Effectiveness by What Measure? Incentives, Institutions and Strategic Networks in China

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INCENTIVES, INSTITUTIONS AND STRATEGIC NETWORKS IN CHINA

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ABSTRACT

We investigate the interplay between an individual decision-maker’s incentive structure and characteristics of the institutional environment as drivers of inter-organizational network evolution. We use longitudinal data on new product development projects in the pharmaceutical industry in China between 1986 and 1994 to study the impact of key reforms on the size, scope and structural patterns of interactions among research organizations and manufacturers. In contrast to findings in developed market economies, network-level results in this context show clear year-on-year increases in all measures of network scale and scope, but the emergence of a distributed network structure. At the organization level, we find considerable homogeneity among actors’ network behaviors in terms of scale and scope, as well as consistency over time. We interpret these patterns in light of the changing institutional environment and incentive structure facing the top managers of these organizations. Furthermore, we evaluate the effectiveness of their network strategies in terms of the rationality of their choices given the specific incentive structure—the complex of motivations and constraints—facing these decision-makers.
INTRODUCTION

In this paper we argue that the “effectiveness” of networks and network strategies should also be evaluated in reference to a particular incentive structure facing focal decision-making actors. Strategic analyses of “effectiveness” typically focus on economic or competitive measures—profits, market share, and so forth—that may be irrelevant to focal actors pursuing a network strategy. Furthermore, strategic perspectives on managerial action and firm behavior typically assume that decision-making top managers have 1) authority for decisions, 2) relative freedom to choose among alternative strategies (“strategic choice”; Child, 1972), and 3) the incentive and motivation to formulate and pursue those strategies. In this perspective, top managers “choose” to build networks as a result of a rational analysis of the most “effective” means to achieve strategic goals. The analysis then focuses on the process by which managers build those networks, and the impact of variation among actors’ networks on their performance.

As Peng and Heath (1996) note, the assumptions of authority, choice and motivation to build networks as a means of achieving “strategic” goals may not be valid in some contexts. Decision-makers may be constrained in the degree of authority they have over decisions or choice among alternatives (Baker et al, 1998). Their incentive structure may include more than one objective, and multiple objectives may be conflicting. They may also be pursuing objectives that are quite different from typical strategic objectives; institutional theory, for example, highlights objectives such as ensuring survival, avoiding failure, and being perceived as legitimate, rather than maximizing economic performance.

There are many contexts in which decision-makers are constrained in both their authority and choice of strategic alternatives, or in which they are pursuing mixed or non-strategic goals. In this paper, we consider one such context—China’s pharmaceutical industry in the midst of transition from central planning to (more) market-coordination of economic activity. The institutional changes facing top managers in pharmaceutical manufacturers and research institutes have on one hand created incentives and opportunities for these organizations to grow, but on the other hand the managers are still subject to considerable external constraints and cognitive orientations (White, 2000). The authority, choice and incentives they are facing are fundamentally different from those of managers with clear authority, relatively unfettered choice, and organizational performance-enhancing incentives.

To investigate the linkage among institutions, incentives and network strategies in the context of the Chinese pharmaceutical industry, we first review alternative motivations that have been argued in other context to give rise to interorganizational networks. We then characterize the Chinese institutional environment, and discuss the resulting incentive structure facing top
managers of research and manufacturing organizations in this industry. Our longitudinal data on new product development projects over the period 1986-1994 allows us to trace the development of interorganizational networks. We then evaluate the effectiveness of these organization-level network strategies in light of the incentive structure facing these top managers during this period of China’s economic transition.

WHY DO INTERORGANIZATIONAL NETWORKS EMERGE

The extensive empirical work on interorganizational networks, as well as the reviews on the topic (e.g., Aldrich & Whetten, 1981, Van de Ven, 1976, Galaskiewicz, 1985; Oliver, 1990, Grandori and Soda, 1995; Ebers, 1997), reveal three different motivations underlying the emergence of interorganizational networks. The first posits networks as a means of achieving organizational, dyad or network-level performance objectives, whether economic or competitive measures (e.g., Gulati et al., 2000). The second, from the institutional theory perspective, examines networks as rational responses to external (institutional) pressures, beyond simply efficiency-seeking or other measures of performance (e.g., Westphal et al, 1997). The third treats the networks as a structural property of the environment, with individual actors selection of relational alternatives as given, rather than emerging from a rational analysis of choices and outcomes (e.g. Boisot and Child, 1996). While not necessarily mutually exclusive, these do represent very different explanations for why a decision-maker may engage in network activities.

