van de Ven et al. (1979), and refer to this phenomenon as *interorganizational clusters,* a term that does not evoke any obvious normative assumptions. Research on interorganizational clusters describes a network form of organizing that is intermediate between markets and hierarchy, and hence maintains the unique skill sets of autonomous organizations while maintaining the flexibility of markets (Podolny and Page 1998; Powell 1990). Interorganizational clusters are described as the harbingers of a new form of competition which is group versus group (Gary 2005; Gimeno 2004; Gomes-Casseres 1994, 2003), rather than firm versus firm. Individual firms ability to compete in this environment is based on their ability to "run in packs" (Van de Ven 2005) and establish interorganizational coordination. These organizational forms are described as a response to competitive pressures towards greater innovation (Dhanaraj and Parkhe 2006) or efficiency (Provan, Fish, and Sydow 2007; Provan and Sebastian 1998) requiring organizations to pool together their distinct and complementary skills. Scholars theorize about how coordination among a set of firms can be maintained and enhanced (Dhanaraj and Parkhe 2006). Like theories of business groups, these theories can be criticized as functionalist teleology.

The difference in theoretical treatment of business groups and interorganizational clusters, without clear definitional differences, and based primarily on national differences is problematic for several reasons. First, it leads to weak theory that simply restates normative assumptions about the phenomenon: "innovation networks" lead to innovation, "strategic blocks" are strategic. Second, the inability to conceptualize the differences between these phenomena makes it difficult to judge whether and to what extent insights gleaned in one context are applicable to another context.

Finally, and perhaps most importantly from a network perspective, current network theory challenges this treatment of business groups and interorganizational clusters as two different, theoretically unrelated, context-specific phenomena. Theories about the structure of large networks predict that various physical, biological, and social networks display small world patterns, which are composed of dense clusters connected to each other by sparse ties (Watts 2004; Watts and Strogatz 1998). Studies of large interorganizational networks confirm that they are small worlds composed of dense clusters of firms connected to each other with sparse ties (Baum, Rowley, and Shipilov 2004; Davis, Yoo, and Baker 2003; Kogut and Walker 2001). Alternative theories of large network structure such as nested theory also predict that large networks are composed of clusters of actors nested within one another (Moody and White 2003). These network structural theories predict clusters in ***all*** large networks, although the underlying dynamics leading to these clusters might differ across contexts. These network structural theories point to the artificiality of the schism between research on business groups and interorganizational clusters, and demand a framework in which the differences between instances of business groups and interorganizational clusters can be studied and compared.

My paper aims to fill this conceptual gap by developing a network structural framework in which business groups and interorganizational clusters can be studied. Current research finds high levels of control and coordination between firms in a business groups, and often treats business groups as conglomerate-like organizational forms. However, I explore definitions, theories, and assumptions of business groups and interorganizational clusters, and argue that the key characteristic used to justify theoretical investigation into business groups and interorganizational clusters is the focus on the *group*, rather than on individual firms or on bilateral relations between pairs of firms. This focus on group suggests the applicability of a network structural perspective, and the second section develops a network structural definition of group coordination among legally independent firms. A network structural perspective has several advantages. It is less susceptible to the biases implicit within current research on business groups, and it opens us new avenues of research into the difference between groups.

In the last sections, I apply the network structural perspective to Indian business groups. Current research treats Indian business groups as conglomerate-like sets of firms in which a strong authority structure ensures that member firms operate like subsidiaries rather than as independent firms (Guillén 2000; Khanna and Palepu 1999, 2000). Some scholars argue that a network structural perspective does not apply to these business groups (Khanna and Rivkin 2006; Smangs 2006). And hence, Indian business groups are a particularly stringent test of the network structural perspective. I find that the network structural definition accurately identifies Indian business groups, and is superior to the method of classification used by current research. The method of classification used by current research is biased towards larger, older, and more visible business groups, hence buttressing the theoretical bias towards larger groups. I also find a wide variation in the position of business groups relative to the rest of the network. This finding suggests a new direction in business group research that takes into account the positional differences between groups.

BUSINESS GROUPS AND INTERORGANIZATIONAL CLUSTERS: A REVIEW

A review of research on business groups and interorganizational clusters reveals a gestalt of assumptions, assertions, and theories that justify the schism between research on business groups and research on interorganizational clusters. Business groups are described with reference to conglomerates – diversified organizations with subsidiaries operating in different industries. The comparison with conglomerates is important because research in the United States in the 1970s indicated that conglomerates have inferior performance compared to other organizational forms, and theories about the conglomerate organizational form emphasize the disadvantages of this organizational form (Amihud and Lev 1981; Prahalad and Bettis 1986; Rumelt 1982). In this theoretical context, research on business groups was framed as an attempt to explain why business groups (treated as conglomerate-like forms) continued to thrive and enjoy superior performance. The answers point to aspects of the developing country context, which make this otherwise inefficient organizational form efficient in the context of developing countries (Amsden 2001; Guillén 2001; Khanna and Palepu 2000).

The treatment of business groups as conglomerates is problematic since the firms in a business group are legally independent, traded on the stock market as independent firms, and governed by shareholders concerned with individual firm performance, and by corporate laws that protect shareholder rights, and limit the extent of concerted action among legally independent firms. Scholars justify the comparison with conglomerates by asserting that business groups display high levels of coordination and centralized control so that group firms act like subsidiaries rather than legally independent firms. The high levels of coordination and centralized control is a result of multiple family and community ties and strong cultural norms that supposedly override rational considerations of individual firm performance, and lead to high levels of conformity and stability; group firms are obligated to act towards group goals even when these actions are detrimental to individual firm performance (Lincoln, Gerlach, and Ahmadjian 1996). Descriptions also emphasize "murky", entrenched ties (Morck, Wolfenzon, and Yeung 2005) between large business groups and the government, which help stymie regulations protecting minority shareholders concerned with individual firm performance rather than group performance. These broad generalizations about "murkiness," irrational cultural considerations, and corruption are perhaps easier to accept in the context of a developing country.

In contrast, studies of interorganizational clusters in the United States reveal a very different gestalt of theory and assumptions. These studies emphasize the new and innovative aspect of these organizational forms. They are a strategic rational response to the need for constant innovation and constant efficiency improvements (Baum, Calabrese, and Silverman 2000; Dhanaraj and Parkhe 2006; Provan, Fish, and Sydow 2007). Enlightened self-interest is the motivational force, and dynamism rather than stability is the distinguishing feature. These clusters are characterized by alliance and joint venture ties, which might be less stable or durable than family, community, or shareholding ties. Network-like processes that rely on informal cooperation rather than the assumed control and coordination of conglomerates are the appropriate reference point. Group coordination therefore is not taken for granted but problematized, and these narratives are concerned with how to establish and sustain these organizational forms (Dhanaraj and Parkhe 2006). In contrast, some of the research on business groups is concerned with disbanding these organizational forms (Morck 2004).

The gestalt of assumptions, assertions, and theory described above frequently runs counter to empirical evidence and/or is theoretically inconsistent. First, the assertion that business groups are characteristic of developing countries ignores the evidence that business groups characterize most countries in the world (La Porta, Lopez-de-Silanes, and Shleifer 1999). Second, the assertion that strong cultural norms lead to high levels of conformity and stability is also problematic. Business groups change, and Stark et al. (2006) find that 86% of group firms changed their network position and/or affiliation at least once over a decade long period. Third, business groups can be small and entrepreneurial (Iacobucci 2002; Iacobucci and Rosa 2005) with simple structures that belie assertions of "murkiness" and corruption. Fourth, interorganizational clusters can have conglomerate-like centralized hub firms (Dhanaraj and Parkhe 2006; Provan and Sebastian 1998), and business groups can display decentralized structures (Gerlach 1992).

Definitions of business groups and interorganizational clusters are very similar in the key attributes that are identified as characteristic of these phenomena. For instance, Khanna and Rivkin (2001:46-48) define business groups as "a set of firms, which though legally independent, are bound together by a constellation of formal and informal ties and are accustomed to taking coordinated action." Leff (1978:663) defines business groups as, "A group of companies that does business in different markets under common administrative or financial control", and Granovetter (2005:429) defines them as "sets of legally separate firms bound together in persistent formal and/or informal ways." Chung (2000) defines business groups as "a set of legally independent firms that are linked to each other through multiple economic and social relationships. Member firms not only operate in a coherent manner but also share a collective identity."

The most commonly used definitions of interorganizational clusters are the following. Strategic blocks are defined as "a set of firms that are connected more densely to each other than to other firms in the industry" (Nohria and Garcia-Pont 1991:106). Provan, Fish, and Sydow (2007:482) in an exhaustive review of the research on "whole networks" defines the term as referring to "a group of three or more organizations connected in ways that facilitate achievement of a common goal." Dhanaraj and Parkhe (2006:659) define innovation networks as "loosely coupled systems of autonomous firms." Baum et al. (2004:699) define "cliques" as "relatively stable groups of firms, more densely interconnected to one another than to other firms in the industry network, and reproduced over time by repeated interactions among a set of firms." Van de Ven et al. (1979) describes interorganizational clusters as "patterns of coordination among clusters of organizations which are all members of a larger network of human service agencies." Gomes-Casseres (2003:328) describes alliance constellations as an alternative to the single firm as a way of governing a bundle of capabilities, and defines alliance constellations as "a set of firms linked together through such alliances and that competes in a particular competitive domain." Strategic alliance networks are defined as "a set of organizations connected through their overlapping partnerships in different strategic alliances" (Knoke 2001:128; 2009).

Without exception, the definitions of interorganizational clusters and business groups focus on the *group* and the presence of ties between groups firms used to establish some form of coordination between groups firms. Definitions of business groups tend to emphasize group coordination to a greater extent. Also, definitions of interorganizational clusters tend to focus on groups of firms operating in the same industry, whereas definitions of business groups sometimes emphasize their presence in "different markets" (Leff 1978). However, inter- or intra-industry ties cannot be a definitional criterion since exceptions abound; business groups are not always diversified (Dyer and Nobeoka 2000; Jameson, Sullivan, and Constand 2000), diversified entities are not always business groups (Chakrabarti, Singh, and Mahmood 2007), and interorganizational clusters are not always industry-specific (Knoke 2001). Some definitions of interorganizational clusters also differ from definitions of business groups in their focus on alliance ties between firms in the cluster. However, the type of tie is a problematic definitional criterion since not all interorganizational clusters are characterized by alliance ties (Provan, Fish, and Sydow 2007), and theory emphasizes the multiplicity of ties between interorganizational clusters. Also, the type of tie used to coordinate activities among firms is a function of laws and norms, which change over time. For example, Morck (2004; 1988) describes how business groups in the United States, a widespread organizational form in the 1930s, disappeared virtually overnight as a result of the institution of double-dividend taxation, which made shareholding ties between firms expensive. More recent research in the United States describes network organizational forms that rely on alliance ties instead. This historical perspective suggests that coordination among legally independent firms in the United States is not a "new" organizational form, although the type of tie used to establish coordination among firms has changed over time.

Definitions of business groups and interorganizational clusters emphasize organizational coordination at the level of the group, and use this focus on the group to justify investigation into this topic separate from investigation into bilateral ties between firms. For example, Gomes-Casseres (2003:327) notes that "[In traditional models of strategy and organization], we find mostly models predicated on the firm as the unit of competition; the notion of a firm competing within and as part of a larger constellation is rarely addressed." Similarly, Nohria and Garcia-Pont (1991:105) notes that "most of the focus has been on individual linkages or on a focal firm and its nexus of relations. Little attention has been paid to how these individual linkages further connect to bind the firms in an industry into a larger system." In the next section, I develop a network structural perspective on group coordination.

A STRUCTURAL PERSPECTIVE ON BUSINESS GROUPS

A structural definition of groups has the advantage of being least susceptible to normative assumptions about particular characteristics of groups, and the desirability of these characteristics. Scholars have relied on the concept of cohesiveness to identify groups (Moody and White 2003; Paxton and Moody 2003). Cohesiveness is the ability of the group to "hang together" and maintain group boundaries above and beyond particular ties between pairs of actors in the group. From a network structural perspective, cohesiveness is the robustness of a group to the removal of particular actors or ties (Moody and White 2001). Other scholars such as Markovsky and Lawler (1994) further clarify the internal structural characteristics of groups; a group is a maximal set of actors that cannot be further split into separate subgroups. I rely on these theories to define *cohesive groups as sets of legally independent firms in the interorganizational network that are robust to the removal of particular ties or actors, and that cannot be further split into subgroups.* I propose that business groups and interorganizational clusters are both *cohesive groups*. This definition of groups takes into account both internal structure; the group is the set of actors that cannot be further split into subgroups. It also takes into account the structure ties surrounding the group; the group is the set of actors that is most robust to the removal of particular actors or ties compared to other larger sets of actors. Hence group boundaries are drawn based on information about the ties that connect groups firms to each other, and also about the structure of ties outside the group.

Scholars have argued against network structural definitions of business groups and instead propose perceptual measures of group identity (Khanna and Rivkin 2006). Network structural definitions are problematic because structurally equivalent sets of firms might differ in their behavioral manifestations. For example, a holding company coordinating the activities of a set of group firms, and an institutional investor holding shares in a variety of firms are structurally indistinguishable, but the former is a business group firm while the latter is not. However, the business group with the holding company has a pure ‘hub and spoke’ structure in which group firms have ties only to the holding company. To ensure that the holding company retains control over group firms, the number of ties that individual group firms have to firms outside the group is limited. In contrast, an institutional investor, somewhat by definition, is one among many shareholders of the firms in which it owns shares. A consideration of the structure of ties in which the above organizations are embedded reveals these differences. Another problem with a network structural definition is that group coordination can be achieved using a variety of structural arrangements. For example, a hub and spoke structure with a central coordinating firm, and a decentralized structure with multiple independent paths between firms reflect different forms of group coordination. I argue that these issues of internal structural heterogeneity and differences in how the group relates to those outside the group are not cause for rejecting the network structural perspective. Instead, these issues increase the need for a network structural perspective that can reveal these differences between groups.

