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Author(s): Dalhia Mani and James Moody

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Moving beyond Stylized Economic Network Models: The Hybrid World of the Indian Firm Ownership Network[1]

Dalhia Mani
HEC Paris

James Moody
Duke University

A central theme of economic sociology has been to highlight the complexity and diversity of real world markets, but many network models of economic social structure ignore this feature and rely instead on stylized one-dimensional characterizations. Here, the authors return to the basic insight of structural diversity in economic sociology. Using the Indian interorganizational ownership network as their case, they discover a composite—or "hybrid"—model of economic networks that combines elements of prior stylized models. The network contains a disconnected periphery conforming closely to a "transactional" model; a semiperiphery characterized by small, dense clusters with sporadic links, as predicted in "small world" models; and finally a nested core composed of clusters connected via multiple independent paths. The authors then show how a firm's position within the mesolevel structure is associated with demographic features such as age and industry and differences in the extent to which firms engage in multiplex and high-value exchanges.

INTRODUCTION

Classical sociologists expend considerable energy establishing the presence of structural diversity, whether in institutions (Montesquieu [1748] 1989),

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belief systems (Weber [1904–5] 1958), or the nature of ties between individuals and groups (Durkheim [1897] 1951; Simmel 1971). Economic sociology, based in this tradition, also often locates the sources of differences in economic activity in structural variation within society, and much of this work incorporates at least some element of network structure in explaining variation: Tocqueville ([1835–40] 1945, p. 114) discusses differences in organizational acumen based on the extent of "unity among themselves by firm and lasting ties," Marx and Engels ([1848] 1967) point out that it is only increases in group density and unity that transform group economic interests into collective action, Durkheim (1951) locates the source of differences across groups in the density of ties, and Coleman (1988) locates it in differences in trust and norms originating in the pattern of ties within groups.

Together, these works paint a powerful picture of structural complexity and diversity that provides a strong contrast to the stylized "transactional" exchange system implied by classical economic models. This elaboration of markets is true both for constraints and opportunities embedded in direct exchanges (Uzzi 1996) and for embeddedness beyond the dyad (Granovetter 1992; Keister 2009) and the structuring of entire markets (White 2004; Uzzi and Spiro 2005; Padgett and Powell 2012). This point is clearly made in canonical theoretical work (Granovetter 1985; White 2004) but also routinely made in empirical investigations: from the structure of trading on the exchange floor (Baker 1984) to the complexities of new computer production markets (Bothner 2003) and a series of excellent investigations of business groups across multiple economies (Lincoln, Gerlach, and Ahmadjian 1996; Dyer 1997; Keister 1998, 1999, 2001).

Given economic sociology's repeated emphasis on market diversity and localized ecologies, it is surprising to see a turn toward highly stylized, one-dimensional network models to characterize the network foundations of economic structure. Network models provide a snapshot of the flow of information and resources within an economy (Mintz and Schwartz 1985) and contain assumptions and predictions about the behavior of embedded individuals. As Granovetter (2002, p. 42) argues, "while cooperation and compliance depend strongly on individual interpersonal relations and their history, they also depend on the overall configuration of social networks in which the individual is situated. Thus, two actors' previous relations

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only partly determine whether they will cheat one another; also important is whether the overall network that contains both is dense (news of malfeasance spreads quickly) or sparse (such news can be concealed for a long time)."

One-dimensional models efface structural variation and neuter the ability to explain these differences in the behavior of embedded actors. While providing substantive alternatives to the simple random connections implied by the "transactional" free market model, the highly unequal models implied by the "scale-free" literature (Barabasi and Albert 1999; Atalay et al. 2011) or the clustered-but-connected "small world" models (Powell et al. 2005; Uzzi and Spiro 2005; Vedres and Stark 2010) seem to replace one single-dimensional frame with another. This strikes us as moving in the wrong direction, since it replaces one insufficient model with another and presents a picture of uniformity within the network that is at odds with the overarching focus of structural variability that is key to economic sociology. Instead, we propose returning to the basic insights from embeddedness to explicate a composite—or "hybrid"—model of economic structure that combines multiple elements of stylized models (Martin 2011). Indeed, the point has been made before that focusing on structural variation in overall networks is the distinctive contribution that economic sociology can make to the instrumental-reductionist vision of markets (Granovetter and Swedberg 2011). Our general point is straightforward: stylized approaches are often successful because they are only partially accurate—we can identify clear empirical traces of most such models. But such features are simultaneously incomplete, missing the ways in which such network configurations are connected to one another and embedded in a more generally structured market.

Our analytic strategy is to explore these ideas by applying a cohesive blocking routine—a general model of network block modeling (Moody and White 2003)—to remarkable new data on the full population of publicly traded firms in India. This model allows us to characterize the nesting of multiple substructures within an overall network ecology and is flexible enough to encompass multiple mesostructural patterns that are characteristic of a rich economic social structure. After first describing the structure of the Indian corporate ownership network in 2001 and 2005, we turn our attention to potential causes and consequences of position in the mesostructure by asking how position in the ownership network is associated with historical firm characteristics on the one hand and with the extent to which firms engage in high-valued or multiplex exchanges on the other.

We find that while elements of different stylized models are present, the network structure is more complex and varied than such models would assume (for related work, see Powell et al. [2005] on the dynamics of the biotech industry). The Indian ownership network seems to follow a hybrid structure composed of a disconnected periphery that conforms to the disconnected networks implied by classical transactional models; a semiperiphery characterized by small, dense clusters with sporadic links, similar to that predicted in "small world" models; and finally a nested core composed of deeply reconnected clusters that echoes the unequal involvement insights of the scale-free literature. Below, we start by laying out the evidence, assumptions, and predictions of work that draws on stylized network models and then match these predictions to the market reality in India and, more generally, to work on business groups and emerging markets.

STYLIZED MODELS OF ECONOMIC SOCIAL STRUCTURE: DISCONNECTED, SMALL, AND NESTED WORLDS

A signal contribution of economic sociology is to draw attention to the structural complexity of markets, in striking contrast with simple structureless economic models. Networks have always featured strongly in this portrayal (Granovetter 1973; Baker 1984; Uzzi 1996; Lin 2001; Burt 2005), as they capture the particular exchange patterns that are otherwise washed out in market models. Baker's classic work on the patterns of commodity exchange is archetypical here: by digging into the empirical pattern of trades, we are able to see where the classic economic model breaks down in favor of a socially structured market. As another example, consider how the power of bridging a structural hole rests on the inability of that hole to quickly close (Buskens and van de Rijt 2008). The empirical work on business groups (Keister 2001, 2009; Luo and Chung 2005) repeatedly demonstrates the stickiness of social structure in emerging markets. New network models applied to the economy are attractive precisely because they promise a modicum of structural heterogeneity while remaining analytically tractable. But, despite this overarching theoretical frame, much of the recent application of network science models to economic sociology problems rests on simplifying networks to a single key feature in a way that threatens to reintroduce overstylized portraits of the economy.

The first such models were "small world" models (Watts and Strogatz 1998), which focused on the key insight that networks were simultaneously locally clustered and globally connected at longer distances. This simple characterization matches our basic understanding of the localized, clustered nature of economic exchange (Baker 1984; Uzzi and Spiro 2005). The second wave of such models focused on the observation that almost all real world networks have long-tail distributions of the number of partners each member has (degree), a feature that maps well onto the wide inequality evident in economic systems. Moreover, such scale-free networks often have a seemingly paradoxical feature in which connectivity is robust to random disruptions but sensitive to any targeted disruption of the high-degree actors, with potentially serious implications for cascading failure in globally connected economic systems.

Moving beyond these two initial models, we find variations on the general theme that take much the same form of identifying a key structural characteristic and explicating the implications. For example, we find models focusing on the extensiveness of core-periphery structures, which are substantively akin to the scale-free models but more exact in their macrostructural specification (Borgatti and Everett 1999). Other models extend the reach of scale-free networks to network community structure, such as Vedres and Stark's (2010) work on evolution of overlapping groups. Combining the heterogeneity of individual degree in the scale-free (or core-periphery) model with the clustering of the small world model takes us to Moody and White's (2003) work on structural cohesion and group nesting. This "nested world" describes differentially positioned clusters connected via multiple independent paths that can provide an underlying substrate for complex multiple-source diffusion (Centola and Macy 2007) that seems characteristic of fields like biotechnology (Powell et al. 2005).

These idealized models move us past the structureless basic free market and echo the long-standing insights from work on tie heterogeneity in the structural holes and weak-tie literatures. Their clear value lies in identifying the implications of structural features of networks, but by virtue of their all-encompassing nature, they have tended to paint a homogenous macrolevel picture of economic networks: the system as a whole follows the characteristic structure of the simplified network model. Sociologists are naturally distrustful of simplified models and have posed a number of alternatives. Martin's (2009) recent treatment of structural models nicely demonstrates how such singly structured networks fail to capture real world variability and ambiguity, and Grannis (2009) shows how much of the empirical work is highly sensitive to methodological choices. Powell et al. (2005) identify the evolving ecology of research and development networks focusing on how multiple cores are nested deeply in the exchange. We are similarly cautious about simple models, as rote actor-level adherence to such models robs economic actors of strategic opportunity and denies the stability of localized structures (see Burt 1992; Buskens and van de Rijt 2008).[2] Instead, we suspect that networks are shaped broadly by a historically dependent economic ecology that yields a widely varying mesolevel structure that is partially consistent with many simplified models but yields a decidedly more complex (and we think interesting) macrostructure. In what follows, as shorthand, we refer to the market net-

[2] "Judging friends on the basis of efficiency is an interpersonal flatulence from which friends will flee" (Burt 1992, pp. 24–25).

work as a "disconnected periphery," the connected-cluster model as "small worlds," and the hierarchical embedding of groups as a "nested" world.