The first set of explanations is most closely linked to strategic analyses, in which interorganizational networks represent one among other possible strategic options for achieving economic objectives, whether growth or efficiency (e.g., Kogut, 1988; Oliver, 1990). Revenue-enhancing ties may be activated to access complementary resources (Gulati & Gaargiulo, 1999; Afuah, 2000), enter new (related or unrelated) markets (Mitchell, 1992), widen existing product portfolios (Roberts and Berry, 1985), diversify distribution channels faster (Heide, 1994), or share risks with the selected partners. Similarly, efficiency-driven relationships emerge as alternative procurement strategies to reduce input costs (Garud and Kumaraswamy, 1995), overcome capital constraints (Tripsas et al., 1995), leverage asymmetric power distribution (Anderson and Narus, 1990), or benefit from differences in labor costs (Harrison, 1994). In all cases, the strategic perspective assumes that networking decisions are made rationally by the actors involved, and that all options are potentially equally available even if not equally attractive.

Research in institutional theory (DiMaggio and Powell, 1983; Greenwood and Hinings, 1996; Scott, 1995) and comparative business systems (e.g., North, 1990; Whitley, 1992, 1999; Redding, 2001) suggests an alternative set of objectives and constraints on network decision-
making. Although still assuming that decision-making is rational, this perspective posits the institutional environment as a major arbiter of which objectives the decision-maker pursues, rather than assuming that economic performance is (or should always be) the clear objective (e.g. Osborn and Hagadoorn, 1997). Relationships and ties therefore emerge as a means to achieve legitimacy, either as a necessary condition imposed through regulations or other means of coercion, or as a signal of accountability to other organizations or to the market in general (Holm, 1995). Such objectives, rather than simple economic/efficiency objectives, are more useful explanations for network strategies in which organizations participate in standard setting bodies (Rosenkopf et al, 2001), trade associations (Chung, 1997), state-led programs, or through product compatibility choices, voluntary standard adoption programs, or corporate philanthropy (Oliver, 1990).

The third set of explanations gives even greater weight to the institutional environment and reduces even further the assumption of rationality (i.e., deliberate choice) from the decision-maker; any relational set is constrained to the specific environmental context in which it occurs (Laumann & Pappi, 1973; Granovetter, 1985; Uzzi, 1996). Although critiqued as over-deterministic, this perspective posits that actors are limited in their choices by the relational constraints in which they are embedded, even to the point that any relational activity observed is not the result of a deliberate choice, but the product of an automatic response, generated by the strong ties and cultural environment in which the actor is embedded (e.g. Nooteboom, 2000; Carney and Gadajlovic, 2002; Whitley, 1999; Wilkinson, 1996). The high relational base of small and medium-sized enterprises (SMEs) in Italian industrial districts (Piore and Sabel, 1982), dense linkages within Japanese keiretsu (Gerlach, 1992) or Korean chaebol (Amsden, 1989, 1997), and the heavy reliance on informal ties (strong or weak guanxi) by Chinese firms (Park and Luo, 2001; Keister, 1998) becomes a cultural property of the institutional environment in which activities are located common to all and result in structural homogeneity among actors.

Clearly, depending on the primary motivation behind the formation of inter-organizational networks, the definition of "effectiveness" can vary considerably. Strategic motivations are associated with a comparative evaluation of economic effectiveness and efficiency, both between networking and not networking and among different types of networking strategies. Effectiveness within the institutional perspective is defined in terms of legitimacy and the degree of acceptance of the networking behavior expressed by the reference community. Cultural-based motivations seek to satisfy a set of values, beliefs and assumptions about what is appropriate in a particular context, and effectiveness is thereby the degree of congruence between actors' behaviors and the salient cultural context.

Although with different emphasis and focus, all three theoretical approaches suggest implicitly that inter-organizational networks need to be examined always with respect to two
fundamental concepts, which are at the root of any analysis of strategic action: the role and characteristics of the relevant decision makers involved, and the role and characteristics of the environment in which relationships occur. While the focus on both dimensions in the analysis of firms’ choices and behaviors has been widely accepted and discussed extensively both theoretically and empirically, inter-organizational research has rarely faced this problem explicitly. Yet, the decisions on whether to rely on inter-organizational relationships or not, why and how are all strategic decisions directly affected by the incentive structures of the decision makers and the opportunities and limitations offered by the external environment. In the next section we focus on China's transition from a central planning to more market-oriented coordination, linking changes in the institutional environment to the salient characteristics of the managers involved in this process.

**CHARACTERIZING THE INSTITUTIONAL ENVIRONMENT**

Decision-makers are not unfettered in their choice among the types of network structuring decisions introduced in the preceding section (Baker et al, 1998). A fundamental premise of our paper is that the institutional environment in which a decision-maker and organization are located has an impact on both incentive structures as well as perceptions of alternatives. Extending Stinchcombe’s (1990) logic, changes in this environment that result in basic changes in a decision-maker’s incentive structure should also be reflected in changes in organizational action manifest in network strategies or dynamics. If we invoke the institutional environment as a fundamental shaper of decisions and behavior, however, we are then obliged to adequately specify the nature of that environment. Therefore, to investigate these issues of contingency and co-evolution, in this section we present a number of general constructs suggested by research on institutional environments, and transition economies in particular, that we would expect to be particularly relevant for network strategies. To do this, we elaborate on the direction suggested by Fligstein (1996:658), focusing on the shared rules and institutions related to control, governance structures, and rules of exchange. These, as well as the nature of organizational mandates and performance criteria, are particularly salient characteristics of China’s transition from a central planning to more market-oriented coordination. Although many of these changes are general to the economic system in China, where appropriate we make reference to features that are more specific to the pharmaceutical industry and the time period covered by our empirical analysis.