Groups vary in the complexity and cohesiveness of their internal structures. Groups vary in their position within the network, and research which describes powerful and dominant business groups implicitly acknowledges the presence of less powerful business groups. And groups vary in the clarity of their boundaries, with some groups having overlapping membership and multiple external ties. Current research focuses on the outcomes of adopting a business group form (a 0/1 decision) rather than on differences between groups. I hypothesize that groups vary significantly in their position within the network, their internal structures, and the fuzziness of their boundaries. Further, the current method of identifying groups relies on perceptions of group identity (Khanna and Rivkin 2006), and is less likely to be unbiased across different types of groups. Existing research and the business media sometimes portray business groups as large, dominant, stable, and entrenched (Bertrand, Mehta, and Mullainathan 2000; Morck, Wolfenzon, and Yeung 2005; Korea Times 2005a; 2005b). Indeed, some studies identify groups based on size (Chang and Hong 2000; Kim, Jung, and Kim 2005) or define groups based on persistence (Granovetter 2005:429). Given these size and age biases in current research on business groups, I expect that currently used classifications of business groups are biased towards larger, older, and more visible business groups. The network structural method is more likely to identify groups unbiased by size, age, or visibility.

Hypothesis 1. Groups vary in their internal structure, position in the network, and the clarity of their boundaries.

Hypothesis 2. The network structural definition more accurately identifies groups compared to the current method of identifying groups.

Hypothesis 3. The current method of identifying groups is biased towards larger, older, and more visible groups.

DESIGN AND DATA

The network structural approach described requires a consideration of ties within the group and also ties to the rest of the network. Hence, it requires complete population data, and I construct a network of shareholding ties (>1%) for all publicly traded firms in India in the year 2001 using data from the Prowess CMIE (Centre for Monitoring Indian Economy) dataset. Below I explain each of these design and data choices. Prowess CMIE is a standard source of annual report and stock market data for Indian firms, and many studies on Indian business groups rely on the Prowess CMIE dataset (Khanna and Palepu 2000; Mahmood and Lee 2004). India is an appropriate site to test the accuracy of the network structural definition for three reasons. First, business groups in India are described and treated as conglomerate-like organizational forms (Khanna and Palepu 2000). Second, multiple studies on business groups are based in India (Bertrand, Mehta, and Mullainathan 2000; Khanna and Palepu 1999, 2000). The network structural approach can be compared to the classification of Indian business groups used by this prior research.

Shareholding ties are used to construct the Indian interorganizational network since prior research in similar contexts suggests that shareholding ties are most indicative of coordination among firms (Khanna and Rivkin 2006; Lincoln, Gerlach, and Takahashi 1992). Conversations with Indian managers and auditors confirmed the importance of ownership ties in establishing coordination between firms the Indian economy. I use a full population design including shareholding data about all publicly traded firms in the Indian economy for which data is available in Prowess, CMIE. The reason for a full population design is that Indian business groups are highly diversified (Khanna and Palepu 2000), and the population of interest cannot be limited to a particular industry.

The Indian interorganizational network is constructed for the year 2001 since it is the first year for which shareholding data became available in easily accessible form. For the year 2001, Prowess has annual report data for 3543 publicly traded firms (traded on the Bombay Stock Exchange or the National Stock Exchange). Shareholding data are sourced from the stock exchanges, and hence are reliable. 2,963 publicly traded firms have between 1 and 47 shareholders holding more than 1% stake in the firm. Scholars have used 10%, 20%, 30%, or 50% shareholding as cutoffs to indicate a significant ownership tie (Chang and Hong 2000; La Porta, Lopez-de-Silanes, and Shleifer 1999). However, the extent to which particular percentages of shareholdings translate into control depends on the overall distribution of shareholdings. Shareholdings distributed among otherwise disconnected shareholders (Berle and Means 1932) have different consequences for control compared to shareholdings among connected shareholders. Given the overall pattern of shareholdings, even a 1% stake can be used to control a company (Morck, Wolfenzon, and Yeung 2005). The approach described in this paper relies on the overall pattern of shareholding ties, and therefore, I use the least stringent 1% shareholding, as the cutoff to include shareholders in my dataset.

In order to make this large network more easily manipulable, and in order to ensure that the network reflects meaningful coordination between firms, I exclude certain categories of shareholders. I exclude shareholders who are pure investors (classified as “Indian Public”) since by definition these shareholders are not involved in organizational decisions. I also bound the network within India, and hence exclude shareholders classified as “Foreign”, or “nonresident Indian.” Bounding the network by country is arbitrary and doesn’t reflect the global ties between firms. However, the network has to be bounded somewhere, and nation states continue to be a meaningful construct reflecting particular laws and norms. Finally, I exclude shareholders classified as “institutional investors.” These investors, usually government bodies, have shareholding interests in a wide variety of firms across the Indian economy, and most frequently are passive shareholders. The final network is constructed using shareholders classified as “private corporate bodies” (defined as public or private firms that are not government controlled), “persons acting in concert” (defined as sets of shareholders, frequently family owners, who operate as a block), and “Indian promoters” (owner-managers).

These choices leave 24,647 firm–shareholder pairings. I cleaned these raw data by manually going through this list. This process was essential since sometimes shareholder names were slightly different across observations – e.g., “Af-tek rolling mills enterprises ltd” also appears as “Aftek rolling mills entr. ltd.” Even more problematic was the presence of different shareholders with the same name. For instance, Ramesh Goyal is a common Indian name and appears on my list six times. I used several techniques to check whether these names referred to the same person. First, I checked the six firms in which Ramesh Goyal appears as a shareholder. I checked if these six firms had other shareholders in common or if related party data indicated that the six firms mentioned one another as "related parties" in their annual reports. If I found no indication of a link between the six firms, I concluded that the six different Ramesh Goyals referred to six different individuals, and marked the six Ramesh Goyals appearing in my list as Ramesh Goyal1, Ramesh Goyal2, Ramesh Goyal3, and so on. This process was important because otherwise the interorganizational network would treat these individuals as the same individual, and hence overstate the level of integration in the interorganizational network. However, ultimately this problem proved fairly minor since there were only 100 instances (out of the 24,647 firm-shareholder pairs) where the above changes were required.

After cleaning the firm–shareholder pairs, I converted these data into a 12,794*12,794 square matrix. The columns (and rows) in this matrix are less than the number of firm–shareholder pairs because firms (and shareholders) have multiple ties, and appear multiple times in the list of firm–shareholder pairs. The matrix contains 12,794 unique actors including 2781 firms listed on the Bombay stock exchange or the National Stock Exchange, 5727 individuals who are shareholders, and 4286 private firms (firms that are not listed on either of the two major Indian stock exchanges). A tie in this matrix refers to an ownership relationship, either between two firms or between a firm and an individual. Individuals cannot have shareholding ties with each other. As a check, I also constructed an interorganizational network where I did not make the above changes. This network had many obvious instances of nonsense data (for example, "MRF ltd" and "M R F ltd", appearing as proximate but separate entities in the network). Therefore I report the results of the cleaned network.

ANALYSIS AND RESULTS

A combination of component analysis and cohesive blocking is used to identify cohesive groups. A component consists of a set of nodes that have at least one path connecting every pair of nodes in the set. Component analysis finds that the Indian shareholding network is composed of 1294 small components (1 to 11 publicly traded firms), and one large component (1050 publicly traded firms). Out of the 1294 small components, 1001 small components contain only one publicly traded firm. These 1001 components represent *isolated firms*, in which neither the firm nor its shareholders have any ties to the rest of the network.

Next I analyze the remaining 293 small components. I find that 78 of these 293 small components are not cohesive (the removal of a single tie or actor disintegrates the component into individual nodes). The remaining 215 small components form 220 cohesive groups (five of the small components consist of two cohesive structures each connected to each other with a single actor or tie). I call these 220 cohesive groups *isolated cohesive groups* (containing 503 publicly traded firms) since they do not have ties to any other actor in the network outside their small component, and because they are robust to the removal of particular actors or ties. Figure 2.2 in Chapter 2 presents the network structure of three isolated cohesive groups. The figure shows that these cohesive groups are characterized by a set of shareholders owning direct shares in ***all*** group firms. This shareholding pattern indicates the incentives for shareholders to work towards group goals rather than individual firm goals. In group C, the shareholders not only own shares in all group firms but also own the same proportion of shares in all group firms – for example one shareholder owns 3.94% in all group firms, while another owns 2.32% shares in all group firms, and so on. This shareholding pattern provides incentives for shareholders to care about the performance of all group firms, and focus on group performance rather than individual firm performance. Figure 2.2, group A and group C, has shareholders with the same last name, and hence most likely belong to the same family. Therefore, both shareholding ties and social ties encourage a focus on group coordination, and explain the high levels of group coordination described among Indian business groups.

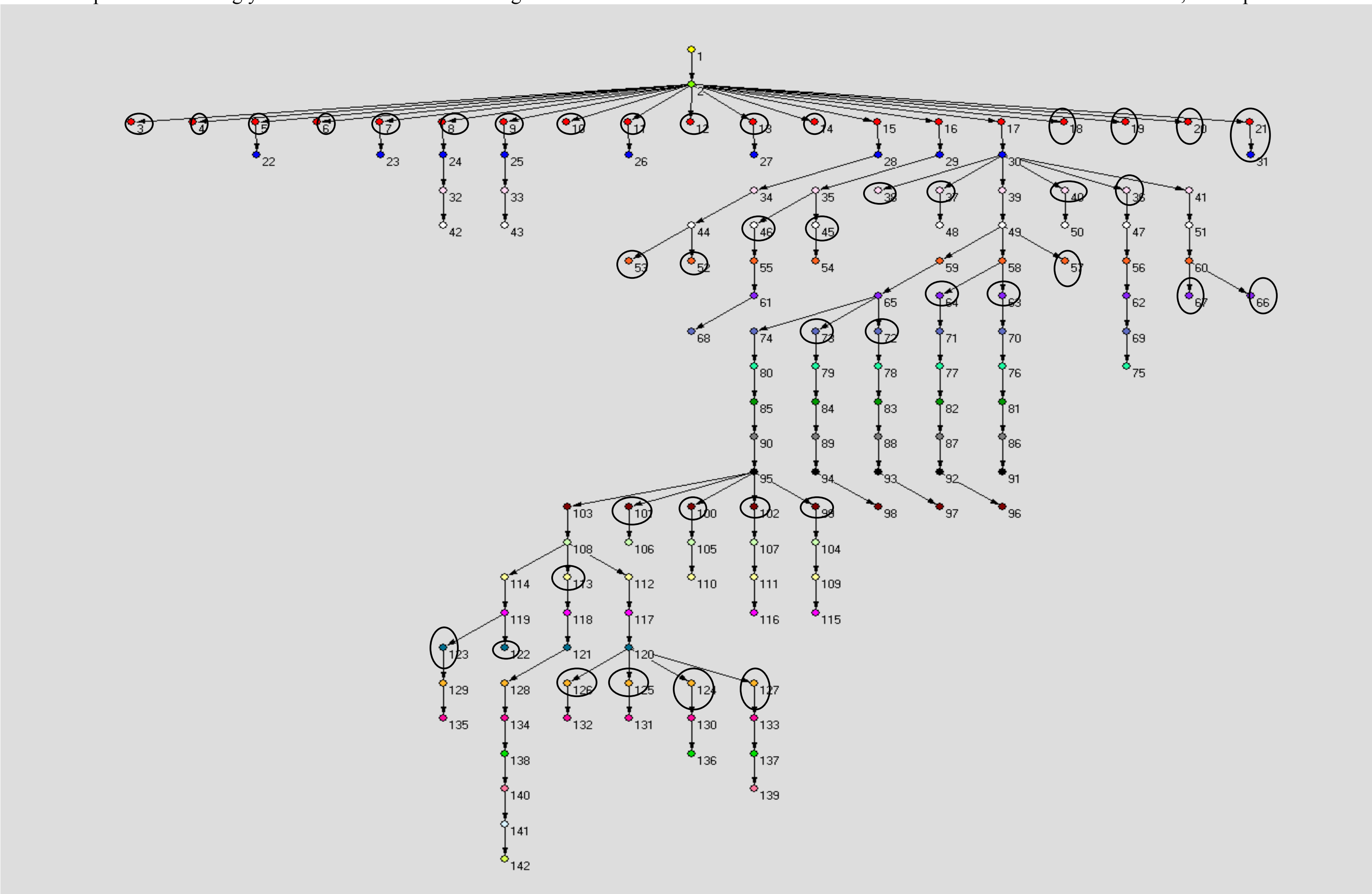
Figure 2.2 also reveals several other aspects of isolated cohesive groups. First, these groups tend to have simple structures characterized by direct shareholdings instead of complex pyramid-like structures with one firm owning shares in a set of other firms, which in turn own shares in yet other firms, and so on. Second, isolated cohesive groups tend to be small, with the large majority containing just two publicly traded firms. Third, the boundaries of isolated cohesive groups are clear in most cases since these isolated cohesive groups do not have ties to any other firm in the rest of the network. In a few cases, for example group B in Figure 2.2, I find a few actors connected to the rest of the group with a single tie (hence these actors are not structurally cohesive even though the rest of the cluster is structurally cohesive). In these cases, the strength of the tie (10% or greater shareholding percentage) is used to determine if the firm is part of the cohesive group or should be identified as an *external* *tie*. I find 57 instances where a publicly traded firm is connected to the 220 cohesive groups with an external tie.

Next, I use cohesive blocking to analyze the large component (containing 1050 publicly traded firms). Cohesive blocking cuts actors or ties, which if removed, split the component into bicomponents. A bicomponent is a set of connected nodes that have at least two paths connecting every pair of nodes in the set. Cohesive blocking continues the process of cutting revealing smaller and smaller nested subsets of actors. Intuitively, the procedure can be described as peeling the layers of an onion to get at the core. The first level of cutting reveals that the large component (containing 1050 publicly traded firms) is composed of 127 small bicomponents (2 to 14 publicly traded firms each), and one large bicomponent (385 publicly traded firms). The 127 small bicomponents are connected to the rest of network with one or two ties, and hence I refer to these cohesive groups as *moderately nested cohesive groups*. Figure 2.3 in Chapter 2 presents the internal structures of two moderately nested cohesive groups. These groups tend to be larger than the isolated cohesive groups, but they are structurally similar to the isolated cohesive groups, and are characterized by group shareholders owning shares in all or most of the group firms. Like the isolated cohesive groups, the moderately nested cohesive groups display simple structures with direct shareholdings. The boundaries are fairly clear, and the groups typically have only one or two ties connecting the group to the rest of the network.