Disconnected Periphery

Classical market models conceptualize organizational activity as a competition between isolated actors making rational decisions based on self-interest. On this view, coordination between firms is an attempt to fix prices, thwart competition, and create anomalies in otherwise efficient markets (Smith [1776] 1976). These theories assume a many-to-many market of trades between actors and view longer-term coordination as the suspect result of market imperfection. Hence, they have difficulty explaining the ubiquity and persistence of longer-term coordination between firms as typified by ownership or joint venture ties.[3] These theories perhaps represent a straw man, and more recently, mainstream economists explain longer-term coordination between firms by aspects of the transaction (Williamson 1981). However, transaction cost theory also does not conceptualize the presence of a larger social world, within which transactions occur. Indeed, Williamson (1994, 1996) focuses almost exclusively on aspects of the dyad and implicitly contests the relevance of larger social structures. Hence, in a network representing coordination between firms, classical economic theories and more recent transaction cost theories lead us to expect a world composed of isolated firms or dyads (pairs of connected firms) or dyad chains (firm A connected to firm B connected to firm C, etc.).[4] Studies building on this model assume that, over time, any imperfections in the form of larger networks of coordination should dissipate (Khanna and Palepu 2000*a*), and firms will remain isolates or display dyadic patterns of coordination.

Small Worlds

Recent research on interorganizational networks often finds properties consistent with small world models by comparing the observed network to similar-sized random networks (Kogut and Walker 2001; Davis, Yoo, and Baker 2003; Baum, Rowley, and Shipilov 2004; Uzzi and Spiro 2005). Small worlds are characterized by tight-knit clusters of firms linked together by an unexpectedly short sequence of extensive relations. That is, the global connectivity of the network is close to that of a random network,

[3] The distinction between theoretical expectations for network structure for different types of ties (many-to-many ties in a network of spot transactions vs. isolates/dyads for a network of longer-term coordination between firms) was clarified by an *AJS* reviewer.

[4] Organizational perspectives on interorganizational ties also focus on the dyadic ties between firms (Galaskiewicz 1985; Ring and Van de Ven 1994). However, the focus is on the content of ties, and this research does not speak to the question of network structure.

but firms are clustered locally much higher than random networks. Small worlds are unique because they combine the paradoxical qualities of a large, sparse network with high connectivity (Watts 1999, pp. 495–96).[5] The sparse ties transfer information among clusters. Information diffuses easily across large networks, without the need for a globally dense network. Firms that bridge between otherwise disconnected clusters enjoy the benefits of brokerage, while firms within clusters enjoy the benefits of closure (Burt 2005; Schilling and Phelps 2007). Hence, this model predicts embedded exchanges (defined as exchanges characterized by trust and rich information transfer; Uzzi 1996, p. 677) between firms within clusters. Kogut and Walker (2001) and Corrado and Zollo (2006), who study small worlds over time, find that intercorporate networks remain stable to economy-wide disruptions and display small world properties over time. This network model predicts stability of networks over time.

Nested Worlds

The archetypical network models described above struggle to account for trusted, embedded exchange (Uzzi 1997) characteristic of closed groups (Coleman 1990). Trust is essential to newly emerging markets (Keister 2001) and to any context in which opportunism can erode standard market-based transactions. Transactional models focus too heavily on features of the dyadic exchange to capture the wider structure of exchanges that shape trust. Small world models do better, as the composition of business teams can be shown to help generate production synergies (Uzzi and Spiro 2005) and the base model of local clusters allows for closed groups at the triad level. But, the small world model has to rely on potentially weak distance-diminishing short paths to spread trust-relevant information to the wider community, which may not be knowable (Goel, Muhamad, and Watts 2009).

"Nested worlds" fare somewhat better. Nested worlds provide a sociological alternative that builds directly on the notion of structural embeddedness from Granovetter, combining elements of differential involvement that is key to the scale-free (and core-periphery) literature and clustering that is key to the small world literature. The notion of clustering is captured by *structural cohesion*, which refers to how hard it is to disconnect

[5] Technically, connectivity, or *path length*, refers to the number of steps required to connect two actors in the network. Clustering is the extent to which focal actors' contacts are connected to one another to form a closed triad. Intuitively, if a network has many closed triads then path lengths overall should be long (if all of one's friends know each other, how does one get out of that closed group to the rest of the world?); the key insight from Watts and Strogatz (1998) is that many networks have very strong clustering but average path lengths that are nonetheless quite close to what would be expected at random.

clusters in a network (see "Data and Methods" below for further definition and examples). Differential involvement is captured by the fact that structurally cohesive sets are nested within one another, with strongly connected subsets deeply embedded within a wider structure. This notion of differential embeddedness is also found in core-periphery (Borgatti and Everett 1999) and overlapping community (Vedres and Stark 2010) models. Unlike some of these models, the lack of an a priori limitation to the number or shape of substructures allows for multicore networks (Borgatti and Everett 1999; Everett and Borgatti 1999), and it is generally agnostic with respect to homogeneous processes over the network. A "nested world" is, in core-periphery parlance, a multicore network with positional differences between cores.

Information about (un)trustworthy behavior passes quickly through clusters, and multiple independent paths between these clusters ensure that clusters receive the same information from multiple sources, hence increasing the value placed on information that might arise from distal sources. The negative effect of distance on information and resource flows is counteracted by the redundancy of independent paths, differentiated by nestedness level (Moody and White 2003, p. 120). Norms and sanctions can be imposed since ties between clusters ensure that information about untrustworthy behavior reaches far beyond the dyadic relationship within which the behavior occurred, and distal others may be less willing to transact with the offending party. The converse effects apply for actors with a consistent record of trustworthy, helpful behavior. Such actors are attractive partners and, over time, occupy more nested positions in a hierarchically embedded cohesive structure. The idea of structural cohesion underlying this model implies stability over time and predicts that firms in nested worlds will engage in embedded exchanges that reinforce connections with historical partners.

GROUNDING NETWORK MODELS: BUSINESS GROUPS

In the long and growing literature on business groups (particularly in Asia), we find many hints for each of these models. Business groups are sets of legally independent firms operating as a group (Khanna and Palepu 1999, 2000*b*; Guillén 2001; Keister 2001). This research explores how and why business groups form (Guillén 2000; Khanna and Palepu 2000*b*; Keister 2001); the performance effects of business group affiliation (Lincoln et al. 1996; Khanna and Palepu 2000*b*; Chang and Hong 2002; Chang 2003); evolution of groups in tandem with economic development (Guillén 2000; Kock and Guillén 2001); sharing of intangible and financial resources across group firms (Chang and Hong 2000); and the role of family, prior social ties (Keister 2001; Luo and Chung 2005), and the state (Tsui-Auch and Lee 2003). The emphasis is on stability of group affiliation, with ownership ties acting as signals of commitment and long-term coordination, leading members to partner in multiple areas (Lincoln, Gerlach, and Takahashi 1992; Khanna and Rivkin 2006).[6] Ownership ties are crucial links in economic sociology generally but particularly important for research on business groups in which strong ties and long-term commitment substitute for weak institutions (La Porta et al. 1999; Khanna and Rivkin 2006). These economic transactions are underpinned by social ties, and research on business groups emphasizes the important role played by social relations in the formation and evolution of business groups (Keister 1998, 2001; Luo and Chung 2005).

Consistent with the emphasis on stability, business group research assumes distinct group boundaries (suggestive of few external ties) and describes closure within the group, all of which are suggestive of a small world. However, this research also emphasizes embeddedness within a larger dense network (Khanna and Rivkin 2006) and places a special focus on prominent business groups as distinct from smaller business groups (White 1974; Keister 1998; Chang 1999; Chung 2000; Campbell and Keys 2002; Choi and Cowing 2002), all of which are more consistent with the cohesion and hierarchical embedding characteristic of a nested world view. For example, the archetypical example of business groups is likely the Japanese *keiretsu* (Gerlach 1992). This research emphasizes the role of embedded relations, multiple crosscutting ties across the big six *keiretsu* (Lincoln et al. 1996; Kim, Hoskisson, and Wan 2004), and intercorporate relations characterized by high levels of trust and low transaction costs (Dyer 1997). This focus on the social embeddedness of economic transactions is echoed in the wider field of business group research in Asia, including work in Taiwan (Luo and Chung 2005), Korea (Guillén 2002; Chang 2003), and China (Keister 1998, 2000, 2001). Given the history of this work, it is important to understand the relational foundation of the Indian case: an emerging economy with an interesting juxtaposition of market and nonmarket coordination (Khaire and Wadhwani 2010; Jain and Sharma 2013), which is also substantively interesting as one of the largest economies in the world.