Although presented in Table 1 as specific states at two different time periods, any changes are best conceived as gradual shifts rather than stark, rapid transitions. Even when changes were embodied in the enactment of particular laws and policies, not only do most of those changes have
antecedent forms (practice often preceding formal adoption), but implementation was usually a gradual and uneven process.

**Property rights and corporate control**

The issue of property rights—defining who has the right to use, extract rents from, and transfer ownership of assets—is a fundamental feature distinguishing communist from capitalist economies. It has also been both the central and most contentious issue among Chinese policymakers in managing the substantive and ideological transition of the economy from communism to market-based socialism (Nee, 1992; Oi, 1992; Woo, 1997). Deng’s 1979 Open Door Policy did not address this transition, and both ideology and action through most of the 1980s was based on the principle that the state held all property rights.

As in most systems claiming “state” ownership (or “ownership by the people”), actual control of these “state” assets was often ambiguous. This engendered all of the conflicts of interest in the situation in which politicians or bureaucrats are acting as agents of “the people” (Buchanan, 1972; Niskanen, 1971), and the organizational and system-level inefficiencies identified by Kornai (1980). This is exacerbated in China, where the “state” is in practice not a singular actor, but includes multiple actors who could make claims on “state” assets. These were located across a poorly coordinated super-matrix—vertical administrative hierarchies including city, county, provincial and central governments, and horizontal functional bureaucracies, including industrial ministries, personnel and labor ministry, finance ministry (Walder, 1995). Rather than a clear separation of turf—rights, roles and responsibilities—the system has been characterized as “fragmented authoritarianism” (Lieberthal, 1995), with actors within the matrix having much more autonomy in decision-making and behavior than suggested by the formal hierarchical structure.

The result is that top managers in Chinese organizations are subjected to multiple bureaucratic “in-laws”, and those in-laws are able to compete for control and extract rents—essentially, each acting as owners of these organizations (see Steinfeld, 1998 for a detailed illustration of this feature and resulting dynamics in the steel industry). The critical feature was that these in-laws’ relative shares of control and “ownership” have never been clarified. Thus, consistent throughout the period we are analyzing in our empirical study, top managers of organizations have a broad range of bureaucratic “owners” to whom they are subject.

This feature is intricately linked to the locus of strategic decision-making and the reason that it is necessary, in this institutional context, to distinguish between the locus of *discretion* over decisions and the locus of *responsibility* for decisions and organizational performance. Over the transition period, responsibility for meeting performance goals has shifted downward to the top managers of organizations (Jefferson and Rawski, 1994; Child, 1994, 2000). Discretion and
decision-making power, however, have not been so completely pushed down to organizations. Top managers have been assigned broader and greater powers to formulate strategy, including most decisions related to materials, production, sales and non-executive personnel (White and Linden, 2002). Their authority, however, continues to be subject to intervention by numerous bureaucratic actors who may have no formal authority, but who are nonetheless able to participate in and strongly influence strategic decisions that are usually assumed to rest with top managers. The role and behavior of these actors is analogous to those of major shareholders and directors, but without the constraints that related corporate law would impose on them.

In contrast to property rights related to productive assets or organizational control, there has been greater change in the area of intellectual property rights. Until the mid-1980s, knowledge assets generated by state-owned organizations were also considered property of the “state”. Organizations did not have the right to extract rents from their use or transfer ownership and, thereby, benefit that organization or its employees. Indeed, industrial ministries or other bureaucratic actors would direct the use or transfer of such assets in order to achieve objectives established within a national or industry-level plan.

Starting in the mid-1980s, the Chinese government loosened its control over the exercise of property rights by organizations with the hope that this would encourage greater dissemination and more effective exploitation of such technology. While still nominally state-owned, organizations could implement the intellectual property—new product or process technology, for example—internally to generate revenues over which the organization would have discretion. They could, alternatively, sell or license the technology to other organizations to generate revenues. The government even established technology markets to facilitate auctions and other transfers between organizations (Gu, 1999).

While the this change freed up intellectual property and facilitated technology transfer between organizations, such property rights were only poorly defined and protected legally. Even though commercial laws were established and refined from the 1980s onwards, intellectual property laws and enforcement have remained rudimentary and, arguably, undependable from the perspective of a intellectual property owner.