Cohesive blocking is used to further analyze the structure of the large bicomponent (385 publicly traded firms). The skeletal structure in Figure 3.1 displays the results of progressive cutting. Figure 3.1 matches Figure 2.4 in Chapter 2, and also identifies business groups (circled cutnumbers). The numbers in Figure 3.1 are cutnumbers, and refer to sets of nodes that remain at particular points in the cutting procedure. For instance, cutnumber 1 refers to all the nodes in the large bicomponent, and cutnumbers 2 to 142 refer to smaller subsets of nodes that are left over after subsequent levels of cutting. Hence lower levels on the skeletal structure represent increasingly cohesive subsets of nodes. I've circled the highest cutnumbers in the lowest undifferentiated branches of each stem because these cutnumbers represent cohesive groups –sets of actors that do not further split into separate subsets, and are robust to the removal of ties or actors. I find 42 cohesive groups (composed of 192 publicly traded firms), and I refer to these cohesive groups as *highly nested cohesive groups* since they require several rounds of cutting to split them from the rest of the network – the most deeply nested of these groups are 20 layers deep in the skeletal structure (see Figure 3). Figure 2.5 in Chapter 2 displays the network structure of a highly nested cohesive group. The figure shows that highly nested cohesive groups tend to have more complex structures, with group firms holding shares in other group firms, who in turn hold shares in yet other group firms. Finally, highly nested cohesive groups have fuzzier boundaries compared to the isolated and moderately nested cohesive groups. They have many ties to the rest of the network. I also find 21 firms within the largest bicomponent which display overlapping membership in two or more cohesive groups.

FIGURE 3.1: Skeletal Structure of the Largest Bicomponent.

The cutnumbers point to the set of nodes that remain at each point in the cutting procedure. Cutnumber 1 refers to the all nodes in the bicomponent, and lower levels of the skeletal structure represent increasingly cohesive sets of firms. The highest cutnumbers in the lowest undifferentiated branches of each stem are circled, and represent cohesive groups.



Hypothesis 1 predicts variation in groups' internal structure, position within the network, and clarity of boundaries. I find strong support for the prediction that groups vary in their position within the network. I find 220 isolated groups, 127 moderately nested groups, and 42 highly nested groups. I find moderate support for the prediction that groups vary in their internal structure. Indian business groups tend to be structurally similar with shareholders owning shares in all group companies. These shareholders sometimes have common last names, and hold the same percentages of shares in all group firms. None of the isolated groups have pyramid-like structures with one group firm owning shares in other group firms. These pyramid-like structures become more common as we move from isolated business groups to moderately nested groups and highly nested groups. Similarly, the isolated business groups have clear boundaries. But the boundaries become fuzzier among the highly nested business groups with multiple external ties and 21 cases of overlapping membership. Figure 2.6 in Chapter 2 presents a compressed image of the Indian interorganizational network. 'A' is included as a single example of an isolated firm (the other 1000 similar isolated firms are not represented in order to make the visual understandable). Similarly, B is included as a single example of an isolated cohesive group. C points to a small bicomponent identified as a moderately nested cohesive group, which is connected to the rest of the network with sparse ties, and F points to a highly nested k-component, which we identify as a highly nested cohesive group.

Hypothesis 2 predicts that the network structural definition is more accurate in identifying a variety of different types of groups compared to the current method of identifying business groups. Current research on Indian business groups relies on

Prowess database classifications of firms into business groups (Khanna and Palepu 2000; Khanna and Rivkin 2001). The Prowess CMIE manual (2007) states that, "the classification of firms into business groups is based on a continuous monitoring of company announcements and a qualitative understanding of the group-wise behavior of individual companies." In cases where Prowess and network structural definitions differ, I use a third method of identifying groups to judge accuracy. Recently, Indian business groups became required to report *related party* information in their annual reports. "Parties are considered to be related if at any time during the reporting period one party has the ability to control the other party or exercise significant influence over the other party in making financial and/or operating decisions" (Indian Accounting Standards 2005). Business groups are required to report the director ties, loan and trade transactions between "related parties." Therefore, business groups are required to report this information only if there were loans, trades, or common directors between groups firms in a particular time period. Therefore, this data does not exist for all business groups. However, this data can be used to judge accuracy in cases where Prowess and network structural classifications of groups differ.

I choose a simple random sampling design for the comparison between different methods of identifying groups. I first select 80 cohesive groups from the population of 389 cohesive groups identified using the network structural definition. The randomly selected cohesive groups approximate the population distribution of isolated, moderately nested, and highly nested cohesive groups. The randomly selected cohesive groups are comparable in size (max 13 firms, min 2 firms, and average 3.46 firms in the cohesive group) to the full population of cohesive groups (max 25 firms, min 2 firms, and average 3.26 firms in the cohesive group). Out of the 80 randomly selected cohesive groups, 67 (83.75%) differ from Prowess classifications of business groups regarding at least one firm. This finding has to be interpreted in light of the small size of most cohesive groups (Table 3.1 shows the size distribution of cohesive groups, and shows that most cohesive groups contain only two publicly traded firms). Out of the 67 cases in which Prowess and network structural classification disagree, related party data on at least one firm in the cohesive group is available for 36 (45%) cases. Out of the 36 cases for which related party data are available, related party data supports Prowess classification in 27.78% (10) cases, and related party data supports network structural classification in 72.22% (26) cases. Therefore, related party data tends to support the network structural identification of business groups compared to the Prowess classification of business groups.

TABLE 3.1: Size Distribution of Cohesive Groups

No of Publicly Traded Firms in the Cohesive Group	No of Cohesive Groups
2	263
3	72
4	22
5	12
6	9
7	3
8	1
9	2
10	1
11	3
21	1
Grand Total	389

Hypothesis 3 predicts that the differences between prowess and network structural classifications are systematic. For instance, Figures 3.2 and 3.3 shows the network structure of two small isolated cohesive groups, which Prowess identifies as independent firms (related party data identifies these firms as business groups). The cohesive groups in Figures 3.2 and 3.3 show group shareholders who own equal percentages of shares in group firms. Also, in Figure 3.3, the shareholders have the same last name. The shareholding patterns and common last names indicate that these firms belong to a business group, and that currently used classifications misidentify these firms as independent firms. T-tests are used to test the hypothesis that currently used classifications are biased towards larger, older, and more visible business groups. The average total assets of all firms in the cohesive group for 2001 (*total_assets_2001*) is used as the measure of size. *Average age* and *maximum age* of the firms in the cohesive group are used as measures of age. *Nestedness*, a measure of integration with the rest of the network, is used to indicate how visible a firm is (Moody and White 2003). Nestedness is calculated as the level in the cutting procedure at which a particular cohesive group splits off from the rest of the network, and varies from 0 to 25 (isolated cohesive groups are marked ‘0’on nestedness to indicate their disconnectedness from the rest of the network). Table 3.2 shows the results of a non-parametric Mann-Witney U and Wilcoxon W t-test. These tests are more appropriate than independent samples t-test since the distribution of the variables on size and nestedness do not conform to the assumption of normal distribution in independent samples t-tests. The results in Table 3.2 support the claim that prowess and network classifications differ most among smaller, younger, and less visible groups. I further investigate the direction of the differences between Prowess and network structural classifications of groups. Table 3.3 presents the results of a non-parametric independent samples t-test, which supports the claim that Prowess tends to underestimate the size of smaller, younger, and less visible cohesive groups.

TABLE 3.2: Non-Parametric Independent Samples *t*-Test Comparing Prowess Classification with Network Structural Classification
Grouping variable is whether cohesive groups align (or don't align) with Prowess classification of business groups.

	Total Assets 2001	Nestedness	Maximum Age	Average Age
Mann-Whitney U	224.000	491.000	371.000	433.000
Wilcoxon W	965.000	1437.000	1317.000	1379.000
Z	-4.138	-1.702	-2.902	-2.188
Asymp.Sig.(2-tailed)	0.000	0.044	0.004	0.029

*Grouping Variable: 0/1 with 0.5 left blank

TABLE 3.3: Non-Parametric Independent Samples *t*-Test Testing Bias Towards Larger Business Groups
Grouping variable is whether Prowess classification underestimates the number of firms in the group when compared to the list of firms identified by the network structural approach.

	Total Assets 2001	Nestedness	Maximum Age	Average Age
Mann-Whitney U	302.000	587.000	532.500	518.000
Wilcoxon W	1205.000	1715.000	1660.500	1646.000
Z	-4.173	-2.066	-2.377	-2.517
Asymp.Sig.(2-tailed)	0.000	0.039	0.017	0.012

*Grouping Variable: Underestimate

FIGURE 3.2: Internal Structure of Isolated Cohesive Groups Identified by Prowess as an Independent Firm (Example 1)
Dots represent firms and shareholders (individuals or firms). Numbers represent percentage shareholding. Shareholders own equal percentages of shares in all group firms.

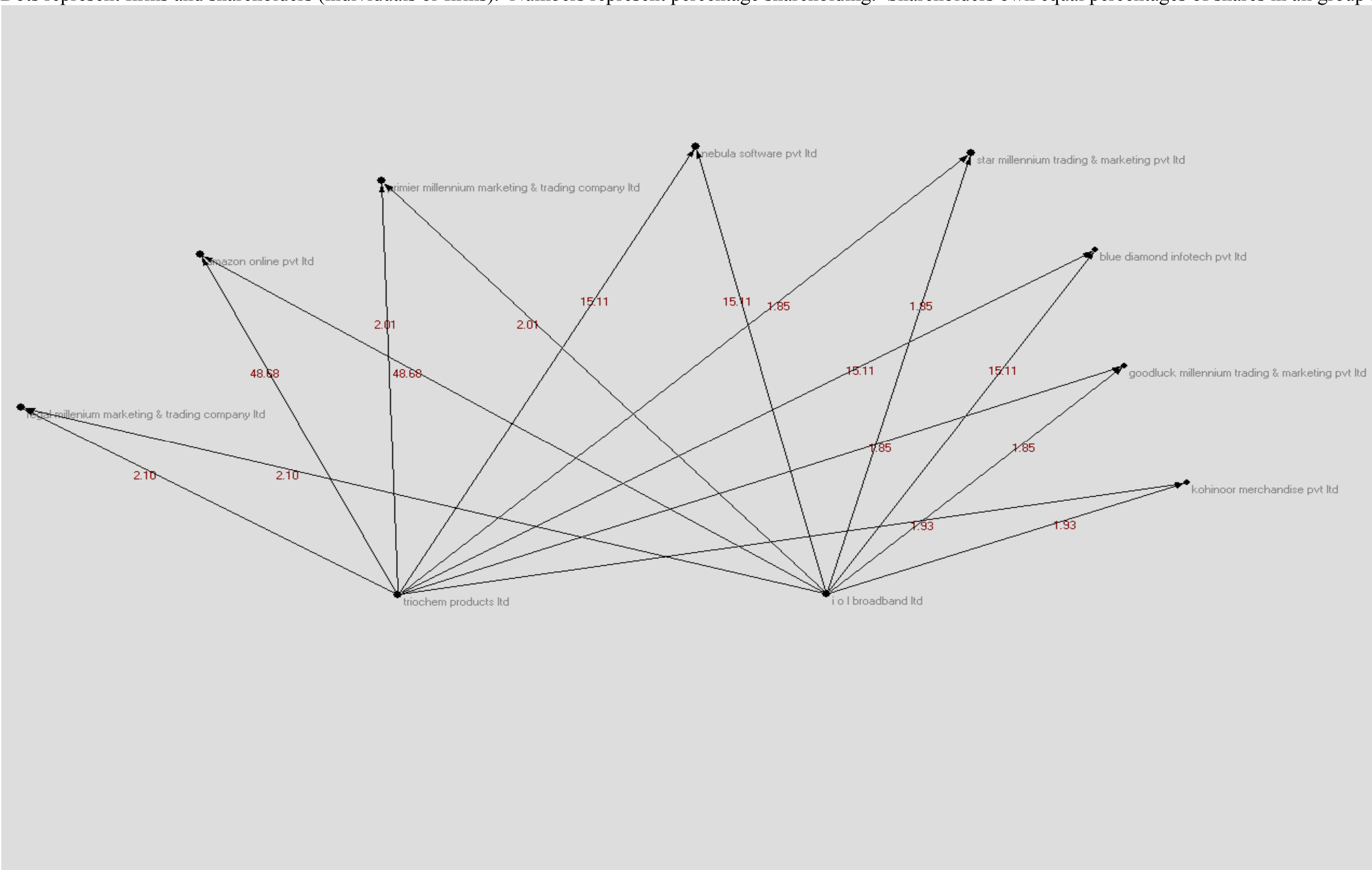
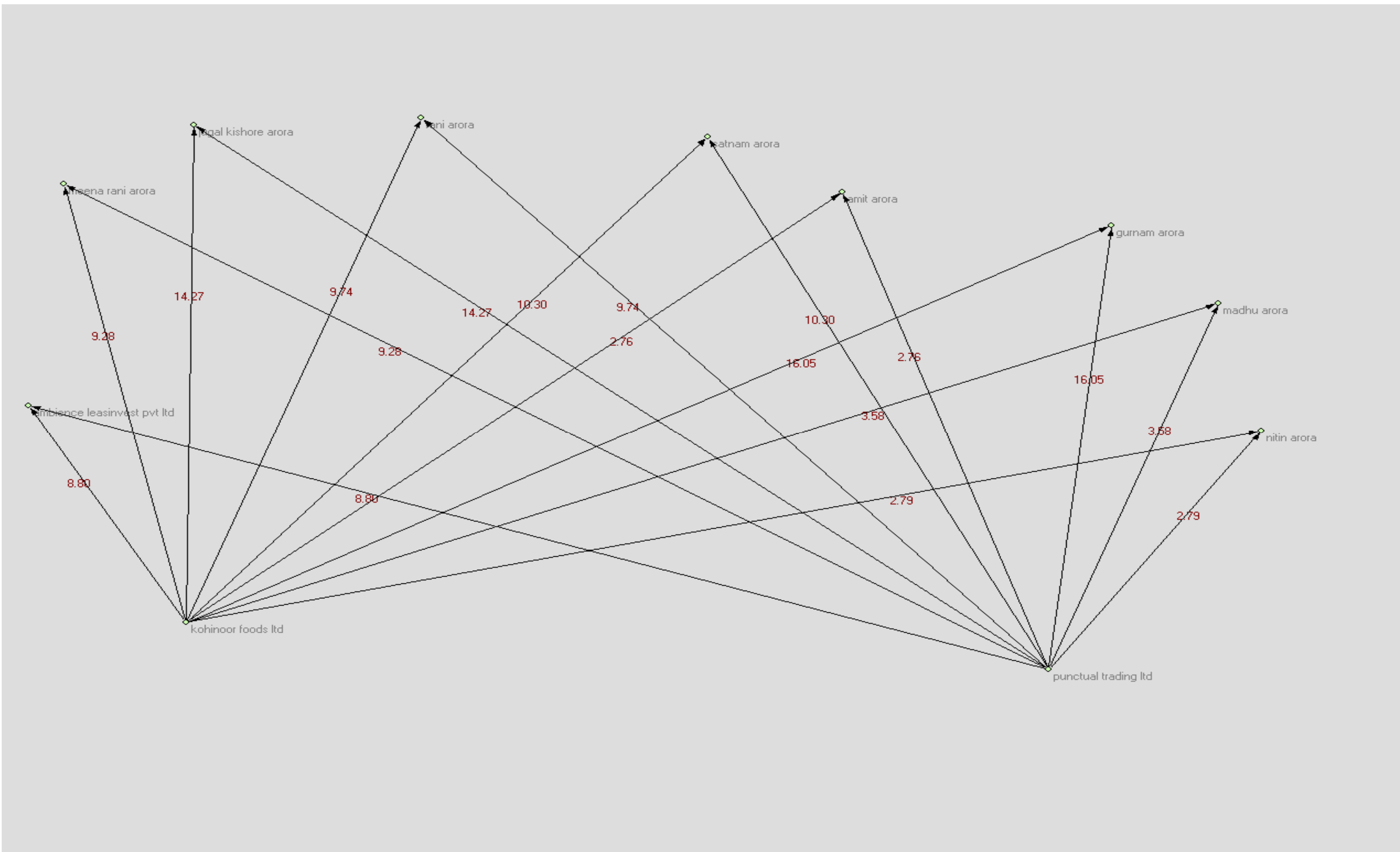