THE INDIAN ECONOMY

Major market liberalization in 1991 reduced the restrictions on Indian businesses and opened the economy to the global market. Preliberaliza-

[6] Studies on long-term ties between firms in the United States tend to use joint venture ties (Todeva and Knoke 2002), but ownership ties are more common in countries characterized by business groups (La Porta, Lopez-de-Silanes, and Shleifer 1999).

tion, expansion or entry into particular sectors of the economy required government licenses. The process of obtaining licenses was difficult, and entrepreneurs who had successfully navigated the process had an advantage in obtaining new licenses to expand or enter new industries (Manikutty 2000). In addition, there were strong restrictions to accessing foreign capital that led to the formation of diversified business groups since a firm that has access to capital or technologies can then use this access for other products creating diversified business groups (Guillén 2000, 2001, 2002). As a result of this history, the Indian economy is characterized by family-controlled, diversified business groups (Khanna and Palepu 2000*b*). Ownership and other types of ties bind groups together, while family ties provide the social underpinning that provides a perceptual boundary to demarcate groups. The assumption in management research on Indian business groups (and in research on business groups in other countries) about clear group boundaries (Khanna and Palepu 2000*a*; Keister 2001) and the focus on ties within the group (Chang 1999; Keister 2000; Chung and Kalnins 2001) suggests a small world structure with trust operating primarily within the group.

In contrast, anthropological and ethnographic work on traditional communities focuses on the trust across groups (Lamb 1955; Nafziger 1978; Iyer 1999; Saha 2003). Traditional entrepreneurial communities such as the Marwaris, Parsis, Gujaratis, and Chettiars have religious roots, and these communities play a disproportionate role among 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 (Lamb 1955; Nafziger 1978; Iyer 1999; 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 (Lamb 1955; Timberg 1978; Iyer 1999). Scholars have noted the willingness of entrepreneurs belonging to these communities to extend capital, know-how, and resources to one another, "even in the absence of direct incentives" and without "expecting repayment in kind" (Kalnins and Chung 2006, p. 234). For instance, Piramal (1998, pp. 142–43) describes how the Birlas established business groups and provided the capital for fellow community members and employees to set up competing businesses, leading to ownership ties across groups. Kalnins and Chung (2006, p. 235) similarly describe how these community ties continue to operate, even when members move to a new country. Indeed, community ties are essential in giving immigrant entrepreneurs the resources and know-how needed to start a business in a new environment (Aldrich, Jones, and McEvoy 1984; Chung and Kalnins

2001). This description of community-based trust across groups is more consistent with a nested world.

Over time, the role of community and family might be reducing, with postliberalization software and service industries geared toward a global market and reliant on attracting professional workers with a meritocratic ethos rather than family or community ties (Arora and Athreye 2002; Nee and Cao 2005). However, interorganizational ties sometimes continue to bear the imprint of communities. For instance, in interviews conducted by us, one of the board members of Tata Steel explained the origins of the ownership tie between the Tata group and the Shahpoorji Pallonji group: "Shahpoorji Pallonji helped the Tatas at a time no one else did. It's the Parsi connection. This was way before my time. But the association still continues to this day. They'll probably never sell. It's his [Shahpoorji Pallonji's] son who now sits on the Tata board."

This portrait of the Indian economy suggests somewhat conflicting structural expectations. First, the rapid expansion and marketization implicit in the 1991 liberalization would lead us to expect greater transactional structures characterized by a disconnected ownership network (Nee and Cao 2005). Second, the description of closure within groups is consistent with a small world structure as strongly linked business groups turn inward with sporadic cross-group contacts creating system-level short paths. This cannot be complete, however, as other relational aspects, including the embeddedness of groups in larger cohesive social structures, suggest a nested world. This history, consistent with canonical work in economic sociology, leads us to expect a diverse structural profile in the Indian ownership network. On the one hand, preliberalization advantages created by licensure likely promote a deeply embedded core of older family-based groups with sparse bridges between them or a thick skein of community-based connections. Expansions into new industries and entry of new entrepreneurs postliberalization, on the other hand, likely favor more market-like disconnected structures. Thus, the Indian interorganizational network allows for varieties of mesolevel structures, rather than a uniformly disconnected or small or nested world.

Although new entrepreneurs following strategies that are true to market exchanges are expanding the economy, the traditional business groups and communities continue to play a significant role. All accounts suggest that they have taken better advantage of the new opportunities available in a liberalized economy (Pradhan 2007). This reality, suggestive of increasing disconnectedness while also indicating continued cohesion, is consistent with the conflicting predictions of transactional, small world, and nested world models about change over time, and we test these conflicting predictions. In addition, consistent with canonical sociological theorizing on structure shaping and constraining the behavior of individual actors, we expect that mesolevel structure is substantially consequential and affects the behavior of individual firms; specifically, we expect that mesolevel structures predict varying degrees of embedded exchanges, with nested world firms engaging in the most embedded ties compared to more disconnected or small world firms.[7]

ANALYTIC STRATEGY

The preceding discussion leads us to examine the grounded network structure of the Indian ownership network. Our analytic strategy is threefold: first, we describe the hybrid structure of the ownership network, proceeding in stages, successively moving from a disconnected periphery to a highly reconnected core. Second, we describe how the network has changed between 2001 and 2005. Our approach for describing the network and network change rests on cohesive blocking that allows us to uncover the contours of the network inductively from the data. In the third stage, our goal is to ask how mesolevel position affects how firms tend to deal with their partners. If the mesolevel social structures proposed are meaningful and consequential, then we would expect to find that actors residing in the nested world will display embedded exchanges to a greater extent compared to actors residing in the small world or disconnected periphery (in that order). We should expect this effect to hold after controlling for other factors that might affect the firm's ability to form embedded ties, which may differentially predict position in the network.

DATA AND METHODS

Constructing the Indian Interorganizational Ownership Network

We collected all network data from Prowess CMIE (Centre for Monitoring the Indian Economy), a standard data source for research on Indian firms (Khanna and Palepu 2000*b*; Mahmood and Lee 2004) that contains annual report and stock market data. To ensure that we have full representation of

[7] As with all network models (Shalizi and Thomas 2011), any causal consequence claim is difficult to identify. One could argue that founding imprints such as cohort are the ultimate source of firm-level behavior and that networks are epiphenomenal or that individual behavior aggregated over time and across actors creates a macronetwork structure. However, consistent with canonical sociological theory that structure is a taken-for-granted "given" (Berger and Luckmann 1980) appearing as exogenous to actors at any given period, we think that a mesolevel structure drives dyadic exchange behavior and that this effect holds even after controlling for historical antecedents. Our fieldwork suggests that these are reasonable traces of the processes determining exchanges between firms. And given the lack of extant empirical descriptions of full-scale economic structures, we feel that this is an important first step in understanding the social structural contours of emergent economies.

the economy, we construct the network for all publicly traded firms in 2001 and 2005, typical years in an economy that has steadily grown for the past two decades (World Bank 2013). Our primary structural interest is in the ownership network, which we capture through shareholding.[8] The first author's conversations with Indian managers and auditors indicated that coordination among business group 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. To effectively track this distributed ownership structure, Indian accounting laws mandate that shareholders 1% and above are reported, and we follow the same threshold.[9]

Our focus is on ownership that provides potential for management and control, rather than simple investment. Company annual reports classify shareholders into different categories that reflect levels of control. We include shareholders classified as "Indian promoters," "private corporate bodies," and "persons acting in concert," a general category defined as "as persons who directly or indirectly cooperate by acquiring or agreeing to acquire shares or voting rights."[10] Approximately 75% of all shareholders are represented by the above three categories. Shareholders categorized as "Indian public," "foreign," "nonresident Indian," or minor institutional investors are excluded since they do not have operational control over the firm.[11]

The data consist of 44,528 firm-shareholder pairs for 2001 and 2005. We cleaned these data by manually going through this list as described in the

[8] The type of tie studied naturally influences the observed network (Mani and Knoke 2011). If short-term transactions or spot transactions were used to construct the network rather than ownership, we might expect a sparser social structure. However, theory suggests that firms residing within small or nested social worlds tend to engage in multiplex ties and use existing relationships for a variety of different transactions. If so, using more short-term ties to construct the network would yield a network that is sparser but continues to correspond roughly to the mesolevel structures we predict. Future research should investigate how the network structure differs by relation and network position.

[9] Shareholdings greater than 50% are treated by Indian law as a hierarchical subsidiary-parent relationship. We reconstructed the network and reran the analysis excluding shareholdings greater than 50%, but this did not change the results.

[10] "Indian promoters" are owner-managers—typically a set of family owners—but this category also includes parent companies, mutual funds, banks, and other investment companies. "Private corporate bodies" are public or private firms that are not government controlled.

[11] Minor institutional investors are defined as "banks, financial institutions, insurance companies, mutual funds, and UTIs" who are not Indian promoters. 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. We report the results of the network excluding foreign shareholders, although results do not change if foreign shareholders are included in the network.

appendix. The 44,528 firm-shareholder pairs in 2001 and 2005 represent 28,429 unique actors and include individuals, privately held firms, and publicly traded firms (2,781 publicly traded firms in 2001 and 2,600 publicly traded firms in 2005). We use these shareholding data to construct the ownership network, where links are both directly between firms (direct investment of one firm in another) and between individuals and firms (proprietor investment ties).[12] As our focus is on the relations among firms, all descriptions below focus on firms.

Measuring Network Position

We use the *cohesive blocking* of the ownership network to identify network structure and position (Moody and White 2003). The technique is useful here as it allows for a very general characterization of any network and captures both clustering and connectivity features that are central to earlier stylized models. The procedure works on undirected networks by uncovering successively more connected sets embedded within the network. The crucial concept in this process is *node connectivity*, the minimum number of nodes one has to remove to break an otherwise connected network apart, which is also exactly equal to the minimum number of node-independent paths connecting every pair in the network. An illustration is given in figure 1.