**Organizational mandate: Roles and performance criteria**

Organizations have mandates that may be described in terms of their roles and performance criteria. These mandates may be vaguely assigned by general society’s expectations and shaped by historical precedent, or formally assigned by a political, legal or other form of authority. Roles may be functional and relatively straightforward—for example, to conduct research, produce oil, deliver goods—or more ambiguous—for example, to increase shareholder value, maintain security,
contribute to society, or support economic development. Similarly, performance criteria may be simple and unambiguous, such as indicated by level of production, stock price, profits or market share, or more complicated when multiple and diverse criteria are applied. Roles and performance criteria may also be interdependent; for example, some options for pursuing particular performance objectives may be precluded because of nature of the role(s) assigned to the organization.

Alas, organizations rarely have clear and simple mandates, either in terms of roles or performance criteria. One reason that mandates are usually more complex is that most organizations are subject to influence from multiple stakeholders, and not just shareholders (Freeman, 1984; Carlton and Kurland, 1995). The more diverse the stakeholders in terms of interests, power and legitimacy (Morgan, 1986; Mitchell et al, 1997), the greater the possibility that they will have divergent expectations of what an organization should do, as well as different views of relevant dimensions of performance.

This concept of the complexity of an organization’s mandate is relevant in any society, and particularly so in characterizing the transition in China’s institutional environment. The large organizations in China, whether research institutes, universities or manufacturers, had two distinct roles. The first was functional, and in terms of value-chain activities organizations were formally assigned functionally specialized roles (Liu and White, 2001). Therefore, research institutes conducted research, universities taught, manufacturers produced, and distributors transported. In the case of research institutes and specialized technical colleges, these roles were also limited to particular domains, whether technical fields (chemistry, electronics, social sciences) in the case of research organizations and specialized technical schools, or industries in the case of manufacturing firms. The second role, common to all organizations, was to provide welfare functions to its employees, their families and retirees (e.g., Walder, 1989, 1991). These functions, managed by the organization itself, ranged from schools, clinics and hospitals and cafeterias, to showers, housing and retail distribution.

Organizational performance criteria, and evaluation criteria for top managers appointed to those organizations, were similarly linked to these two roles. The organization was assigned production targets within national five-year and annual plans that corresponded with its functional role. In most cases, the main criteria were measures of output scale, i.e., production volume or production value (output x assigned “price”, not a market price). Operational scale, in terms of fixed assets, was another scale-based performance criterion. Managers who fulfilled or exceeded output measures, and those who increased an organization’s fixed assets, were evaluated highly by the Communist Party and the industrial bureau or other ministry who had a stake in their subordinate organizations fulfilling or exceeding their assignments within the central plan.
Similarly, for the organization’s performance as a provider of welfare functions, performance criteria included number of ancillary operations and the number of people they provided for. Notably missing from these organization- and individual-level performance measures are any indicators of quality or efficiency (White and Liu, 1998). Furthermore, top managers in these organizations were not only focused on meeting externally-determined targets, but also extremely risk averse. Managerial performance evaluation was not based on market-based measures of performance, but on 1) meeting or exceeding targets and 2) not making mistakes. They had no external incentives to introduce changes outside the scope dictated or suggested through the policies of their bureaucratic superiors.

This characterization of organizational and top-manager mandate began to change with a series of reforms introduced from the mid-1980s. First, organizations were allowed and encouraged to expand their functional roles. For example, a number of national programs were implemented that provided funds and other assistance to manufacturers for them to establish R&D facilities internally to support their manufacturing activities, or to support collaboration between research organizations and manufacturers. Policies introduced by the State Council in 1987 and 1988 made it legitimate for research institutes and universities to vertically integrate into business activities, either alone or through relationships with manufacturers (Gu, 1999). Researchers were allowed, even encouraged, to establish commercial enterprises and spin-offs, first under the auspices of their home institute and later on their own.

During this same period, there were important changes in the performance criteria for both organizations and their top managers. First, the ability to generate and increase tax payments to the government became an important criterion. One of the reasons that the government was relaxing constraints on organizational roles was the hope that managers would then pursue activities that would increase revenues and, for the bureaucracies, tax revenues. Although organizations were given the discretion to allocate more of the revenues they generated—whether as bonuses, welfare facility improvements or, less often, productive purposes (Walder, 1995)—this was after the government extracted its share as taxes. Second, the ability to develop and introduce new products proactively, not according to a central plan, became an important performance criterion. During this period, the Chinese leadership and key bureaucracies (e.g., State Science and Technology Committee) began to see the link between innovation—developing and exploiting new technology to make qualitative improvements in products and services—and national economic development. The level and economic value of new product development became an additional measure of organizational and top manager performance. Furthermore, it became the basis for attracting targeted funds to support new product development, as well as subject to tax breaks for revenues generated from new products.
Exchange governance

Interorganizational strategies require some mechanism to govern the behavior of the exchange partners. Zucker’s (1986) conceptualization of three bases of trust provides a useful means of distinguishing among alternative means to govern such transactions. The first—experience-based—emerges through the series of interactions between the actors; experience enables them to develop rational expectations for each other’s behavior. The second—shared norms—is common between actors sharing identities that include social norms of interaction and social sanctions for transgressing those norms. The third—formal institutions—represent mechanisms that help guarantee that an actor will behave “correctly” and that a transaction will proceed as expected.