FIGURE 3.3: Internal Structure of Isolated Cohesive Group Identified by Prowess as an Independent Firm (Example 2)

Dots represent firms and shareholders. Numbers represent percentage shareholding. Shareholders have the same last name, and own equal percentages of shares in all group firms.



DISCUSSION

This paper questions the treatment of business groups as conglomerate-like and interorganizational clusters as network-like phenomena. Instead, I propose a network structural perspective that can bridge this artificial schism in current research. The theoretical contribution of this paper is that it offers a network structural framework for bridging the schism in the research on business groups and interorganizational clusters. My analysis of the Indian interorganizational network shows that a network structural perspective is a viable framework, and is as applicable to business groups in developing countries as it is to interorganizational clusters observed in the United States.

The network structural perspective yields some interesting insights, and points to a much greater focus on the differences between groups. I find that groups vary significantly in their position with the network. As we move from isolated to highly nested cohesive groups, groups become larger, more structurally complex, have fuzzier boundaries, and have more external ties to the rest of the network. This finding counters the prevalent assumption that business groups have clear boundaries and are structural homogeneous within a particular country. Also, it questions the assumption that business groups are large, dominant, and entrenched (Morck, Wolfenzon, and Yeung 2005). I find that 42 of the 389 cohesive groups are highly nested within layers of ties, and could be interpreted as entrenched in a network of ties. However, the large majority of business groups (347 of 389 business groups or 89.2%) are isolated or only moderately connected to the rest of the network. This finding counters current business group research, which sometimes conflates organizational form with characteristics of particular business groups such as size and network position. For instance, some studies use size as a definitional criteria, and identify only the largest firms in the economy (firms likely to be the most influential in the economy) as belonging to a business group (Chang and Hong 2000; Kim, Jung, and Kim 2005). Instead the network perspective allows investigation into the differential effects of the group organizational form at different positions in the network.

The practical contribution of the network structural perspective is that it offers policy makers, investors, and watch dog groups a method to identify group coordination among legally independent firms. Coordination among legally independent firms relies on the overall pattern of ties among firms, and hence is difficult to identify and regulate. This difficulty in identifying group coordination leads to "murkiness" and opacity in the financial system (Morck et al 2005); investors find it difficult to assess the extent to which the performance and growth prospects of legally independent firms are affected by the groups to which they are affiliated. Policy makers in different countries attempt to regulate the activities of these groups, but usually focus on particular prominent examples on an ad-hoc basis. The practical contribution of the network perspective proposed is that it offers a tool to identify group coordination, and is the first step towards effective regulation.

My study is based in India, and this choice of context might raise questions of generalizability. Studies of interorganizational clusters are explicit in their network orientation (Baum, Calabrese, and Silverman 2000; Baum, Rowley, and Shipilov 2004; Dhanaraj and Parkhe 2006; Nohria and Garcia-Pont 1991). In contrast, scholars have questioned the feasibility of using a network structural perspective in the context of conglomerate-like (Smangs 2006) business groups in developing countries (Khanna and

Rivkin 2006). Hence India is a stringent test for the network structural perspective, and was a reasonable choice to study the feasibility and practical value of the network structural perspective. However, a simple application of the approach developed in this paper to other contexts is inadvisable. For instance, I've used ownership ties to construct the interorganizational network in India. However, in the United States, alliances and joint-venture ties between firms indicate interorganizational coordination (Knoke 2009; Morck 2004), and should be used to construct the network. Similarly, German business groups tend to coordinate around banks and other institutional investors, and hence removing institutional shareholders, as I have done in the Indian interorganizational network, would be inadvisable. Similarly, the government plays a big role in the formation of Chinese business groups, and hence removing government organizations, as I have done, would not be reasonable in that context. Hence questions about the boundaries of the network and the type of ties used to construct the network should be informed by the norms and laws dictating how firms in particular contexts coordinate activities. In addition, the patterns observed should be checked against other indicators of coordination between firms.

A disadvantage of my study is the 1% shareholding cutoff that I have used. Using this 1% cutoff reduces the number of firms in my set from 3543 publicly traded firms for which shareholding data is available to 2,963 firms, which have at least one shareholder holding a 1% or higher stake. An even lower cutoff might have revealed business groups in which shareholders each individually own less than 1% shares, but the overall network of ties reveals a cohesive group structure. A 1% shareholding is the lowest cutoff that I have seen in previous studies. However, my research shows strong support for the claim that very small percentages of shareholdings can be leveraged to control the company based on the overall pattern of shareholdings (Morck et al. 2005). However, unlike in prior research where pyramid-like structures are used to achieve such leverage, I find that in India direct shareholdings create the same effect. Each individual shareholder holds a relatively small stake in the company but collectively the promoters, usually family members, hold a controlling stake in a group of companies. For future research, my suggestion is to be as inclusive as possible when determining the cutoff points for strength of tie (in this case percentage of shareholdings), and to rely on the pattern of ties to discern business groups.

Another disadvantage of my study is that it focuses on structure, and business groups and interorganizational clusters are a multi-dimensional phenomenon. Although there might be a structural basis for integrating the study of business groups and interorganizational clusters, these phenomena could be functionally different (example diversified versus industry-specific), and lead to different outcomes. Future research must clarify these differences. The objective in this paper is to develop a structural definition that can be used to reliably identify this phenomenon, and then explore differences across functions, time, and countries.

CHAPTER 4: THE CONSEQUENCES OF NESTEDNESS FOR FIRM PERFORMANCE

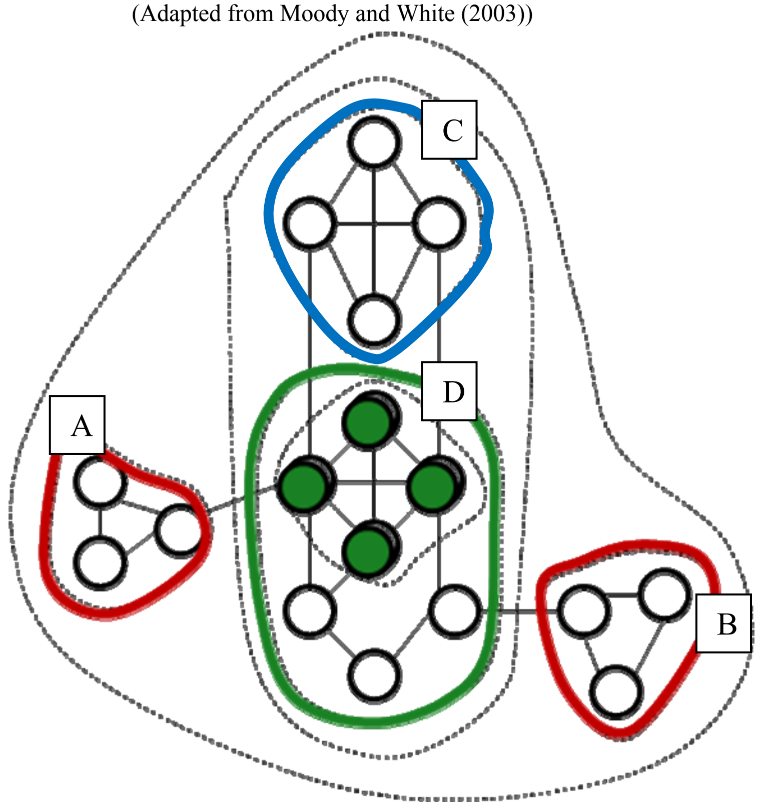
Classical theorists described the importance of the structure of ties in which actors reside, and the consequences for actors' behaviors and outcomes (Durkheim 1966; Simmel 1971). More recently, Granovetter used the term *structural embeddedness* to refer to the idea that economic actions and outcomes, like all social actions and outcomes, are affected by the overall structure of ties in which the actor resides (Granovetter 1992b:33). However, current interpretations of this concept have been fairly narrow, and focus on the structure of the actors' immediate network. For instance, Granovetter relied on Burt's brokerage theory, and described structural embeddedness as "the extent to which an actor's mutual contacts are connected to one another" (Granovetter 1992b:35). Other organizational scholars focus on degree centrality or the number of ties firms have to others in the network (Powell, Koput, and Smith-Doerr 1996). Indeed the large majority of interorganizational research is *egocentric*, and focuses on the firm and its immediate network of contacts. This egocentric research has proved very effective in predicting organizational behavior and outcomes. For instance, firms with greater number of ties, whose contacts have a greater number of ties, and whose contacts are unconnected to each other have higher performance (Bae and Gargiulo 2004; Baum, Calabrese, and Silverman 2000), pay lower premiums for acquisitions (Beckman and Haunschild 2002), and are more innovative (Ahuja 2000). However, by focusing exclusively on the firms' immediate network, this research misses the forest for the trees, and implicitly assumes that the overall network structure for all networks is equivalent. This assumption is problematic, and *sociocentric* research, which focuses on the structure of overall networks, finds that interorganizational networks differ, and can follow a small world structure (Watts and Strogatz 1998) or a core-periphery structure (Mintz and Schwartz 1985).

Sociocentric research is a small but promising area of network research. However the exclusive focus on overall structure has meant that sociocentric research misses the trees for the forest, and this inattention to the specifics of organizational activity has lead to broad ideal types (small worlds versus core-peripheries) that do not take into account the complexity of interorganizational networks. For instance, core-periphery structures consist of a few core actors connecting the peripheral actors to one another (Borgatti and Everett 1999), while small worlds consist of dense clusters of firms connected to each other with sparse ties (Watts 1999; Watts and Strogatz 1998). Core-periphery structures emphasize the importance of hierarchical differences between firms. Indeed, scholars who focus on power and centrality implicitly assume that the overall network structure of all networks is a core-periphery structure, and propose that core actors in the network are more influential (Benson 1975; Cook 1977). Small world theorists present a different conception of overall network structure, and propose the presence of multiple dense clusters within the network (Watts 1999). However, they ignore hierarchical differences in position, and do not consider positional differences between actors within the clusters, and positional differences between clusters. Research into particular phenomenon such as business groups suggests that firms differ in their positions within the group, and that groups differ in their position in the overall network. This paper broadens current interpretations of structural embeddedness (which focus on firms' immediate network of contacts) to include the structure of second-level contacts, third-level contacts, fourth-level contacts (and so on). This broader scope allows for hierarchical differences within and between groups, and hence offers a more fine-grained conceptualization of overall network structure. Also, the focus on structural embeddedness within the overall network is a return to the original conception of structural embeddedness. For instance, Granovetter (1992b: 33) describes structural embeddedness within the overall network of ties. Network sociologists have also suggested the need to return to original conceptions of actors' structural embeddedness within the overall network, and have proposed *nestedness* as an indicator of structural embeddedness within the overall network (Moody and White 2003; Paxton and Moody 2003). To my knowledge, nestedness is the only available concept that considers the **structure** of first-level contacts, second-level contacts, third-level contacts, and so on, ultimately taking into account the structure of the overall network. Nestedness is defined as a measure of integration with the rest of the network (Moody and White 2003), and indicates the position of the actor within a group, and the position of the group within the overall network.

NESTEDNESS: CONCEPT AND DEFINITION

Nestedness was proposed in the context of high school friendship networks. Intuitively, one can imagine high school students forming groups (Groups A, B, C, and D in Figure 4.1). While these groups have ties to others outside the group, the groups tend to have perceptible boundaries. In addition, the groups are not all equal; and some are fairly peripheral in the network compared to others (for example groups A and B easily split away from the rest of the network with the removal of a single tie). Finally, within the groups, students differ in their positions; some students form the core of the group, connect more peripheral students in the group to each other, and are involved in all the group's decisions and activities (for instance, students 1-4 in Group D). In this simple network, students 1-4, are highly nested, and occupy a core position within a group, and the group itself occupies a core position within the network. Paxton and Moody (2003) find that highly nested students report greater attachment to the school. This concept of nestedness has several parallels in the organizational context.