If a graph is unconnected, then node connectivity = 0. If the graph is connected by a single path (and thus removal of a single node would disconnect), we say it is "1-connected" and generally a k-component consists of a set of actors connected by at least k node-independent paths, or equivalently, the removal of k nodes is required to disconnect a k-component.

The network in figure 1 consists of two components, and the first component is a simple dyad with no ties to the rest of the network. This dyad matches descriptions of the disconnected periphery, where actors are not embedded within a larger social structure. The second component (within the "3" dashed line) is larger and splits into three bicomponents. Two of these bicomponents (marked "5" and "6") split away from the rest of the network with the removal of a single actor; these two bicomponents are connected to the rest of the components with a single tie and are representative of a small world—dense clusters sparingly connected to other clusters (Watts and Strogatz 1998). These two bicomponents are simply structured, and any further cutting leads only to isolated nodes. The third

[12] Network data are available by request from the first author. The network is also reconstructed as a firm-to-firm network by replacing indirect ties between firms (established via individual promoters) with direct firm-to-firm ties; the results do not change.

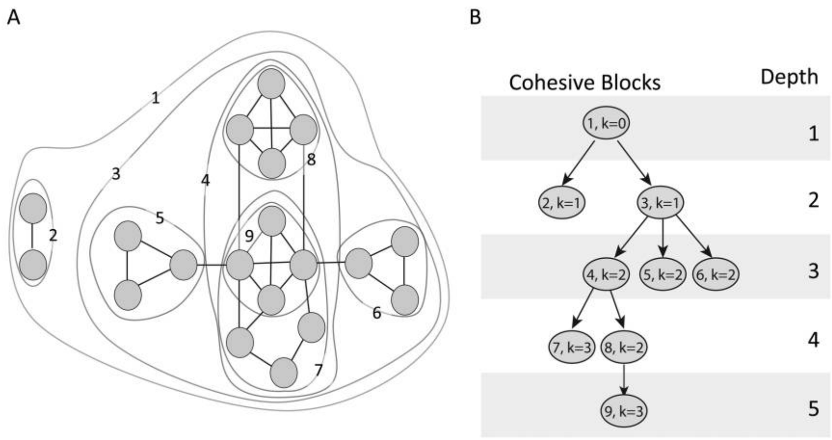

FIG. 1.—Illustrative example of cohesive blocking routine. *A*, sociogram with firms linked by ownership in a hypothetical economy. Dashed hulls contain the nested k-components that are successively revealed by stronger connectivity (k) levels. *B*, reduced-form structure of this setting rooted at the entire graph (connectivity $=$ 0) and drilling down to two $k = 3$ components.

bicomponent (marked "4") is structurally more complex and reveals the presence of nested and branching k-components. The removal of two actors splits this bicomponent into two k-components (marked "7" and "8"). K-component 8 disintegrates if any further cutting is done, but k-component 7 contains a more nested subset of actors (marked "9") that split away from the rest of the network with the removal of two additional actors. Figure 1B shows the nestedness structure of the network. The numbers in the nestedness structure mirror the levels in the sociogram, revealing the nested branches described above.

The primary focus of the first stage of the analysis is using the cohesive blocking routine to describe the structure of the ownership network and comparing this with descriptions from alternative modeling frameworks. After identifying the structure, we ask how a firm's position in the ownership network is related to the extent to which firms engage in embedded ties. We capture position with mesolevel structure indicators. There are two indicators for firms essentially disconnected from the rest of the system: *disconnected periphery*, if a single isolate or isolated dyad, and *isolated cluster*, if in cohesive small component. Among those connected, we distinguish those in *small world*, if members of a small bicomponent, and *nested world*, if embedded in the larger nested and branching bicomponent.

Measuring Embedded Exchange

Firms are required to report transactions with "related parties" (Indian Accounting Standards [IAS], 2010). "Related party" transactions are related to, but distinct from, ownership ties. Firms can have trades, loan guarantees, loans, or license agreements with other firms (both owners and nonowners). The law does not require the exact nature of each transaction with a particular party to be disclosed, but it does require firms to report each transaction and its value (IAS 18, 2000). This law was issued in 2000 (IAS 18), became mandatory in 2004, and is available in Prowess from 2005 onward. Prowess records a total of 25,136 related party transaction dyads for 2005, and we use these data to compute two firm-level dependent variables to measure the extent to which firms engage in embedded ties: *transaction value* and *multiplexity* of ownership ties. Dyad multiplexity is defined in the usual manner as the number of different types of relations within the dyad, and dyad value is simply the reported economic value of the transactions (over all transaction types). To transform dyad multiplexity to a firm-level measure, we sum the number of different types of exchanges within each owner dyad and divide by the number of owner dyads. Similarly, to construct firm-level transaction value, we sum the value of all different types of exchanges within owner dyads and divide by the number of owner dyads.

Control Variables

Firm multiplexity and transaction values are likely affected by features of the firm, so we control for such features in those models. These are *age* (years from incorporation), *size* (total assets), firm performance (*return on assets*, or ROA), and *business group* (dummy indicating whether firms belongs to a business group). Firms belonging to a business group (whether in small or nested worlds) are likely to have more embedded relations (Gerlach 1992). Prior research in India also differentiates the newer cohort of computer and technology services industries from the older capital intensive industries (manufacturing, chemical, basic materials, consumer and industrial goods, construction, agricultural, and textile industries), and we include an indicator for industry based on this categorization (Arora et al. 2001; Arora and Athreye 2002; Khanna and Palepu 2004, 2005). Post- and preliberalization, firms differed in the access to domestic and foreign capital markets, and preliberalization firms relied more on corporate investment. Hence, we control for *cohort*, an indicator of whether a firm was founded postliberalization. Family businesses typically tend to be protective of maintaining family control and are wary of external partnerships, but community ties might help overcome this distrust. Hence, we include controls for *community* and *family*. Typical community last names are used to identify founders' membership in traditional entrepreneurial communities, and the list of typical community last names is developed using past research on traditional entrepreneurial communities (Russell 1916; Timberg 1978; Iyer 1999; Kalnins and Chung 2006) and directories of community organizations (Tantra, Tantra, and Dubash 2009). Company websites and the last names of the top management team (provided in the Prowess data set) are used to determine whether the business has at least two family members (individuals with the same last name) among the top management team, and these firms are coded *family* firms.

Transaction value and multiplexity are likely to be a function of degree; firms with a large number of ownership ties are likely to spread themselves thinner, with ties being less multiplex and lower value. Therefore, we also control for *ownership degree* (number of ownership ties). The inclusion of local network characteristics in a model predicting the effect of mesolevel structure is consistent with our general point that mesolevel structure is distinct from local network characteristics. Figure 2 presents a visual ex-

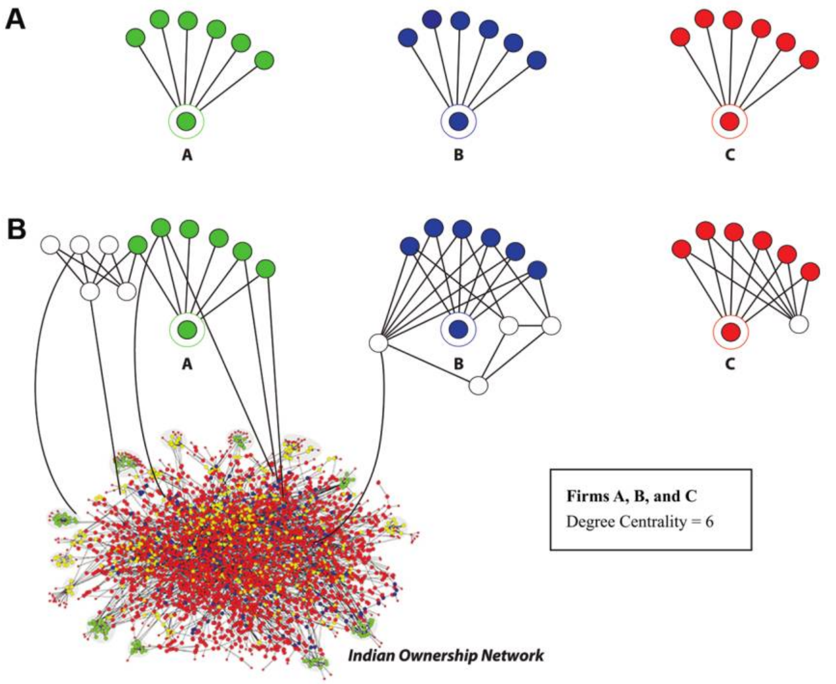

FIG. 2.—Exemplar cases with similar local structure but different mesopositions. *A*, local networks of firms A, B, and C; *B*, structure of first, second, third (and so on) contacts of firms A, B, and C.

planation of how firms with equivalent local networks (firms A, B, and C in fig. 2*A*) differ in their mesolevel structures: firm C resides within an isolated cluster, firm B resides within a cluster that is connected to the rest of the network with a single tie, and firm A resides within a cluster connected to the rest of the network with multiple paths.