In any interaction, all three of these bases of trust may be at work. However, in particular environments, they may not be equally salient or effective. Therefore, we distinguish among institutional environments based on the degree to which interactions depend on any of these three bases of trust.

The Chinese business environment has been described as “network capitalism” and “alliance-based”, in which personal relationships (“guanxi”) are critical for interpersonal and, by extension, interorganizational relationships (e.g., Boisot and Child, 1988, 1996; Peng and Heath, 1996; Park and Luo, 2001). While Chinese individuals do have strong ties that qualify as true guanxi ties (Xin and Pearce, 1996), the bulk of relationships are actually quite instrumental and grounded in deep suspicion of a partner’s true intentions or willingness to behave opportunistically (e.g., Fukuyama, 1995). This is reflected in the strong distinction between in-group and out-group relationships, and the very different norms of behavior associated with each (Gudykunst et al, 1992; Leung and Bond, 1984; Rhee et al, 1996).

Using Zucker’s distinctions among the bases of trust, too often the existence of interpersonal and interorganizational relationships in the Chinese economic system is assumed to rest on the second form of trust, shared norms. In practice, the first dominates interpersonal relationships, but its impact on governing relationships is limited to a focal individual’s relatively few true guanxi ties. The third—formal mechanisms—has played the most important role in interorganizational relationships in China’s recent history under central planning, in the form of bureaucratic hierarchical controls (rather than, for example, disembodied institutions such as the legal system). While recognizing that experience-based interpersonal trust is relevant for interactions between organizations, it is the nature of the formal institutions supporting trust that have changed most during the transition period.
Under central planning and into the 1980s, industry and political hierarchies were the formal mechanisms safeguarding transactions between organizations (Naughton, 1990), at least, those transactions that were part of the national plans or mission projects. In the case of the pharmaceutical industry, for example, the State Pharmaceutical Administration of China (SPAC) or predecessor bureaus performed this role (White and Liu, 2001). In addition to setting functional output targets for the research, manufacturing and distribution organizations under its purview, it also directed interorganizational transfers and collaboration. Between research organizations and manufacturers, the resulting structure was one of trilateral governance (Williamson, 1985:74), with the two functional organizations subordinate to a common superior; in this industry, SPAC.

The series of economic and enterprise reforms that began to be introduced during the 1980s directly affected this interorganizational governance structure. Increasing organization-level responsibility and authority (Child, 1994; Naughton, 1994) corresponded to the withdrawal of bureaucratic actors like SPAC from strategic decisions such as whether and with whom to form interorganizational relationships. The role of bureaucracies as the formal mechanism for promoting and ensuring adherence to interorganizational transactions, however, was not completely compensated by other formal mechanisms. Although the government recognized the need to introduce commercial law, especially that governing interorganizational contracts for asset transfers and other forms of collaboration, formulation was piecemeal and experimental and lagged the increasing need for such law. Familiarity with new legal frameworks, and uncertain implementation by courts that had no domestic precedent for interpreting such laws, further reduced commercial law’s effectiveness as a formal mechanism to create trust.

While we are not critiquing the pace that such laws have been introduced or implemented (indeed, legal systems in Europe have had centuries to develop), this vacuum in terms of formal mechanisms did clearly result in a reduced level of trust in the institutional environment. At least during the early years of China’s transition, the development of experienced-based interpersonal trust could not keep up with opportunities and demands for interorganizational relationships, nor did shared norms serve as an adequate substitute for the drop in formal mechanisms.

**NETWORK STRUCTURAL DECISIONS AND INNOVATION PROCESSES**

In addition to variations in underlying motivations and definitions of the effectiveness of particular network strategies, the range of more specific decisions that must be made as part of a network strategy also depends on the nature of the task. The nature and implications of decisions facing buyers and sellers, however, are qualitatively different than those facing competitors
contemplating a horizontal alliance. This suggests that any discussion of structuring decisions must be made in reference to a particular type of inter-organizational network. In our empirical study, we focus on innovation (new product development) networks.

Innovation activities can be modeled as heuristic search processes (Nelson and Winter, 1977), wherein the actors involved are engaged in the combination and elaboration of knowledge and resources (Perrow, 1984). Whenever the available pool of knowledge or other resources is inadequate, actors need to scan the external environment to complement the internal base or to find indications on possible alternatives for the combination of the available resources. Studies of the innovation process has shown that the propensity to engage in this search and to accept externally developed solutions varies across different decision-makers and institutional environments (e.g., Rappa & Debackere, 1992; Allen, 1970; Katz and Allen, 1982; Henderson & Clark, 1990), and is moderated by various managerial mechanisms such as boundary spanning roles (Allen, 1977; Tushman, 1977; Roberts & Fusfeld, 1981), personnel rotation (Imai, et al., 1985; Aoshima, 1996), and the combination of development and commercialization responsibilities (Imai, et al., 1985; Clark & Fujimoto, 1991). Furthermore, the search process occurs not only through predetermined formal channels, but also (and oftentimes more effectively) through informal contacts (e.g., Granovetter, 1974; von Hippel, 1987; Schrader, 1991).