Figure 4.1: High School Friendship Network.
(Adapted from Moody and White (2003))



NESTEDNESS IN THE ORGANIZATIONAL CONTEXT

Research on business groups in developing countries (Khanna and Rivkin 2001; Khanna and Yafeh 2005) describes sets of legally independent firms which coordinate activities. Multiple trade, loan, ownership, and common personnel ties bind group firms, and help coordinate activities as a group. Research on interorganizational clusters in more advanced economies (Knoke 2001, 2009; Nohria and Garcia-Pont 1991) also describes sets of legally independent firms which display some level of group coordination. Both of these substantive areas of research, business groups and interorganizational clusters, describe hierarchical difference between firms in the group; some firms in the group are referred to as *flagship firms* or *hub firms* or *strategic centers*, and are described as enjoying special protection and access to the resources of the other group firms (Dhanaraj and Parkhe 2006; Lincoln, Gerlach, and Ahmadjian 1996; Rugman and D'Cruz 2000).

Business group research also notes the embeddedness of business groups within a larger network of ties (Khanna and Rivkin 2006). Some business groups are described as larger, and more entrenched in the economy (Morck, Wolfenzon and Yeung 2005). Therefore substantive research into business groups and interorganizational clusters suggests the presence of groups, differences in hierarchical position within the group, and differences in hierarchical position among groups; hence this research suggests the applicability of nestedness in the organizational context.

Further, research on business groups and interorganizational clusters suggests that highly nested firms (core firms within core groups) are likely to benefit from their position. For instance, Rugman and D'Cruz (2000) discuss flagship firms (core firms in the terminology used so far) within the interorganizational network, and note that:

"[Flagship firms] can make use of the resources owned by others [in the group]. While some of these external resources are tangible […], others are based on the skills and relationships of the people in the [group] firms."

Therefore, a highly nested firm enjoys the double of advantage of being in a core position within the group, and also belonging to a core group.

CONSEQUENCES OF NESTEDNESS

Classical theories of centrality (Boje and Whetten 1981), closed groups (Coleman 1990), and conflict between groups (Marx and Engels 1967) help clarify the consequences of nestedness, and the mechanisms by which nestedness affects organizational outcomes. The theory of conflict between groups, developed in the context of struggle between the social classes, suggests that groups that are more connected with the other actors in their environment are more successful at mobilizing resources, and legitimizing their perspectives and interests (Engels 1967; Marx and Engels 1848). This theory is especially useful since it focuses on the consequences of the group's position within a network, as separate and consequential above and beyond the position of individual members of the group.

The theory of centrality can also be extended to take into account a network with multiple groups. Indeed, conceptually nestedness differs from centrality only when the network consists of multiple groups; in a network with a core-periphery structure, nestedness is conceptually indistinguishable from betweenness centrality. Therefore, the mechanisms proposed by centrality theory can be applied to understand the consequences of nestedness. Theories of centrality suggest that central firms in the network enjoy more influence among other firms (Boje and Whetten 1981; Galaskiewicz 1979). Several mechanisms are used to explain this relationship. First, central firms are theorized to have more success in mobilizing resources. Second, theories focusing on the interorganizational context suggest that firms in the network perceive central firms as influential (irrespective of their actual resources), and hence are more likely to make decisions in their favor (Boje and Whetten 1981). Third, studies focusing on managers find that most actors in the network have an inaccurate perception of the structure of the network. However, central actors have an information advantage, and are likely to have a more accurate perception of the network structure and the position of actors in the network (Freeman and Romney 1987; Freeman, Romney, and Freeman 1987; Krackhardt 1990).

Finally, Durkheimian theories of mechanical solidarity, and more recent theories of closed groups (Coleman 1990) describe an integrated social structure. Actors within this social structure benefit from the lower transaction costs, trust, and monitoring inherent in this social structure. Highly nested firms, somewhat by definition, reside within multiple layers of ties. Closed group theory would suggest that such actors enjoy the higher trust and coordination implicit in such a social structure. However, structural hole theory (Burt 2004) counters the prediction in closed group theory. Structural hole theory predicts that actors whose contacts are not directly connected to one another (and hence occupy a structural hole) are less constrained, and can broker a new connection between the two unconnected actors. Extrapolating structural hole theory to nestedness suggests that highly nested firms, by definition nested within multiple layers of ties, have lower performance. However, the most recent research into the debate between closed groups and structural holes suggests that occupying a structural hole is more advantageous in a sparse network rather than an integrated network (Shipilov 2009). Therefore, in the contexts such as those described by business group research (contexts where nestedness is most applicable), closed group theory is more applicable. Therefore, theories of group conflict, closed groups, and centrality suggests that highly nested firms have higher performance compared to minimally nested firms.

Hypothesis. Nestedness has a positive relationship with firm performance, with highly nested firms having higher performance compared to minimally nested firms.

DESIGN AND DATA

This paper defines firms' structural embeddedness within the overall network, and hence this research requires a complete population design (information about all ties between the population of actors is required). The use of complete population data constrains the number of countries and the number of different types of ties that can be analyzed and interpreted in a meaningful way. A single-country design is consistent with most prior network research (Davis, Yoo, and Baker 2003; Kogut and Walker 2001; Mintz and Schwartz 1985). India is an appropriate context to test the consequences of nestedness since prior research describes a complex social structure with multiple business groups, and positional differences between business groups, and between firms in the business groups. Hence this context promises sufficient variation in firms' nestedness to test the effect of nestedness on firm performance. However, the single country design limits generalizability, and bounds the results of this research to networks where there is sufficient variation in firms' nestedness. Put another way, the results are bounded to contexts such as those described by business group research and research on interorganizational clusters, where at least some portion of the network consists of an integrated social structure with multiple groups embedded within a network of ties.

The selection of India rather than Japan, Korea, Taiwan, or any other country characterized by business groups was driven by practical data considerations. India is one of the few countries in the world where data about shareholding ties, loan ties, trade ties, and interlocking directorates is available in accessible form, along with stock market and accounting data. In addition, I have worked and studied in India, and have some contextual understanding of Indian organizations and business groups. Hence India presented an acceptable and practically feasible setting for testing my hypothesis.

Another design choice is the type of tie used to construct the network. The theory relies on firms' embeddedness within a social structure. Hence the network of ties between firms should reflect a meaningful level of control and coordination between firms. Constructing a network of multiple types of ties (example, loan ties, and trade ties, and ownership ties) is one method of ensuring that the network reflects meaningful coordination between firms. However it is difficult to construct and analyze a multiplex network in the context of a complete population economy-wide network. Therefore, I propose to construct the network using a single tie, but choose a tie which reasonably approximates control and coordination between firms. Scholars have used several different types of ties to represent control and coordination between firms. Davis et al (2003) and Mintz and Schwartz (1985) rely on interlocking directorates to construct the network. Kogut and Walker (2001) use shareholding ties to construct the network. Scholars have criticized the use of interlocking directorates because it is difficult to interpret what, if anything, interlocking directorates indicate (Mizruchi 1996). Interlocking directorates might indicate coordination and control between firms. Instead, it might simply indicate the propensity of board members to recruit board members with whom they have worked before on other boards. Ownership ties are more easily interpretable; a significant ownership tie can be reasonably interpreted to indicate some form of control. In addition, research across the world shows the importance of ownership ties in establishing coordination among firms (Khanna and Rivkin 2006; La Porta, Lopez-de-Silanes, and Shleifer 1999). Also, research based in countries like India, which are characterized by business groups, finds that ownership ties are predictive of other types of ties (Khanna and Rivkin 2006; Lincoln, Gerlach, and Takahashi 1992). Finally, conversations with Indian managers and auditors confirmed the importance of ownership ties in establishing and reflecting control and coordination between firms in the Indian economy. Therefore, I use ownership ties to construct the Indian interorganizational network. The Prowess CMIE (Centre for Monitoring Indian Economy) dataset is a standard source of data for research on Indian firms (Khanna and Palepu 2000; Mahmood and Lee 2004). Prowess CMIE includes annual report data, shareholding data, and data about stock market performance. Prowess CMIE sources shareholding data and stock market information from India's two major stock exchanges, the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE).

I construct the ownership network for 2001 because it is the first year for which the Prowess CMIE dataset includes shareholding data. For 2001, Prowess has annual report data for 3,543 publicly traded firms (traded on the Bombay Stock Exchange or the National Stock Exchange), and has shareholding data for 2,963 firms for that year. Table 4.1 shows the differences between firms for which shareholding data are available and firms for which shareholding data are not available. The latter firms tend to be smaller and younger, and hence my dataset, like most other organizational research, is skewed towards larger firms.

Table 4.1: Analysis of Missing Data.

	Shareholder Information Available	Shareholder Information Not Available
Number of Firms	2963	1102
Mean Total Assets	689.54	367.37
Mean Age	28.54	24.73

I include only those categories of shareholders which represent a control and coordination relationship. Therefore, I include shareholders classified as “private corporate bodies” (defined as public or private firms that are not government controlled). I also include shareholders classified as “persons acting in concert” (defined as sets of shareholders, frequently family owners, who operate as a block), and “Indian promoters” (owner-managers). These individuals have to be included since ties between firms are frequently established through common controlling owners who own shares in multiple firms. The firms might not have direct ties with each other, and the relationship between these firms can be captured only by including common owners.

I exclude shareholders categorized as "pure investors" since they refer to investors who do not have any operational control over the firm. I also exclude shareholders classified as "Foreign", or "nonresident Indian." Certain foreign shareholders have managerial and strategic influence on particular firms (Douma, Pallathitta, and Kabir 2006). Therefore, in the regression model, I include controls for all insider-shareholders (including foreign shareholders classified as *insiders*). However, I exclude foreign shareholders in the interests of bounding the network. Also, foreign firms are described as forming ties with Indian firms explicitly for the purpose of gaining entry into the Indian economy; the Indian firm provides the contextual and relational capital. Hence foreign firms are likely to be fairly peripheral in the Indian interorganizational network, and excluding them for the purposes of bounding the network is unlikely to affect the basic structure of the network.

I also exclude shareholders classified as "institutional investors." These investors, usually government bodies, have shareholding interests in a wide variety of firms across the economy, and are not actively involved in the management of the firm. Even though institutional investors sometimes have directors on the boards of firms in which they hold investments, conversations with Indian managers revealed that these government appointed directors typically are expected to play a passive role. Including these shareholders in the network threatens to exaggerate the level of integration in the network, and hence I exclude these shareholders for the purposes of constructing the network. However, some institutional shareholders have directors representing their interests on the board of the firm, and these directors might affect firm performance. Therefore, I include controls for director-shareholdings.

Another design choice is the minimum percentage of shareholding that should be used to establish a tie. Shareholdings distributed among otherwise disconnected shareholders (Berle and Means 1932) have different consequences for control compared to shareholdings among connected shareholders, even if the percentages of shareholdings is the same. Given the overall pattern of shareholdings, even a 1% stake can be used to control a company (Morck, Wolfenzon, and Yeung 2005), although theoretically a 51% stake is required to control a company. Hence, the overall pattern of shareholding ties is more indicative of coordination and control rather than particular percentages of shareholding. In addition, my research is based on the structure of ties rather than the strength of ties, and therefore, I use the least stringent 1% shareholding (and above) as the cut-off point. Based on the above design choices my data consists of 24,647 firm-shareholder pairings.

I cleaned these data by manually going through this list. This process was essential since shareholders appeared in slightly different ways across different observations – e.g., "Af-tek rolling mills enterprises ltd" also appears as "Aftek rolling mills entr. ltd." Not correcting these data entry errors would mean that these firms would be treated as two separate entities. Even more problematic was the presence of different shareholders with the same name. For instance, Ramesh Goyal is a common Indian name and appears on my list six times. I used several techniques to check whether these names referred to the same person. First, I checked the six firms in which Ramesh Goyal appears to see if these six firms had other shareholders in common. This method increases the likelihood that it is the same person since Indian business groups tend to have a set of people, usually family members, who own shares in all the group firms. As an additional check, I looked at related party disclosure information for the six firms to check whether the firms in question had listed one another as a "related party" in their annual reports. Related parties refer to firms with which the focal firm has some form of control or coordination relationship. I followed these heuristics for all relevant firm-shareholder observations. This process was important because otherwise these individuals would be treated as the same individual, hence overstating the level of integration in the interorganizational network. However, ultimately this problem proved fairly minor since there were only 100 instances (out of the 24,647 firm-shareholder pairs) where the above changes were required. I also constructed an interorganizational network where I did not make the above changes. This network had many obvious instances of nonsense data ("MRF ltd" and "M R F ltd", appearing proximate to each other in the network). Therefore, I report the results of the cleaned network.

After cleaning the data, I converted the firm-shareholder pairs into a 12,794*12,794 square matrix, representing the 12,794 actors in this network (2781 publicly traded firms, 5727 individuals, and 4286 privately held firms). The columns (and rows) in this matrix are less than the number of firm-shareholder pairs (24,647) because firms (and shareholders) can have multiple ties, and hence appear multiple times in the list of firm-shareholder pairs. Each cell in this matrix represents either a firm or a shareholder (shareholders can be individuals or private or public firms). A tie in this matrix refers to an ownership relationship, either between two firms or between a firm and an individual. Individuals obviously cannot have shareholding ties with each other. I could have converted the network into a pure interorganizational network by removing individual owners who own shares in multiple firms, and replacing these with direct ties between firms. However, this conversion would not change the overall network structure, and hence I report the results of the original network since it retains the original information about how ties between firms are established (via common owners or directly through corporate shareholdings).