RESULTS

The Structure of the Indian Ownership Network

A disconnected periphery.—The Indian shareholding network in 2001 is composed of 1,294 small components (each containing 1–11 publicly traded firms) and one large component (composed of 1,050 publicly traded firms). Of the 1,294 small components, 1,001 contain only one publicly traded firm. For example, Infosys Technologies and Dr. Reddy's Laboratories are both isolated firms with shareholding ties only to their promoters. 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. Another 78 small components contain 71 dyads (pairs of connected firms with no other ties to the rest of the network) and several dyad chains (sets of connected firms with one firm owning shares in the next). These 78 small components (containing 170 firms) are not cohesive, since they disintegrate into disconnected actors with the removal of a single actor or tie. Since these firms are not bound in a larger pattern of ties, we classify them as belonging to a disconnected periphery: 1,171 firms (1,001 isolated firms and 170 firms in dyads or dyad chains), or 42% of the 2,781 publicly traded firms in the Indian ownership network, are in the disconnected periphery (39% in 2005).

Firms like Infosys Technologies Ltd. and Dr. Reddy's Laboratories represent a newer cohort of postliberalization Indian software and technology 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 simple shareholding structure. 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. These firms are in industries that tend to be less capital intensive and, even if they require capital, tend to have easier access to global capital markets (Khanna and Palepu 2004, p. 489). However, their isolated position in the Indian interorganizational network is not without costs; for instance, Infosys's isolated position in the Indian corporate network might help explain its failure in penetrating the Indian corporate market for software and technology services (*Economic*

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

Isolated clusters.—The remaining 215 small components in the 2001 network have cohesive structures—the removal of a single actor or tie does not disconnect the rest of the component. These 215 small components (containing 560 firms ranging in size from 2 to 10 firms each) represent 20% of the 2,781 publicly traded firms in the Indian ownership network (10% in 2005) and do not clearly conform to any of the stylized models presented in prior literature. They are isolated clusters of firms that do not have ties to any actor outside the small component. Figure 3 presents the network structure of three isolated clusters.

In figure 3, the Asian Paints group has shareholders with the same last name. Similarly, in the second cluster, the Ranka group, the shareholders share the same last name. In addition, shareholders own the same proportion of shares in all group firms—for example, in the Ranka group, Rachana Ranka owns 3.94% in all group firms, while Kusum B. Ranka owns 4.16% of shares in all group firms (and so on). The common last names and equal shareholdings suggest that these isolated clusters represent family business groups, although neither family belongs to a traditional entrepreneurial community. The third cluster, the Eicher group, originated as a foreign firm importing and selling Goodearth tractors to the Indian market (Eicher 2013). The lack of ties to traditional communities might have made it harder for these groups to form shareholding ties with firms outside the group, perhaps explaining why these groups are isolated from the rest of the network. Business groups exhibit dynamics different from direct dyadic ties between firms, and current research treats them as conceptually different from dyadic ties between firms. We follow this research and treat these isolated clusters as a separate category.[13]

A small world.—Next we analyze the largest component (composed of 1,050 publicly traded firms in 2001 and 1,322 publicly traded firms in 2005) using the cohesive blocking routine. The largest component in 2001 is composed of 120 smaller bicomponents (having between 2 and 14 firms) and one large bicomponent with 385 firms. The 120 small bicomponents are (by definition) connected to the rest of the network by a single node and are easily split away from the rest of the network. These groups conform to the small world archetypical structure of dense clusters weakly linked to the rest of the network. These groups have internal structures similar to

[13] Model results presented below do not change if these firms are dropped from the analysis or categorized as “disconnected periphery.”

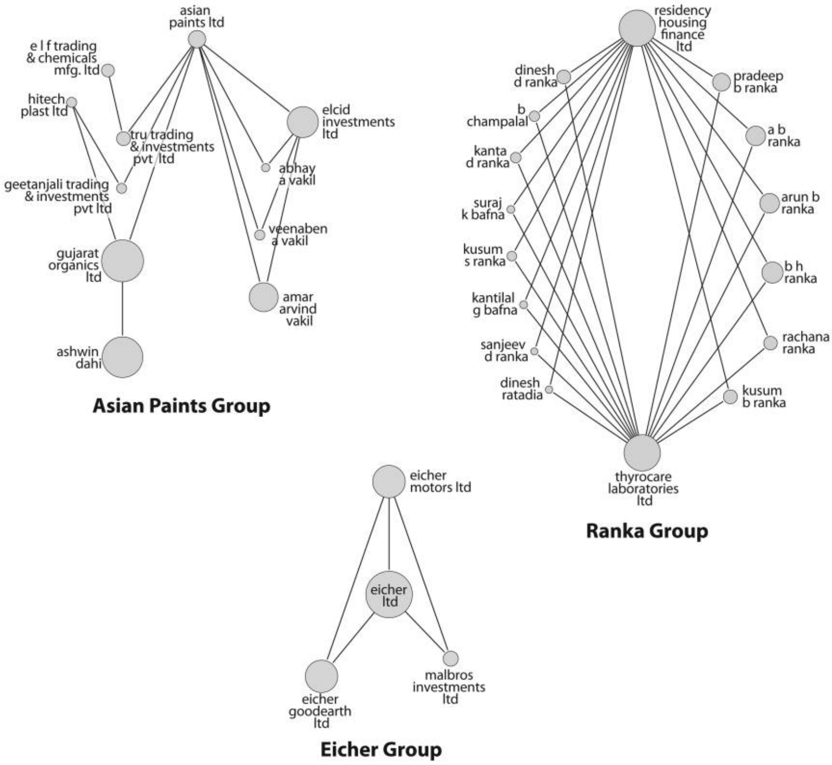

FIG. 3.—Examples of isolated clusters: node size proportional to weighted degree

the isolated clusters described above but differ in that they are connected via a single node to the rest of the large component. Figure 4 presents two examples of these small bicomponents, the Pantaloon group and S. Kumar's group. The promoter shareholders and block shareholders in these two business groups have the same last names (Biyani in the Pantaloon group and Kasliwal in S. Kumar's group), and these last names indicate that these families belong to a traditional entrepreneurial community, making it easier for these groups to form bridging ties to the rest of the network. In sum, 665 firms, or 24% of publicly traded firms, in the 2001 Indian ownership network (28% in the 2005 network) conform to a small world pattern.

A nested world.—Figures 5 and 6 show the sociogram and a schematic representation of the nestedness structure of the large component of the 2001 network; figures 7 and 8 show the analogous data for 2005. The figures show that the small bicomponents (marked yellow or green in the

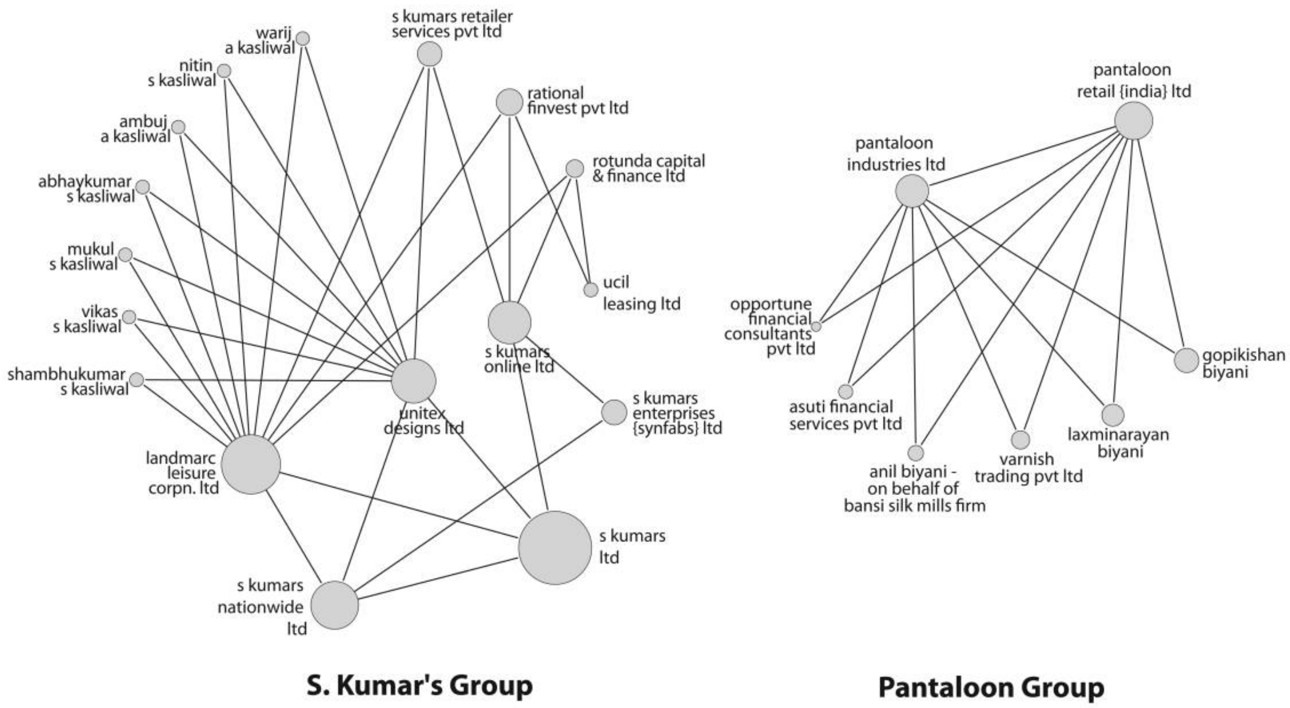

FIG. 4.—Examples of small bicomponents: excluding ties to the rest of the component, node size proportional to weighted degree