In the context of innovation activities to develop new products, three fundamental network structuring decisions must be made. The first, relational scale, represents the extent to which an organization relies on external partners and how large is a partners’ relational set (Freeman, 1991). Cohen and Levin (1990), show that more extensive R&D collaboration favors innovativeness in the presence of adequate internal investments. Kogut and colleagues (1995) document how external linkages nurture complementarity in the innovation process and increase barriers-to-entry for direct competitors. For example, Clarysse (1996) finds in his longitudinal analysis of US biotechnology firms that investing in external ties and activating multiple contacts across the value chain can overcome operational scale constraints.

The second type of structuring decisions involves relational scope, i.e. the composition of the relational set. Increasing relational scale is not marginally beneficial unless the nature of partners being accessed is diverse in salient dimensions; actors who access a more varied pool of resources are better off (Arora & Gambardella, 1991; Badaracco, 1991; Ciborra, 1991). High levels of transactions with the external environment cannot be a sufficiently effective search strategy, if the relational domain is not diversified. First of all, by distributing the exchanges among different actors dyadic dependency is limited (Pfeffer & Salancik, 1978; Anderson & Weitz, 1989; Heide & Miner, 1992). Moreover, the more varied the activated set, the lower the chances of overlap among its members, and therefore the lower the redundancy of the established exchange
structure (Burt, 1992; Powell and Brantley, 1992). Finally, a wider scope decreases the cohesiveness of the actor’s exchange structure, allowing greater freedom of action and choice (Burt, 1992). Consequently, lower pressure to conform and higher acceptance of variance create more favorable conditions to overcome competency traps (March, 1981; Levitt & March, 1988).

In addition to focusing on the volumes of the exchange and the resulting scope of resources, the third factor is the \textit{structural pattern of interaction} through which the process occurs. Indirect influences are exerted by intermediaries or as a result of multiple contexts of interaction, and emerge as a function not only of positioning within a relational set, but also of the articulation of the relational set. Padget and Ansell (1993), for example, use the concept of multiplexity to show how the activation of different types of relationship (trade and wedding) were used by Cosimo de’ Medici to leverage power and status. Research in diverse settings shows that alternative structural arrangements are conducive to different results depending on the content of the exchange (Wellman & Wortley, 1990; McAdam & Paulsen, 1993). The structural manifestation of the exchange becomes in part a function of the characteristics of the interaction. For example, Mitchell and Singh (1996) find that alliances are more likely to benefit partners when established to target new market or new commercial applications leveraging on an existing technological base. Hagedoorn (1995) reports different partners’ propensity to engage in cooperative R&D depending on the degree of newness of the projects. Sobrero and Roberts (2001, 2002) find alternative relational approaches in managing joint development in vertical relationship depending on the characteristics of the shared problem-solving.

\textbf{EMPIRICAL ANALYSIS}

The questions motivating our study are how elements of the institutional environment affect the perception and decisions by organizations to develop interorganizational networks, and how changes in the institutional environment are reflected in network strategies. We investigate these questions in China’s pharmaceutical industry and over a period of time in which several relevant elements of the institutional environment were changing. We focus on relationships among research organizations and manufacturers involved in new product development, using network analytic techniques to track changes over a nine-year period at both the organizational and industry levels. More specifically, we focus on changes in relational size, scope and structural patterns of interactions both at the individual organizational level and at the whole network level. These patterns of evolution are then related in the discussion section to the abovementioned changes in the institutional environment to derive a theoretical interpretation coherent with the
expected interactions among decision-makers’ characteristics, institutional environment features and inter-organizational network structuring decisions.

**Data sources and structure**

The data used in this analysis are based on the registration records for all new products (bulk active ingredients and formulations) which were approved for sale by the Chinese Ministry of Public Health (MPH) for sale during 1986-94 inclusive. Many of the approvals are for the same compound, but the applications are sponsored by different firms and, in some cases, several firms are listed as co-producers in the same application. These records also indicate whether the producer firm was involved in R&D supporting the application and, if so, whether jointly with a research organization or alone. Of the 765 new products that were approved, complete information was not available for 63 and these were excluded from the sample analyzed. We also excluded those products that were licensed from abroad and produced by foreign firms. This left us with a total of 689 new products introduced by Chinese firms into the domestic market between 1986 and 1994. A total of 618 organizations—mainly research institutes, hospitals, schools of pharmacy—were involved in the R&D and manufacturing of these products.

Given the empirical context, one alternative for constructing the matrices needed for the network analyses was to build a matrix of collaborating actors by year that included only those actors which had been involved in at least one product during that year. This approach, however, would make any longitudinal comparisons of the resulting organization- and network-level results difficult, both quantitatively and conceptually, because the size and composition of the networks would change over the years.