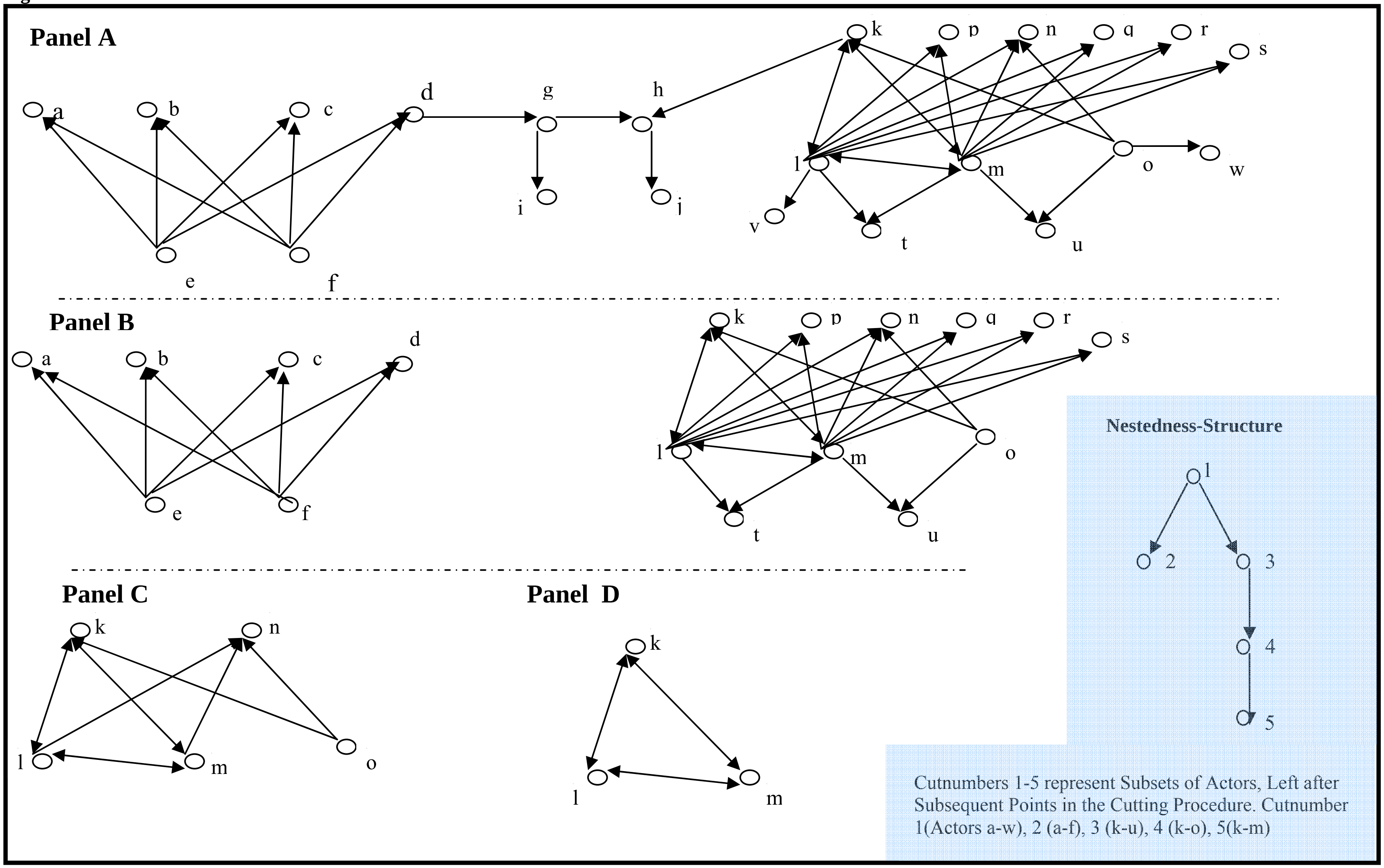
Consistent with prior network research, I analyzed the resulting network by first removing all isolates and small components. A component is a set of actors that have ties to one another but to no other actor in the network. 77% of these small components contain only one publicly traded firm. The largest of these small components contains 11 publicly traded firms. After removing small components and isolates, I am left with a large component composed of 1050 publicly traded firms. Therefore, out of the 2963 publicly traded firms for which data are available, 1050 reside within the large component (the rest are isolates or small components). Below I describe the process by which nestedness and the other variables are measured.

Nestedness

Moody and White's analytical technique starts with the graph, and proceeds by progressively cutting ties that, if removed, split the graph into subgraphs. It progressively continues this procedure until it reaches subgraphs that disintegrate into disconnected nodes if further cutting is performed. Nestedness is the deepest cutset level within which the actor resides. A cutset of a graph is a collection of specific nodes that, if removed, would break the graph into subgraphs.

Figure 4.2 illustrates this procedure. The procedure starts with the entire network, and attempts to pry away actors that are most loosely integrated with the rest of the network. Figure 4.2, Panel A represents a small network with 23 actors (*a*-*w*). This network is 1-connected (also called a component), and has at least one path connecting any two actors in the network. Actors *g, h, i, j, w,* and *v* split away most easily since they require the removal of just one tie to split them from the rest of the network. Removing these actors results in two 2-connected sub-graphs shown in Panel B (*a*-*f* and *k*-*u*). Since these are two-connected sub-graphs, splitting them any further requires removing actors who are connected to the rest of the network with two ties. Such cutting disaggregates sub-graph *a-f* into separate nodes. In contrast, similar cutting performed on sub-graph *k-u* reveals more nested sub-graphs – actors' *p, q, r, s, t,* and *u* split away leaving a 2-connected sub-graph, *k-o* (Panel C). Further cutting reveals a more nested sub-graph, *k-m* (Panel D), which in turn disaggregates into separate notes if further cutting is performed. In this network, actors, *g, h, i, j, w, and v,* are most easily pried away from the rest of the network (and hence are identified as *minimally nested*), while actors *k-m* are hardest to pry away (and hence are identified as *highly nested*). The inset *nestedness structure* in Figure 4.2 displays the skeletal structure of this simple network, and shows that this network has 5 levels of nesting, and the most highly nested actors in this simple network (k-m) have a nestedness score of 5.

Figure 4.2: Nestedness in a Small Network.



I applied this network analytical technique to the large component in the Indian interorganizational network, and Figure 4.3 shows the nestedness structure of this large component. This network splits into multiple groups, each of which is a bicomponent (defined as a set of actors with at least two paths between any two actors in the bicomponent). The bicomponent on the extreme right is the most complex. It bifurcates repeatedly into sub-graphs which in turn bifurcate again. This complex bicomponent displays 25 levels of nesting, and hence the most highly nested actors have a nestedness score of 25. Table 4.2 shows the distribution of nestedness scores. The number of firms reduces at the higher end of the nestedness scale, and at the highest level of nestedness (25) there are only 4 firms. This distribution is to be expected since, highly nested firms, somewhat by definition, are fewer in number compared to minimally nested firms. Nestedness is an interval measure, and for the purpose of regression analysis, I treat this interval variable as both a continuous and a categorical measure. The categorical measure of nestedness *(nestedness_dummy)* is constructed using a cutoff point of nestedness 5 and above. I choose nestedness 5 as the cutoff since the majority of firms in the large complex bicomponent (on the extreme right in Figure 4.3) have nestedness of 5 and above.

Figure 4.3. Skeletal Structure of the Largest Component (1050 Publicly Traded Firms).

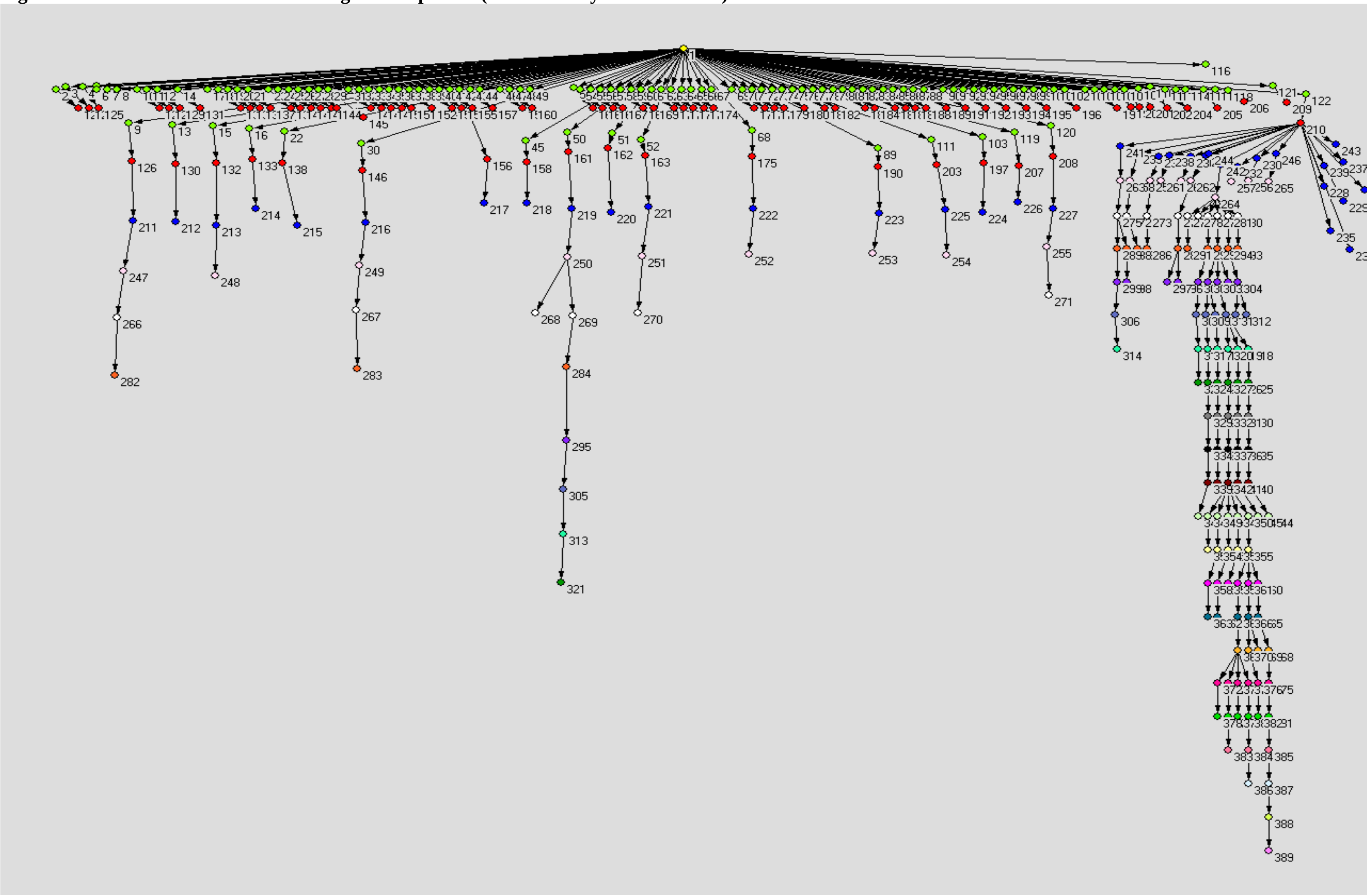


TABLE 4.2: Distribution of Firms across Nestedness Values.

Nestedness	Frequency (Number of Publicly Traded Firms)
1	358
2	186
3	199
4	91
5	27
6	36
7	17
8	20
9	8
10	13
11	4
12	9
13	4
14	13
15	7
16	4
17	10
18	9
19	5
20	7
21	7
22	4
23	5
24	3
25	4
Total	**1,050**

Firm Performance

I measure individual firm performance using return on assets and Tobin's *q*. Return on assets (ROA) is a standard accounting measure of performance used widely in the organizational literature. ROA is measured as *(Net Income/Total Assets)*, and refers to the income earned for each dollar (or Rupee) of assets. Tobin's *q* incorporates stock and accounting measures of performance, and incorporates both actual performance, and expectations of future performance (Lang and Stulz 1994). Tobin's *q* is measured as a ratio of market to book value of assets: *(market value of equity + market value of debt)/(book value of equity + book value of debt).* Tobin'*q* indicates the market value of the firm in relation to the book value of the firm. However, measures of the market value of debt are difficult to calculate, and prior research in the Indian context relies instead on the book value of debt (Khanna and Palepu 2000). Hence Tobin's *q* is calculated as *(market value of equity + book value of debt)/(book value of equity + book value of debt).* Tobin's *q* is interpreted as the market's valuation of a firm's current and future earnings in relation to its book value.

Control variables

I control for several categories of variables suggested by current theory: firm level characteristics, industry level characteristics, group level characteristics, and other network characteristics. *Age* is the number of years since the firm's founding year, and captures cohort effects that might affect performance. I also control for *firm size* using the log of total assets for the year 2001. A firm's knowledge and managerial resources is expected to improve performance. I control for *Knowledge Assets: Research and Development expenditure+ advertising expenditure+ marketing expenditure*. A firm's industry type is likely to affect its performance. In India, scholars have noted the differences between the new software and technology services industries, and the older manufacturing, chemical, consumer and industrial goods industries (Khanna and Palepu 2005). Hence I control for industry type using a dummy variable, *industry_dummy*, which is coded 1 if the firm primarily operates in the software and technology services sector. *Market share* is the ratio of a firm's sales by the total sales in the industry, and provides a measure of the firm's market dominance. Insider shareholding creates opportunities for controlling shareholders to suck value from minority investors (Bertrand, Mehta, and Mullainathan 2000). Hence I control for the extent of insider shareholding. *Insider shareholding* is the sum of shares held by shareholders classified as "directors", "promoters" (Foreign or Indian), and "Persons acting in concert." This measure is meant to capture the shareholdings of entities or individuals involved in the management of the company.

I also use a dummy variable to indicate whether a firm belongs to a business group. The use of a dummy variable to identify business group activity is consistent with prior research (Khanna and Palepu 2000; Mahmood and Lee 2004). Prior research identifies business groups using the Prowess CMIE classification of firms into business groups. Prowess classifies business groups using a variety of different measures of group activity, including "qualitative judgments" (Prowess CMIE manual). Other research identifies business groups using network measures of group activity. Therefore, I construct an additional business group dummy variable, which identifies business groups using a network analytical technique. I define a group as one which has multiple independent paths between members of the group (Moody and White 2003), and which cannot be further split into separate subgroups (Markovsky and Lawler 1994).

I also control for *degree centrality* (Brass 1985) and *structural constraint* (Burt 2005) since research shows the importance of these characteristics in predicting outcomes for actors in the network. Degree centrality refers to the number of lines incident with the focal actor (Nooy, Mrvar, and Batagelj 2005:63) or the number of other vertices the focal actor is connected to. Structural constraint indicates the extent to which an actor's contacts are connected to one another (Burt 1997). *Structural constraint* is defined as the sum of the dyadic constraints on the actor, created by each of the actor's ties, and the dyadic constraint on vertex *u* exercised by a tie *v* is the extent to which *u* has more and stronger ties with neighbors who are strongly connected with vertex *v* (Nooy, Mrvar, and Batagelj 2005:147). Structural constraint relies only on the actor's immediate network (i.e., egocentric network). *Betweenness centrality* is considered a more accurate measure of structural constraint in sociocentric networks where complete population information is available. Therefore, I also run the regression model with betweenness centrality as the measure for structural constraint. Betweenness centrality for an actor depends on the extent to which it is located on the geodesics (shortest paths) connecting all pairs of actors in the network.