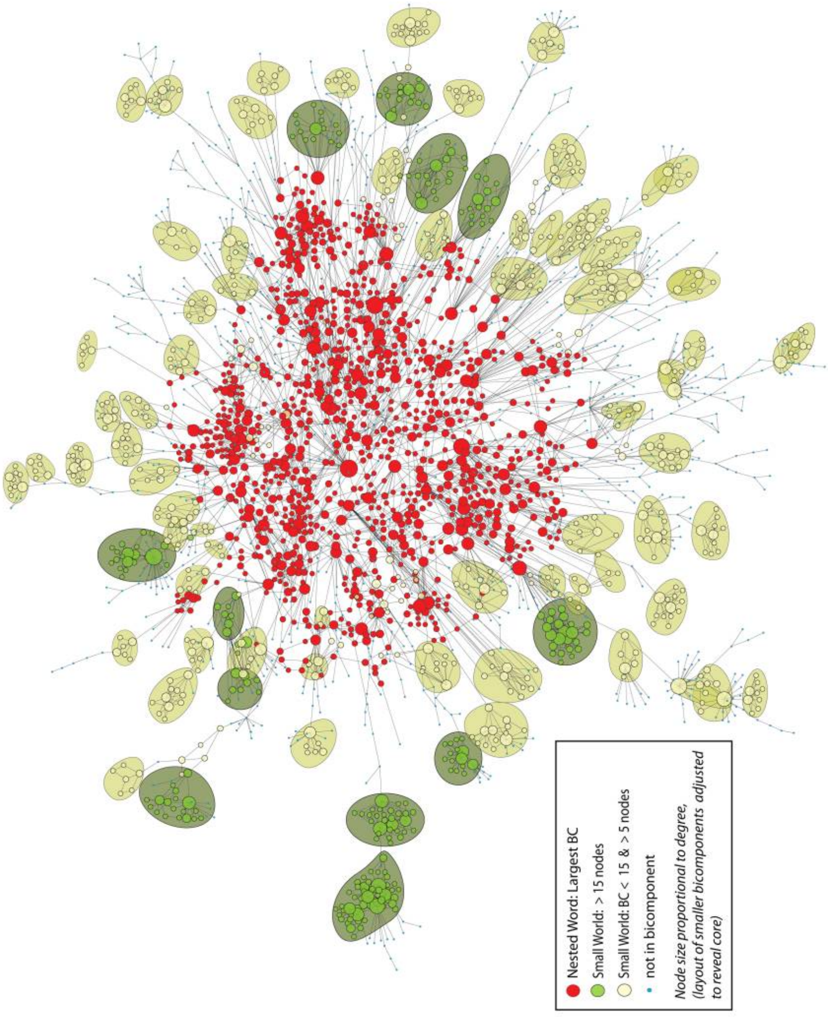

FIG. 5.—Largest component of the Indian ownership network, 2001

FIG. 6.—Indian ownership network, nestedness structure, 2001: cohesive blocking results, collapsed chain with max depth of two or three

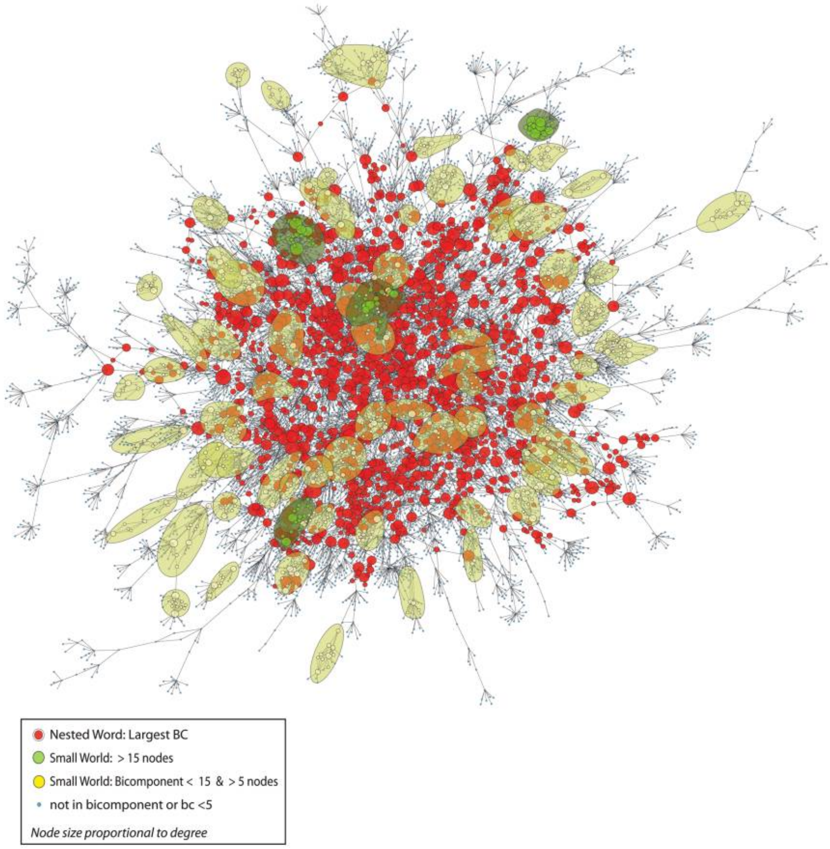

FIG. 7.—Largest component of the Indian ownership network, 2005

sociogram) differ markedly from the large nested and branching bicomponent (red in the sociogram; on the extreme right in the schematic).

The large complex bicomponents on the extreme right in figures 6 and 8 each have a highly nested structure, which splits repeatedly into deeply embedded k-components. If we use the criterion that a group is cohesive if it does not split into separate subgroups (Markovsky and Lawler 1994; Moody and White 2003), there are 42 business groups in the 2001 largest bicomponent and 49 groups in the 2005 largest bicomponent. These turn out to be the largest and most prominent business groups in India, with the Tata Business group being the most deeply nested. Other business groups that reside within the large bicomponent include the Bajaj group, Birla group, Lakshmi group, Murugappan Chettiar group, Essar group, RPG group, and Wadia group. These are all prominent, diversified business

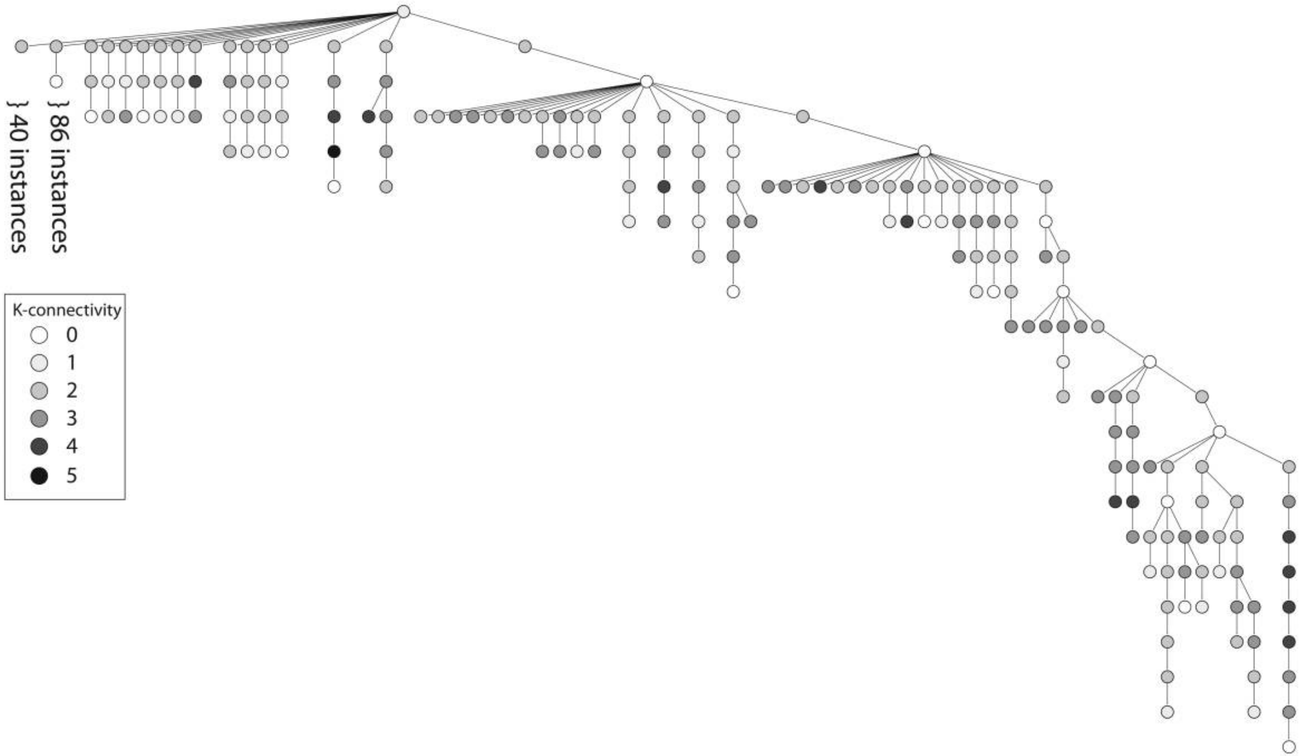

FIG. 8.—Indian ownership network, nestedness structure, 2005: cohesive blocking results, collapsed chain with max depth of two or three

groups, operating in a wide variety of industries from automobiles to information technology. They tend to represent an older cohort of firms; for instance, the Tata group began in 1968. The families associated with these groups tend to belong to traditional entrepreneurial communities (e.g., the Parsi community in the case of the Tata and Shahpoorji Pallonji groups, the Marwari community in the case of the Birla and Bajaj groups, and the Chettiar community in the case of the Murugappa group). Figure 9 takes the example of the Tata group to illustrate cross-group ties, and it shows that Tata group firms have ties to other highly nested groups such as the Shahpoorji Pallonji group, Lakshmi group, Jindal group, Jiwarajka group, and others. The large nested bicomponent in which the Tata group, Birla group, and other large business groups reside represents 14% of the Indian ownership network in 2001 and 23% of the network in 2005.