The nature of the organizations in our sample, however, allowed us to use another alternative for structuring the matrices. Specifically, the population of organizations potentially active was stable during the whole period. All had been established before the period analyzed, and government-led consolidations and mergers did not begin until after the period of this study. We therefore included all 618 organizations actively involved in the research, development or manufacturing of at least one pharmaceutical product during the observed period, generating nine asymmetric valued squared matrices (one per year) of 618x618, with the same organizations included in each annual matrix.

In network analysis, matrices report the number of “messages” between actors. In our empirical context, a “message” is a connection between two organizations represented by their common involvement in an approved product. Matrices are “valued” because cells report the number of messages (new products) between two organizations in any year. Matrices are asymmetric, as we can distinguish between senders and receivers based on who is listed as acting
first in the whole drug development process. Data were coded so that row-actors were considered as senders, and column actors as receivers. Off-diagonal cells report the presence of a collaboration between two different organizations in developing a new product while the diagonal cells represent the work performed internally by a single organization. Given a product, and considering messages exchanged between firms, we can distinguish where its development is the result of either some kind of collaboration or the work of a single firm (serving as both the R&D and manufacturing organization).

**Operationalizations of network decisions and outcomes**

**Relational scale**

Relational scale refers to the volume of transactions occurring in the network. To analyze the level of relational scale we first determine the density of each network, expressed as the ratio between the number of contacts observed and the number of contacts theoretically possible (Wasserman and Faust, 1994). The density index varies between 0 and 1; the closer to 1, the more interconnected the network. This is an overall index applicable to the whole network and sensitive to the network’s size (i.e., the number of actors included in the matrix). This sensitivity, however, was not an issue in our analysis because of the constant size of the matrices over the years. Thus, we are able to make longitudinal comparisons of the density indices.

While useful for obtaining a high-level view of the data, network level density indices hide any inter-actor differences. To move to the level of individual actors, for each year-matrix we focus on the edges (i.e. an ordered pair of connected organizations) to calculate an organization’s proportion of work that was internal (developed independently), the proportion that was undertaken across organizational boundaries, and the number of contacts sent and received. All calculations are based on the analyses of diagonal and off-diagonal values and their aggregations. Resulting values are compared over time.

**Relational scope**

Focusing only on the level of exchange within the different relational sets only addresses the scale of such activities, not the scope of network activities. The very nature of the search process with the goal of introducing new products would suggest a strategy of forming relationships to access different resources. If so, we would expect to see variation in the scope of network relationship.

The degree of scope is a function of three elements: (a) the size of each individual relational set, (b) the distribution of the exchanges within such set, and (c) the characteristics of the
actors involved in the set. Like scale, the definition of the scope of relational activities in network analysis is applied to both the overall network and actor levels. At the network level the focus is on the variance in the relational set; the higher the variance, the more distributed are activities and the wider the scope of exchange.

This aggregate network-level measure, however, does not provide insights into the network behavior of individual actors. For this purpose, network analysis is used to calculate an actor’s rank or prestige indices. To do this, we use two measures: the proximity prestige index to capture the scope of each actor’s relational domain (Lin, 1976), and the status prestige index to weight the observed relational domains depending on the type of actors included. The proximity prestige index considers simultaneously how large is each actor’s senders group and how far he is from his senders. The size of the senders group provides an estimate for the number of relations activated, and the distance from the senders weights the received ties with respect to their closeness. The index is then calculated as the ratio between this weighted measure of the size of an actor’s influence domain focusing on the relations received (i.e. all the actors who directly or indirectly send a tie to actor i) and the measure of the average distance between actor i and all the actors in his influence domain. It varies between 0 (no actor sends any tie to i) to 1 (all actors send a tie to i); the higher the index, the higher the actor’s prestige.

\[
\text{PROXIMITY PRESTIGE INDEX} \\
P_p(d_i) = \frac{I_i/(n-1)}{\sum_j g(d_i,d_j)/I_i}
\]  

(1)

The status prestige index (Wasserman & Faust, 1994) is used to compare actors’ influence domains on the basis of their composition. In this index, rather than the size and scope of the influence domain, the characteristics of the actors included in the domain are the focus. As a relational structure becomes more distributed, there will be higher variance status distribution among the actors observed. A concentrated structure, on the contrary, suggests a predominant role for relatively few actors. Technically, the index requires a set of simultaneous equations to be solved, where the prestige of any actor is a weighted measure of the prestige of the actors in his influence domain. To solve this system of n equations, for any given matrix \(D\), the status prestige index for each actor \(i\) is calculated as follows, where the parameter \(\alpha\) is required to obtain a non-trivial solution:

\[
\text{STATUS PRESTIGE INDEX} \\
P_r(d_i) = \sum S_i(\alpha + \beta P_r(d_i))
\]

(2)
Because this procedure ignores directionality, to preserve our full data set, we first diagonalize each $D$ matrix in respect to the lower part, then to the upper part, and then we sum these two matrices obtaining a symmetric matrix $S$. Following Bonacich (1972), we then compute $\beta$ as the inverse of the largest eigenvalue derived from a factor analysis performed on $S$.