Finally, *Eigenvector centrality* appears to take into account the structure of first-level contacts, second-level contacts (and so on). Eigenvector centrality was first suggested in the context of AIDS transmission, and is based on the intuition that it wasn't just how many people an actor knew that counted, but also the number of people the actor's contacts knew (i.e. not just the number of first-level contacts but also the number of second-level contacts, third-level contacts (and so on)) (Bonacich 1972). Eigenvector centrality is a refined form of degree centrality, and considers the number of contacts beyond first-level contacts. However, it does not consider the **structure** of first-level contacts, second-level contacts (and so on). This distinction becomes extremely important in complex networks such as the Indian interorganizational network, which has multiple cores. Eigenvector centrality, like the other centrality measures, assumes a core-periphery overall network structure (i.e., assumes a single core and periphery). In the Indian interorganizational network, which has 249 bicomponents, the first eigenvector factor explains only 0.8% of the total variation in distances in the network (basically, the eigenvector scores are produced for just one of the 249 bicomponents). The rule used to interpret Eigenvector centrality is that the percentage of the overall variation in distances accounted by the first factor should be over 70%. Values below 70% imply that the dominant pattern describes less than 70% of the data. Therefore, I do not use eigenvector centrality scores since this measure is not interpretable in this network. The infeasibility of eigenvector centrality in this network also demonstrates the importance of considering the structure of first-level contacts, second-level contacts (and so on), and not simply using counts of the contacts.

RESULTS

Descriptive Statistics

Table 4.3 reports descriptive statistics for all the variables. Average return on assets is negative. This might reflect attempts to underreport accounting performance for tax purposes, but is more likely due to the presence of a few outliers with extremely low ROA. Logarithmic transformations help normalize distributions with extreme values but are inappropriate for ROA, which has zero and negative values. I use a logarithmic transformation for Tobin's *q*. I correct for the presence of extreme outliers by excluding the handful of firms with unacceptably large residuals and leverage.

TABLE 4.3: Descriptive Statistics for Independent and Dependent Variables.

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
ROA	910	-0.04	0.59	-15.80	3.77
Log of Tobin's *q*	828	0.13	0.75	-2.37	5.09
Nestedness	1050	3.97	4.76	1.00	25.00
Business Group Dummy (Using Network)	1050	0.49	0.50	0.00	1.00
Business Group Dummy (Using Prowess)	1050	0.54	0.50	0.00	1.00
Degree	1050	4.45	4.11	1.00	29.00
Betweenness Centrality	1050	0.01	0.01	0.00	0.17
Structural Constraint	1050	0.59	0.31	0.05	1.24
Age	1049	29.69	20.06	5.00	144.00
Log of Total Assets	926	4.31	1.96	-1.90	12.66
Knowledge Assets	691	9.91	42.20	0.01	835.74
Industry Dummy	1050	0.11	0.31	0.00	1.00
Market Share	821	0.24	0.33	0.00	1.00
Insider Holding	994	45.79	19.81	1.13	99.00

Table 4.4 provides the listwise correlations for all the variables. The majority of correlations between the variables are low in magnitude. The only exception is the correlation between degree and structural constraint (-0.73). This counter-intuitive relationship only makes sense when the overall network of ties is considered. Actors with high degree are likely to be highly nested, and hence they connect minimally nested firms even while residing in an integrated social structure. The high magnitude of the correlation between degree and structural constraint might cause issues of multicollinearity. I check for multicollinearity, and find that the VIF (variance inflation factor) is within the acceptable range. Also, coefficients remain stable when adding or

removing independent variables from nested equations. Therefore, I do not find evidence for unacceptably high multicollinearity.

Table 4.5 reports the average values for minimally nested and highly nested firms on a variety of indicators. Highly nested firms are, on average, older, larger, spend more on knowledge assets, and have higher market share. The percentage of highly nested firms which belong to the newer software and technology service industries is slightly lower (9.72%) compared to the percentages of firms in these industries among minimally nested firms (10.79%). Table 4.5 also shows that the average ROA and Tobin's *q* is higher for highly nested firms compared to minimally nested firms. These summary statistics on ROA and Tobin's *q* support the claim that highly nested firms have higher performance compared to minimally nested firms.

TABLE 4.4: Correlations for Variables in the Study (N=633)

	ROA	Log of Tobin's *q*	Nestedness	Business Group Dummy Using Network	Business Group Dummy Using Prowess	Degree	Betweenness Centrality	Structural Constraint	Age	Log of Total Assets	Knowledge Assets	Industry Dummy	Market Share
ROA	1.000												
Log of Tobin's *q*	0.366	1.000											
Nestedness	0.049	0.073	1.000										
Business Group Dummy (Using Network)	-0.004	0.005	0.475	1.000									
Business Group Dummy (Using Prowess)	-0.023	0.175	0.285	0.357	1.000								
Degree	0.039	0.019	0.509	0.633	0.268	1.000							
Betweenness Centrality	-0.013	0.002	0.313	0.113	0.111	0.402	1.000						
Structural Constraint	-0.024	0.013	-0.494	-0.599	-0.271	-0.740	-0.352	1.000					
Age	-0.016	0.165	0.218	0.102	0.289	0.119	0.111	-0.077	1.000				
Log of Total Assets	0.120	0.347	0.267	0.160	0.506	0.223	0.160	-0.161	0.365	1.000			
Knowledge Assets	0.123	0.355	0.088	0.100	0.136	0.121	0.101	-0.078	0.199	0.360	1.000		
Industry Dummy	0.143	0.200	-0.032	-0.114	-0.131	-0.107	-0.058	0.063	-0.122	-0.093	-0.013	1.000	
Market Share	0.068	0.071	0.065	-0.001	0.102	0.006	0.002	0.025	0.058	0.150	0.134	-0.194	1.000
Insider Holding	0.057	0.140	-0.073	0.010	0.004	-0.030	-0.065	0.062	-0.006	-0.066	-0.071	-0.045	-0.031

TABLE 4.5: Descriptive Statistics for Firms by Nestedness (High and Low).
Five is the cutoff used to distinguish high and low nestedness since the large majority of firms occupying the small bicomponents have a nestedness of 4 and below (49 of 721 firms in the small bicomponents). The large bicomponent has 229 of 421 firms with a nestedness of 4 and below. I also use cutoffs 3 and 6 and find similar results.

	Low Nestedness (1-4)	**High Nestedness (5-25)**
Return on Assets (Average)	-0.0375	0.0011
Tobin's *q* (Average)	0.11	0.28
Age (Average, in years)	28.29	34.14
Total Assets (Average, in Crores of Rupees)	385.33	2997.80
Knowledge Assets (Average, in Crores of Rupees)	6.97	14.27
Market Share (Average, in Crores of Rupees)	0.23	0.29
Industry Type (% of firms in *new* industries - software and technology)	10.79	9.72
Insider Holding (Average of stake held by shareholders involved in the management of the firm)	46.46	46.25

Multiple Regression Analysis

The data show some evidence of heteroskedasticity and extreme values. I correct for the latter by excluding nine observations with high Cook’s D. In addition I use Huber-White Robust estimation to correct for heteroskedasticity. Another potential issue is endogeneity. For instance, the relationship proposed between nestedness and performance could be due to the effect of past performance on nestedness. I check for the possibility of endogeneity by using the instrumental variables age and structural constraint. I choose these instrumental variables using the criteria that they should be correlated with nestedness but not significantly predictive of firm performance. The Stock-Yogo critical values and tests for the exogeneity of the instruments indicate that these instruments are acceptable. Using these instrumental variables I do not find evidence for endogeneity (Hausman test Chi-Square p-value = 0.8048), and hence below I report the results for the regression model with robust estimators.

Table 4.6 presents results of the regression analysis investigating the relationship between nestedness and ROA. Model A1 introduces the control variables. Log of total assets, knowledge assets, market share, insider holding, and industry dummy, are all positively related to ROA. These results conform to theoretical predictions. Membership in a business group is negatively related to ROA, which is consistent with prior research on Indian business groups (Douma, Pallathitta, and Kabir 2006). Betweenness centrality has a significant negative effect on ROA. Recent research finds evidence that firms that act as brokers have lower performance in contexts where the social structure is integrated (Shipilov 2009). The negative effect of betweenness centrality on firm performance is consistent with this result.

Table 4.6, Model A2, introduces the independent variable of theoretical interest, nestedness. Nestedness is positive and significant at the 1% level. Models B1 and B2 use alternative measures to identify business group membership. Models C1 and C2 use structural constraint rather than betweenness centrality. As predicted, betweenness centrality is a better predictor compared to structural constraint. The reason is that in networks where information about the population of ties is available, betweenness centrality takes into account the overall network of ties, and is a superior measure of brokerage compared to structural constraint. Models D1 and D2 use a categorical measure of nestedness. The positive significant effect of nestedness on ROA remains stable across different models.

TABLE 4.6: OLS Regression Predicting Return on Assets.

	Model A1	Model A2	Model B1	Model B2	Model C1	Model C2	Model D1	Model D2
Nestedness		0.0018 *** (0.0005)		0.0015 *** (0.0005)		0.0013 ** (0.0005)		
Nestedness Dummy								0.0185 ** (0.0076)
Business Group Dummy (Using Prowess)			-0.0160 ** (0.0076)	-0.0177 ** (0.0077)				
Business Group Dummy (Using Network)	-0.0153 ** (0.0074)	-0.0204 *** (0.0078)			-0.0161 ** (0.0074)	-0.0190 ** (0.0076)	-0.0153 ** (0.0074)	-0.0185 ** (0.0075)
Degree	0.0021 ** (0.0008)	0.0015 * (0.0008)	0.0010 (0.0007)	0.0002 (0.0008)	0.0000 (0.0010)	-0.0003 (0.0010)	0.0021 ** (0.0008)	0.0015 * (0.0008)
Structural Constraint					-0.0262 * (0.0156)	-0.0217 (0.0160)		
Betweenness Centrality	-0.3739 ** (0.1615)	-0.4692 *** (0.1652)	-0.2990 * (0.0164)	-0.3547 ** (0.1703)			-0.3739 ** (0.1615)	-0.4499 *** (0.1630)
Age	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)
Log of Total Assets	0.0049 ** (0.0021)	0.0043 ** (0.0021)	0.0070 *** (0.0023)	0.0067 *** (0.0023)	0.0045 (0.0021)	0.0041 * (0.0021)	0.0049 ** (0.0021)	0.0044 ** (0.0021)
Knowledge Assets	0.0002 *** (0.0000)	0.0003 *** (0.0000)	0.0002 *** (0.0000)	0.0003 *** (0.0000)	0.0003 ** (0.0000)	0.0003 *** (0.0000)	0.0002 *** (0.0000)	0.0003 *** (0.0000)
Market Share	0.0244 *** (0.0090)	0.0226 ** (0.0089)	0.0240 *** (0.0089)	0.0233 *** (0.0089)	0.0256 *** (0.0090)	0.0241 *** (0.0090)	0.0244 *** (0.0090)	0.0223 ** (0.0090)
Insider Holding	0.0007 *** (0.0007)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0008 *** (0.0001)	0.0007 *** (0.0001)	0.0007 *** (0.0001)
Industry Dummy	0.0670 *** (0.0101)	0.0647 *** (0.0102)	0.0660 *** (0.0100)	0.0648 *** (0.0101)	0.0668 *** (0.0100)	0.0653 *** (0.0102)	0.0670 *** (0.0101)	0.0653 *** (0.0102)
Constant	-0.0666 *** (0.0148)	-0.0643 *** (0.0149)	-0.0713 *** (0.0150)	-0.0701 *** (0.0150)	-0.0444 *** (0.0202)	-0.0465 ** (0.0204)	-0.0666 *** (0.0148)	-0.0624 *** (0.0149)
N	676	676	676	676	676	676	676	676
F-Statistic	10.50 ***	10.12 ***	10.30 ***	9.76 ***	10.43 ***	10.07 ***	10.50 ***	9.98 ***
R-Squared	0.1088	0.1159	0.1101	0.1154	0.1094	0.1137	0.1088	0.1143

*0.1 level of significance; *0.05 level of significance; ***0.01 level of significance
Unstandardized Coefficients Reported; Two-tailed tests for all variables; Huber-White Robust Standard Errors are in Parenthesis