In summary, cohesive blocking indicates that the Indian ownership network has a hybrid structure with significant portions conforming to transactional (42%), small (24%), and nested (14%) worlds. This mesolevel struc-

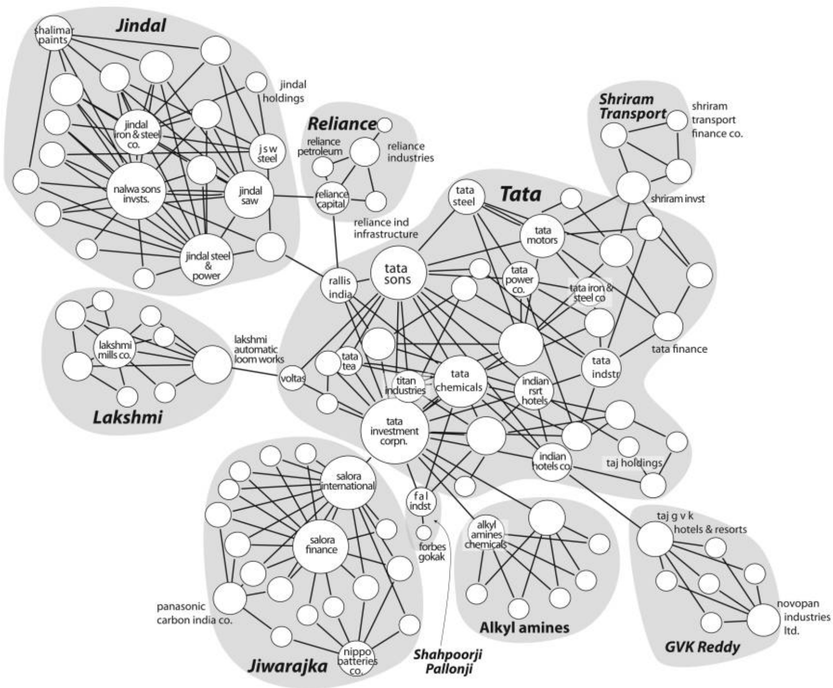

FIG. 9.—Tata business group and other Indian business groups: includes ties that the Tata group has to other prominent business groups only and does not include ties to other firms and ties between the other business groups. Groups are indicated and labeled by shaded areas.

tural variation within the network is fairly stable, and the 2005 network is also composed of transactional (39%), small (28%), and nested (23%) worlds. Figures 5 and 7 show that firms in the small and nested worlds are not disconnected but represent stylized positions present within the same larger network ecology.

Structural Change between 2001 and 2005

Table 1 shows the number and percentages of firms residing within the different mesolevel social worlds in the 2001 and 2005 networks. Small world theory leads us to expect that, over time, large networks will tend to display small world properties (Kogut and Walker 2001). The changes in the Indian interorganizational network between 2001 and 2005 are consistent with this theoretical expectation. Current management theory also suggests that as countries develop and market imperfections reduce, complex network structures should become less prominent (Khanna and Palepu 2000*a*, 2000*b*). Therefore, we expect that the transactional portion of the network increases over time, while the nested world decreases over time. However, between 2001 and 2005, dyads and isolates reduce from 42% to 39%. In addition, the percentage of firms residing within the nested world increased from 14% to 23%. Anecdotal evidence backs this finding and suggests that highly nested business groups such as the Tata, Birla, Thapar, and Mahindra groups are rapidly expanding within India and abroad (Pradhan 2007), contrary to market modernization expectations. These nested groups had easier access to the resources and information needed to take advantage of the growing Indian economy between 2001 and 2005.

Antecedents of Network Position

Examination of the disconnected periphery and small and nested worlds suggested differences between embedded firms in founding and cohort that

TABLE 1
2001 and 2005 Indian Ownership Network

	Disconnected Periphery	Isolated Clusters	Small World	Nested World	Total
2001:					
Number	1,171	560	665	385	2,781
%	42.11	20.13	23.91	13.84	100
2005:					
Number	1,003	275	722	600	2,600
%	38.58	10.52	27.77	23.08	100

are broadly consistent with our understanding of historical changes. Firms in the small and nested worlds represent an older cohort of firms born preliberalization, when tight controls over exports and global investment made domestic corporate capital the most important source of capital. Founders' ties to traditional entrepreneurial communities are likely to have eased the formation of shareholding ties between family business groups. In contrast, a postliberalization cohort of firms is focused on the computer and technology services industry. These firms are reliant on global markets, have access to global capital, and rely on a steady supply of domestic professional talent insisting on a meritocratic ethos. Family might also affect mesolevel network structure. Family businesses tend to be very protective about maintaining control and, hence, are less likely to exhibit the ownership ties across groups required for a small or nested structure. Table 2 shows support for these associations: firms in the disconnected periphery, compared to small world or nested world firms, tend to belong to a younger postliberalization cohort of computer and tech service firms and are less likely to have founders belonging to a traditional community. Family firms represent the majority of firms in all social worlds but are most prevalent in the disconnected periphery, which matches the portrayal of family firms as insular in maintaining family control.

The differences between the population means of firms residing within different mesolevel social worlds is tested using the Kruskal Wallis test (when the dependent variable is continuous) and the Pearson χ^2 test (when the dependent variable is categorical). These tests support the claim that mesolevel social structures are associated with historical antecedents such as age, cohort, industry, family, and community. This result is 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)

TABLE 2
AGE, COHORT, INDUSTRY, COMMUNITY, AND FAMILY AFFILIATION OF FIRMS BY POSITION IN THE NETWORK

	Average Years since Founding	% Founded Post-1991	% New Industry	% Entrepreneurial Community	% Family Business
Disconnected periphery . . .	23.96	35	14	40	70
Isolated cluster . .	25.93	31	13	50	62
Small world	28.46	21	10	45	57
Nested world . . .	32.03	26	11	49	64
Test	KW	P	P	P	KW
χ^2	71.84	38.38	7.021	23.01	19.7
P	.000	.000	.071	.000	.000

NOTE.—KW = Kruskal Wallis; P = Pearson.

TABLE 3
MEAN (SD) OF MULTIPLEXITY AND TRANSACTION VALUE BY NETWORK POSITION

	Multiplexity	Transaction Value (Rs million)
Disconnected periphery . . .	2.02 (2.18)	273.11 (2,563.3)
Isolated clusters	2.52 (3.39)	300.81 (1,133.3)
Small world	2.59 (3.13)	905.41 (6,865.8)
Nested world	3.33 (4.2)	1,044.34 (4,449.0)

and also by the founder's experiences (Simons and Roberts 2008). This result also indicates support for the substantive meaning of mesolevel variation linking it to macrostructural forces unfolding over time.

Consequences of Mesolevel Network Structures

Table 3 shows multiplexity and transactional value for firms in different social worlds and shows that firms in the nested world have higher average multiplexity and transaction value compared to firms in the atomized, isolated cluster, and small worlds (in that order). Appendix table A1 provides descriptive statistics and correlations for the variables used in modeling multiplexity and transaction value (logged to correct for skew). The highest correlations are between business group and isolated cluster (.44), between transaction value and total assets (.43), and between age and cohort (−.43). All other correlations are low, including between ownership degree (an ego network characteristic) and mesolevel network structure, reinforcing the idea that mesolevel social structure is distinct from ego network characteristics and lessening concerns with multicollinearity.[14] Table 4 provides the model results.

Models 1 and 3 provide the results of a robust regression model on transaction values and multiplexity including only control variables. Older firms tend to have more multiplex transactions. Larger firms are expected to have higher-valued transactions and the stability to maintain multiplex relations, and our models support this. Business group research leads us to expect that firms within a group have more embedded exchanges, and the results show

[14] Thanks to an *AJS* reviewer for drawing our attention to the potential conflation between local and mesolevel structures. Correlations between ego network characteristics and mesolevel network structure are low (see the appendix); model diagnostics such as the variance inflation factor (VIF) are within an acceptable range (mean VIF = 1.21, and the highest VIF value for an isolate cluster dummy is 1.5), suggesting that multicollinearity is not an issue. Finally, exclusion of this variable from the model does not change our results.

TABLE 4
Robust Regression Models of Average Transaction Value and Multiplexity: Coefficients and SEs

Variable	ln(Transaction Value) Model 1	ln(Transaction Value) Model 2	Multiplexity Model 3	Multiplexity Model 4
Isolated cluster		.27*		.37
		(.16)		(.33)
Small world		.25***		.53**
		(.09)		(.21)
Nested world		.46***		1.40***
		(.11)		(.25)
Age	.00	.00	.01*	.01**
	(.00)	(.00)	(.01)	(.01)
ln(total assets)	.35***	.33***	.24***	.18***
	(.03)	(.03)	(.05)	(.05)
Return on assets	.07	.05	−.68*	−.74*
	(.13)	(.14)	(.40)	(.40)
Business group	.33***	.27***	.31	.28
	(.09)	(.10)	(.21)	(.24)
New industry	−.12	−.12	−.74***	−.77***
	(.14)	(.13)	(.21)	(.21)
Postliberalization cohort	.07	.06	.42*	.37
	(.12)	(.12)	(.24)	(.24)
Community	.13	.09	.31*	.20
	(.08)	(.08)	(.18)	(.17)
Family	−.15	−.11	−.18	−.07
	(.10)	(.10)	(.19)	(.19)
Ownership degree	−.02**	−.03***	−.11***	−.14***
	(.01)	(.01)	(.02)	(.02)
Constant	2.21***	2.19***	1.46***	1.52***
	(.18)	(.19)	(.44)	(.43)
R^2	.20	.21	.07	.09

Note.—Robust SEs are reported in parentheses and transaction values in millions of rupees. Analyses are based on 1,260 cases.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

that group firms tend to engage in significantly higher-valued transactions. Firms in the new software and service industry are less likely to have multiplex exchanges, which matches our expectations of the differences between older manufacturing and newer software and service firms. We also find that firms with a higher ownership degree (greater number of ownership ties) engage in fewer multiplex ties and lower-valued transactions; this likely represents a trade-off, as it is difficult to maintain both highly multiplex and high-valued transactions with many firms simultaneously.

Models 2 and 4 add the indicators for network position (disconnected periphery is the omitted category). The general result is that greater levels of embeddedness increase both multiplexity and transaction value relative to the disconnected periphery. Model 2 shows that firms residing in small and nested worlds (in that order) have significantly higher transaction values compared to firms residing in the disconnected periphery. Model 4 shows that firms residing in the small and nested worlds (in that order) have more multiplex ties compared to firms residing in the disconnected periphery. These findings support the claim that actors residing within different social worlds differ in the extent to which they engage in embedded exchanges. Our finding of mesolevel variation and its consequences, antecedents, and change over time together paint a picture of complexity and structural diversity that is nicely consistent with economic sociology's distinct contribution to the study of markets.

CONCLUSION AND CONTRIBUTIONS

We find that mesolevel variation in firms' network structure is related to founding imprints, and this has consequences for the ways firms engage in nonownership economic transactions. Firms residing in the nested core have more multiplex ties and larger transaction volumes with partners, compared to firms in the small world or the disconnected periphery, even after controlling for other factors that might explain a firm's propensity for embedded exchanges. However, exchange patterns are the tip of the proverbial iceberg, and mesolevel social structures hold the tantalizing possibility that variation in social environment determines a variety of firm-level outcomes. Theory predicts that social structure shapes behavior and presents actors with differing opportunities and constraints. Specifically, in the context of economic networks, social structure can provide an enforcement mechanism improving the ability of actors to exchange and tap into the available information and resources (Coleman 1988). As such, variation in social structure should lead to differences in firms' growth, innovation, accounting and stock market performance, ability to raise capital, adoption and diffusion of practices, influence with policy makers, and survival (to name a few). The presence of multiple stylized structures within the same network and connected to one another also raises questions about how these various social environments interact with one another, the spillover effects from one to the other social world, and how shocks might affect these different structures. Nested structures might be more susceptible to shocks with effects reverberating across the cohesive structure, or nested structures might withstand shocks better by sharing and hence diffusing effects.[15]

These questions are consistent with the tradition of sociological theorizing about the structural basis of economic activity (Pfeffer and Salancik

[15] Thanks to an *AJS* reviewer for these suggestions.

1978; DiMaggio and Powell 1983; Hannan and Freeman 1984). Mesolevel structural variation provides a useful theoretical bridge linking egocentric research on individual network attributes with sociocentric research on overall network structure. Most stylized network structures average out this variation within networks and force scholars to look across networks to study the links between macrostructures and micronetwork attributes. The study of mesolevel structural variation preserves the complexity of real world networks and is a useful theoretical device for linking macro- and microlevel analysis.

Most network research is sensitive to methodological choices (Grannis 2009). Prior research indicates that the interorganizational network in the United States, Germany, and Italy follows a small world structure (Kogut and Walker 2001; Davis et al. 2003). More recent research, using the more generalized analytical technique used here, shows that the U.S. alliance network contains elements of a nested structure (Mani and Knoke 2011). All networks are likely to display elements of different stylized models, and our research suggests that questions focusing on variation within networks are better addressed using these generalized tools. Our generalized approach allows us to uncover interesting features related to the study of social closure. The finding that 14%–23% of the publicly traded firms reside within a nested structure suggests the importance of closure in the interorganizational context. Current research tends to limit closure effects within small clusters: for instance, Frank and Yasumoto (1998) theorize that ties across clusters are sparse, and hence these ties are likely to be based on the logic of reciprocity (you help me, and I'll help you); in contrast, ties within a cluster are dense and are based on the logic of enforced trust (I help you even if you don't reciprocate, and this trust is enforced by the group). Our work suggests a structure that would allow closure to operate across clusters with multiple paths between clusters. Substantively, the finding that some business groups are connected to others with multiple independent paths is important and provides the structural underpinning that can explain how business groups are embedded within a larger social environment characterized by trust.

From a practical perspective, the contribution of this research is to shed light on the Indian economy and the structure of the ownership network in India. India is an important emerging economy, and this study helps us understand the opaque world of interorganizational ties, which will be of interest to investors and managers, and also, more broadly, adds to our growing understanding of social embeddedness in emerging markets. Prior research on overall network structural patterns was based in the context of Western developed countries. Coleman (1988, p. 104) proposes that "[closed structures] are the social capital that builds young nations (and then dissipates as they grow older)." Perhaps the presence of closed structures, over time, leads to the internalization of particular norms so that the closed structure is no longer required for enforcing trustworthy behavior—actors continue to act in a trustworthy fashion even when closed structures have dissipated (Keister 2009). If so, then the nested structures we find in India reflect a particular developmental phase, and this raises interesting questions about how this network structure will change over a longer span of time and how it compares across countries over time.

Evidence of mesolevel network structural variation also holds implications for research in other fields. The study of mesolevel network structure can inform country-level cultural explanations by revealing network structural variations within countries corresponding to within-country cultural variations. At the interpersonal level, mesolevel structural variation might help explain the intractability of class and poverty across generations; individuals can strategically change their first-level contacts, but it is more difficult to change mesolevel social structure.

This research follows Granovetter's call to understanding network embeddedness: "Networks of social relations penetrate irregularly, and in differing degrees in different sectors of economic life" (Granovetter 1985, p. 491), and "the fundamental issue is not to get the right model of individual action [over- or undersocialized], but rather to understand properly how *variations in social structure* create behavior that appears to follow one model or the other" (Granovetter 1992, p. 7; emphasis added). Mesolevel variation preserves the sociocentric focus on collective structure and, by locating structural variation within the network, gives us a more accurate reflection of real world networks that makes it practically easier to link collective structure to egocentric attributes.

APPENDIX

Data-Cleaning Procedure

The data were cleaned by manually going through the list of 44,528 firm-shareholder pairs. This process was essential since sometimes shareholder names were slightly different across observations—for example, "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 our data set. We used several techniques to check whether these names referred to the same person. First, we checked the six firms in which Ramesh Goyal appears as a shareholder. We checked whether these six firms had other shareholders/directors in common or whether *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" (IAS 18, 2005). Second, we conducted Internet searches of the individual and the companies involved and looked for evidence of links. If we found no indication of a link between the firms, then we would conclude that the six different Ramesh Goyals referred to six different individuals, and we marked the six Ramesh Goyals appearing in our 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. We conducted this check for the 2001 network, but ultimately this problem proved fairly minor since there were only 100 instances (out of the 24,647 firm-shareholder pairs in the 2001 network) in which the above changes were required. Finally, companies change names, merge, and divest parts over time. We corrected for this by using information from the stock exchanges about the above events.

TABLE A1

FIRM-LEVEL DESCRIPTIVE STATISTICS AND CORRELATIONS

	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1. ln(transaction value)	4.28	1.6	3.2	18.1	1												
2. Multiplexity	2.60	3.2	1	35	.26	1											
3. Isolated cluster	.11	.3	0	1	.02	−.01	1										
4. Small world	.27	.4	0	1	.02	.01	−.22	1									
5. Nested world	.25	.4	0	1	.16	.15	−.21	−.35	1								
6. Age	31.77	17.8	3	140	.10	.09	.04	−.03	.05	1							
7. ln(total assets)	6.39	2.0	−.5	13.7	.43	.16	−.05	−.01	.22	.25	1						
8. Return on assets	.05	.2	−3.7	2.4	.02	−.05	.00	−.04	.05	.02	.03	1					
9. Business group	.36	.5	0	1	.11	.04	.44	.01	−.03	.09	.05	−.04	1				
10. New industry	.11	.3	0	1	−.01	−.06	.00	−.02	.01	−.08	.01	−.02	−.03	1			
11. Postliberalization cohort	.21	.4	0	1	−.06	−.01	−.03	.01	.00	−.43	−.18	−.03	−.03	.12	1		
12. Community	.54	.5	0	1	.03	.03	−.01	.00	.10	.01	−.01	.01	.03	−.13	.05	1	
13. Family	.69	.5	0	1	−.06	−.04	−.03	−.02	−.03	.00	−.03	−.02	−.03	−.06	−.03	.18	1
14. Ownership degree	8.06	4.6	1	41	−.06	−.15	.04	−.05	.18	.00	−.01	.03	.15	−.07	−.01	.14	.14

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