TABLE 4.7: OLS Regression Predicting Tobin's *q*

	Model A1	Model A2	Model B1	Model B2	Model C1	Model C2	Model D1	Model D2
Nestedness		0.0114 ** (0.0052)		0.0098 ** (0.0051)		0.0102 ** (0.0051)		
Nestedness Dummy								0.1219 ** (0.0640)
Business Group Dummy (Using Prowess)			0.0654 (0.0563)	0.0555 (0.0560)				
Business Group Dummy (Using Network)	-0.0145 (0.0559)	-0.0443 (0.0560)			-0.0134 (0.0576)	-0.0337 (0.0572)	-0.0145 (0.0559)	-0.0622 (0.0557)
Degree	-0.0142 * (0.0078)	-0.0188 ** (0.0083)	-0.0172 *** (0.0066)	-0.0236 *** (0.0074)	-0.0195 ** (0.0096)	-0.0231 (0.0101)	-0.0142 * (0.0078)	-0.0138 (0.0087)
Structural Constraint					-0.0561 (0.1213)	-0.0281 (0.1213)		
Betweenness Centrality	-1.2318 (1.064)	-1.9026 * (1.148)	-1.0997 (1.0471)	-1.5490 (1.1123)			-1.2318 (1.0644)	-1.9262 * (1.1185)
Age	0.0014 (0.0011)	0.0011 (0.0011)	0.0012 (0.0011)	0.0010 (0.0011)	0.0014 (0.0011)	0.0011 (0.0011)	0.0014 (0.0011)	0.0013 (0.0011)
Log of Total Assets	0.1283 *** (0.0192)	0.1245 *** (0.0195)	0.1187 *** (0.0212)	0.1166 *** (0.0214)	0.1272 *** (0.0191)	0.1235 (0.0195)	0.1283 *** (0.0192)	0.1195 *** (0.0191)
Knowledge Assets	0.0033 *** (0.0009)	0.0034 *** (0.0009)	0.0034 *** (0.0009)	0.0035 *** (0.0009)	0.0034 *** (0.0009)	0.0035 (0.0009)	0.0033 *** (0.0009)	0.0043 *** (0.0015)
Market Share	0.0612 (0.0630)	0.0504 (0.0627)	0.0617 (0.0631)	0.0532 (0.0628)	0.0633 (0.0628)	0.0537 (0.0626)	0.0612 (0.0630)	0.0503 (0.0633)
Insider Holding	0.0063 *** (0.0013)	0.0064 *** (0.0013)	0.0062 *** (0.0013)	0.0063 *** (0.0013)	0.0064 *** (0.0013)	0.0065 (0.0013)	0.0063 *** (0.0013)	0.0065 *** (0.0013)
Industry Dummy	0.4841 *** (0.1030)	0.4694 *** (0.1046)	0.4896 *** (0.1029)	0.4774 *** (0.1042)	0.4827 *** (0.1041)	0.4706 (0.1053)	0.4841 *** (0.1030)	0.4708 *** (0.1040)
Constant	-0.7745 *** (0.1015)	-0.7585 *** (0.1021)	-0.7587 *** (0.1018)	-0.7476 *** (0.1020)	-0.7248 *** (0.1555)	-0.7335 (0.1556)	-0.7745 *** (0.1015)	-0.7376 *** (0.1030)
N	658	658	658	658	658	658	658	657
F-Statistic	16.77 ***	15.41 ***	16.95 ***	15.44 ***	17.43 ***	15.89 ***	16.77 ***	13.75 ***
R-Squared	0.2024	0.2071	0.2044	0.2077	0.2021	0.2060	0.2024	0.2069

*0.1 level of significance; *0.05 level of significance; ***0.01 level of significance
Unstandardized Coefficients Reported; Two-tailed tests for all variables; Huber-White Robust Standard Errors are in Parenthesis; Dependent Variables is logged.

Table 4.7 tests the effect of nestedness on Tobin's *q*. Table 4.7, Model A1 regresses the control variables against the log of Tobin's *q*. Log of total assets, knowledge assets, insider holding, and industry dummy, are all positively related to Tobin's *q*. Market share is also positive but the effect is not significant at the 5% or 10% level. Comparing these results to Table 4.6 Model A1, (dependent variable ROA), the relationships between the control variables and Tobin's *q* is largely similar. Betweenness centrality has a negative, but insignificant effect on Tobin's *q*. However, degree is a negative and significant predictor of Tobin's *q*. Table 4.7, Model A2, introduces nestedness, and nestedness is positively and significantly related to Tobin's *q*. This effect remains stable when I introduce alternative measures to identify business groups, alternative measures of structural constraint, and a categorical instead of continuous measure of nestedness (Table 4.7 Models B1 to D2).

The addition of the nestedness variable increases the amount of variation explained from 10.8% to 11.59% (for ROA; Models A1 and A2 in Table 6), and 20.24% to 20.77% (for Tobin's *q;* Models A1 and A2 in Table 7). The 0.5% increase in explanatory power has to be considered in the context of the 10.8% variation explained by the base model. The low R-square is consistent with prior research in India which finds R-squares of 8% to 15% in models predicting ROA. In this context, where current theories explain only about 10% of variation in ROA, a 0.5% increase in R-square is noteworthy.

DISCUSSION

The positive effect of nestedness on firm performance is applicable in contexts where groups of firms are a substantial feature of interorganizational networks, and there is variation in the position of groups in relation to one another. Most recent research on interorganizational networks finds that these networks have a small world structure, and are composed of multiple groups. Business group research also describes groups of firms embedded within multiple layers of ties, and cross-country research on business groups finds the presence of these groups in most countries in the world, including most Western countries (La Porta, Lopez-de-Silanes, and Shleifer 1999). Therefore, current research suggests that most interorganizational networks are likely to be complex networks, future research must confirm the structure of interorganizational networks across countries (and/or industries), and test the extent to which nestedness predicts organizational behavior and outcomes across countries (and/or industries).

In contexts where the network consists of a simple core-periphery structure, nestedness will be very closely aligned with measures of centrality. Therefore, the contribution of my research can be seen as extending the theory of centrality to multi-cored networks. The theory of centrality, in its current form, assumes a core-periphery structure, and hence current operationalizations of centrality are astructural (that is, even when they account for the overall network of ties, they use some variation of the count of ties, and do not consider the structure of first-level contacts, second-level contacts and so on). Hence these centrality measures are either uninterpretable (as in the case of eigenvector centrality) or take on a very different meaning (as in the case of betweenness centrality) in a significantly multi-cored network. For instance, in a simple core-periphery network, actors high in betweenness centrality[2] are those that connect peripheral actors to one another, and hence benefit from the resource and perceptual benefits predicted by power and centrality theories. In a multi-cored network, actors high in betweenness centrality are those that connect the cores (densely connected clusters) to each other, and hence benefit from the role of broker predicted by structural hole theory. In a multi-cored network where the cores are hierarchically different from each other, betweenness centrality becomes interpretable only after considering the structure of the cores, and the structural relations between cores. Therefore, to meaningfully interpret centrality measures (or other positional measures), it is essential that we understand the structure of the actor's immediate vicinity of contacts in relation to the structure of the overall network. Nestedness conceptually satisfies this requirement, and hence allows for a world where networks can be either core-periphery, or small-world, or some hybrid form combining both structural forms.

A possible concern with my research is that the observed relationship between nestedness and firm performance is simply an agency effect. Agency theory predicts that firms at the top of pyramid-shaped business groups have higher performance because funds and resources from firms lower down the pyramid are *tunneled* (Bertrand, Mehta, and Mullainathan 2000) to firms higher up the pyramid. This process benefits controlling shareholders, who typically own a larger percentage of shares in firms at the top of the pyramid. I control for insider shareholding to account for agency effects. Further, the pyramid effect is not applicable to Indian business groups, which

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[2] Betweenness centrality is a widely used measure of centrality, and hence I use this measure in this example.

do not display a pyramid-like structure. Instead they have a cluster structure, with multiple independent ties connecting the firms within a group.

Another possible concern with my research is the effect of particular design choices on the results. For instance, the relationship between nestedness and firm performance is in the context of an ownership network, and can be explained only if the ownership network reflects more general coordination and control between firms in the network. The analysis in Chapter 3 for a subset of the sample compares the ownership network with loan, trade, and key personnel ties (page 84 – comparison with *related party* data). Consistent with prior research, I find that the ownership network corresponds to other types of ties.

One limitation of this study is that it is cross-sectional, and raises the concern that past performance is driving nestedness. The lack of evidence for endogeneity partially addresses this concern. Another possible method of addressing this concern is to introduce past performance within the regression equation. However, introducing a lagged performance variable in an equation predicting performance raises numerous econometric issues. In addition, it is not clear whether introducing a lagged performance variable is justified since current performance is likely to encompass the effects of all prior performance. The second possibility is to simply test if past performance predicts nestedness. In addition to lagged performance, I introduce independent variables age, industry_dummy, size (lagged total assets), degree, aggregate constraint, and family presence (dummy variable marked “1” if the controlling shareholders of the firm share the same last name). I find that past performance does not significantly predict nestedness. Age is the most significant predictor of nestedness. This result is consistent with a social-structural explanation: Nestedness is a result of multiple ties by multiple actors over time, and actors are unlikely to have the information or the ability to strategically manipulate the structure of second-level contacts, third-level contacts (and so on). Undoubtedly, firms make strategic decisions to form ties based on performance. For instance, firms might attempt to invest in high performing firms. However, this direct tie alone will not make the firm highly nested. Firms are highly nested only if their second-level contacts, third-level contacts (and so on) have a particular network structure.

Another limitation of the study is that it does not distinguish between different mechanisms that explain the proposed relationship between nestedness and performance. Current theory suggests that highly nested firms enjoy superior access to resources, legitimacy, and perceptual advantages, and hence enjoy superior performance. The resource argument suggests that highly nested firms reside within integrated networks, and hence have greater ability to mobilize resources when needed. One method of testing this mechanism is to test the difference in the asset size of new firms that are highly nested compared to new firms that are minimally nested. Firms are founded either by entrepreneurs or by existing firms. When an existing firm (highly nested or minimally nested) starts a new venture, frequently the parent firm is the only significant shareholder, and the new firm does not have shareholding ties with any other parties; in this case the new firm is minimally nested (irrespective of whether the parent firm is highly or minimally nested). However, in some cases, a highly nested parent firm directly invests in the new firm, and other related shareholders, with ties to the parent firm, also invest in the new firm. This pattern of existing highly nested relationships gives these new firms a highly nested position in the network. If nestedness did not confer any resource advantages, then we would expect that highly nested new firms are no different from minimally nested new firms in their resource base. Table 4.8 shows that highly nested new firms have significantly greater asset size compared to minimally nested new firms. This difference provides some support for the argument that highly nested firms reside within integrated networks, and hence have an advantage in mobilizing resources. Future research should test and distinguish between alternative mechanisms more systematically.

TABLE 4.8: Access to Resources: Highly Nested New Firms versus Minimally Nested New Firms

	Average Total Assets of New Firms In Crores of Rupees
Low Nestedness (1-4)	**417.67**
High Nestedness (5-25)	**679.95**
Kruskal-Wallis Chi-Square Test of Difference	**10.44*** **

***0.01 level of significance; New Firms are publicly traded firms which are less than 10 years old.; Five is the cutoff used to distinguish high and low nestedness since the large majority of firms occupying the small bicomponents have a nestedness of 4 and below (49 of 721 firms in the small bicomponents). The large bicomponent has 229 of 421 firms with a nestedness of 4 and below. I also use cutoffs 3 and 6 and find similar results.

Nestedness simultaneously takes into account both the firm's position within the business group, and the position of the group within the larger network. Therefore, it does not indicate whether the performance effect is driven by the position of the firm within the group, or the position of the group within the network. I distinguish between these two by running a fixed effects model (which captures only the variation in nestedness within the group) and a between effects model (regression on group means, which captures the effect of differences in nestedness between groups). In both these models, nestedness is not a significant predictor of performance (results are available upon request). Hence nestedness within and between groups is simultaneously important to increase firm performance. Firms that enjoy superior performance hold a core position within a core group.

An important insight from my research was the significant negative effect of betweenness centrality on firm performance. In a network with multiple groups, firms with high betweenness centrality are those that connect business groups. In this integrated network structure, it appears that brokers who attempt to take advantage of their network position are penalized. This result supports Shipilov (2009), who finds that brokers benefit from their network position in sparse networks rather than in integrated networks.

My results also have implications for business group theory and interorganizational cluster theory. They emphasize the importance of distinguishing between nestedness (an indication of position within the overall network) and clustering. Interorganizational cluster research tends to ignore network position and focuses exclusively on clustering. Business group research tends to conflate nestedness and clustering, sometimes describing and theorizing only about the most dominant business groups. My research clarifies the distinction between clustering and nestedness, and supports recent research which calls for a distinction between position and clustering (Bell 2005).

The primary practical implication of this study is for managers considering partnerships or engaging in competitive actions against rivals must consider not only the rivals resources but also rivals' position in the overall network. Highly nested rivals benefit from the perceptual, resource, and knowledge benefits of their position in the network. Second, highly nested rivals reside within an integrated social structure, and benefit from the trust and lowered transaction costs inherent in this structure.

CHAPTER 5: CONCLUSION

My dissertation suggests the importance of focusing on structural embeddedness in the overall network. This broader definition of structural embeddedness leads to insights at different levels of analysis. At the network level, it reveals a hybrid network that combines several ideal-typical network structures. I find significant meso-level variation in social structure, with different portions of the network displaying different social structures. These differences are not random and are closely linked to the context – The atomized portions are populated by a newer cohort of post-liberalization software and technology firms that rely on global markets and professional ties; the nested portions are populated by older manufacturing and heavy industrial firms bound within community and family ties.

At the group level, structural embeddedness within the overall network reveals that business groups vary widely in their position within the overall network. Some are isolated while others are nested with multiple layers of ties. These differences correspond closely to business group size, age, and internal complexity. The lack of attention to these network structural differences leads to incorrect conclusions about power and dominance, which might be applicable to a small portion of the highly nested business groups, but does not describe the majority of Indian business groups. The majority of the Indian business groups are small, structurally simple, and fairly isolated from the rest of the network.

The final paper tests the consequences of structural embeddedness within the overall network. At the level of the firm, structural embeddedness within the overall network reveals the position of the network within the business group, and the position of the business group within the network. Neither by itself affects performance. However, taken together, structural embeddedness within the overall network predicts firm performance after even controlling for other firm, industry, and network characteristics.

The three papers in my dissertation have an overarching theme. They make the case for broadening the definition of structural embeddedness to include overall network structure. From a sociological perspective, this shift is important because it suggests dynamics that go beyond self-interested, rational activity (example, individuals choosing to occupy structural holes). Structural embeddedness within the overall network is a result of multiple choices by multiple actors over time, and cannot be reduced to rational actor explanations. Hence, my research melds network theory more closely to its sociological origins. If applied to other contexts such as individual friendship or professional networks, my research provides a network structural explanation for the difficulties individuals face in significantly altering their social networks, even after making changes to their immediate networks.

The findings across the three papers are largely consistent. One difference is the treatment of the atomized world. In my first paper, I found that the atomized world represents a newer cohort of high technology firms that rely more on the global market, and professional rather than community or family ties. In the last paper where I study the consequences of nestedness on firm performance, these isolated firms are discarded (as is conventional in studies of social networks and outcomes). However, in a different type of network such as a professional network, these firms might not be isolated.

Future research should include professional ties, and study the effect of the inclusion of different types of ties on the network structure, and outcomes.

Research on the interorganizational networks in Germany, Italy, and the U.S. suggests that these networks display small world structures. My research, when compared to this previous research, suggests that network structures vary based on national differences. Future research should compare the overall network structure in these different countries, and explore the links between institutional differences and network structural differences.

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