**Structural Patterns of Interaction**

In addition to possible differences in the size and scope of the relational flows, we may also expect to observe consequences at the structural level of the relations. A more complete analysis of the overall structure of the interactions would include indirect contacts among the actors, and such an analysis requires alternative analytic techniques. Sub-group analyses are appropriate for providing additional characterization of the structural patterns of interaction. Intuitively, for any given set of actors, the higher the number of the sub-groups, the higher the chances of between group interaction via some key actor and the more interconnected the overall relational structure. Similarly, for any given set of actors, the higher the number of members in any of the sub-groups, the higher the chances of co-membership within different groups for any actor and, consequently, the more interconnected the overall relational structure through higher levels of multiplexity. Moreover, cohesive sub-groups are theoretically important for several reasons. First, social forces operate strongly by contact with others belonging to the relevant reference group (McAdam & Paulsen, 1993). Second, exposure to exchanges in the network is frequently mediated by the reference group (Ibarra, 1992). Third, unbalanced cohesion among the members within and outside the reference group is frequently observed (Gerlach, 1992).

Clans are a central concept in the technical analysis of sub-groups. A clan is defined as a subset of nodes for which the geodesic distance is not greater than a predetermined value $n$ for paths within the subset (Wasserman and Faust, 1994). Looking at clans within a network provides additional information on its substructure, as it maps subsets of actors which are either directly connected, or connected via a limited number of intermediaries who are in turn members of the same subset. The higher the number of clans for any given $n$ (i.e. the maximum distance between any two members of the clan), the more distributed the exchange activity within the network. The same is true with respect to clan size; the greater the number of members in each clan, the more connected the network. For a given network size, however, clan size and numerosity are related (Wasserman & Faust, 1994); namely, the larger the number of clans and the larger their memberships, the higher the chances of overlapping contacts among network members. An analysis of the number and size of clans therefore represents a third level of the analysis of relational activities, complementing the results for exchange scale and scope by focusing on the structural patterns of the exchange.
Since the data to be analyzed are directional, we can choose among different notions of connectedness to identify the actors. Weak connectedness simply requires any two actors to be reachable through direct or indirect linkages. Unilateral connectedness specifies the direction through which the actors are connected (i.e., from i to j or vice versa). Strong connectedness requires reciprocity (ex. from i to j and vice versa). Recursive connectedness extends reciprocity to also include the intermediaries involved (ex. from i sends information to j, via k, and j sends information to i via k as well).

The notion of weak connectedness is particularly appealing to model structural exchange incorporating spill-over effects and taking into consideration indirect contacts. It implies that actors benefit from relational exchange both directly and indirectly within cohesive subgroups, even through unplanned contacts. For example, by working with B, A might find out about C and decide to activate the relationship or benefit indirectly from a spillover deriving from B and C’s interaction. For the purpose of this analysis, we therefore use the weak connectedness requirement and identify n-clans as those sub-graphs in which all actors are connected by a semi-path of length n for any semi-path within the subgroup.

RESULTS

From 1986 to 1994, the number of new products introduced in China steadily increased. Table 2 reports three-year moving averages, from an initial low of 24 to a high of 173 by the end of the observation period. Similarly, the number of organizations actively involved in new pharmaceutical development and manufacturing in a given year increased from 25 to 185.

The aggregate and organization-level trends for independent development and collaboration present an interesting contrast over this period. In rough proportion to the increase in new products introduced, the total number of collaborations increases from 11 to 112 per year. At the organization level, however, the average number of new product introductions in which any single active organization is involved in any given year remains fairly stable around an average of 1. In terms of the ratio of new products introduced by a single organization compared to jointly, at the aggregate level the ratio of new products introduced by a single organization varied between 56% and 73%, with no clear trend over time. At the organizational level, we find a similar trend. If the total amount of work performed in each year by each active organization included in our sample is set to 100, during the observed period on average between 30 and 40% of that amount is performed through some form of collaboration.
Relational scale

As a first indicator of network scale, we focus on the edges—a relationship between two organizations—and trends over the period observed. Focusing only on the actors active in any single year, we notice that the three-year moving average between 1986 and 1994 varies around 1.5, indicating that the average number of ties remains stable (Table 3). We find similar trends if we focus only on off-diagonal values, thereby eliminating all values that can reflect a higher proportion of internal work. Even in this case, the average value is around 1.5. ANOVA results comparing the averages across years are not statistically significant.

Shifting our focus to matrix density reveals complementary information. First, when we consider the whole matrix, all of the different measures reported in Table 4 show a clear increasing trend. Using valued density indices, we see a 42-fold increase between 1986 and 1994, from 0.000026 to 0.001102. Similarly, binary density indices increase from a low of 0.000016 to a high of 0.000710, a 44-fold increase. These trends are also replicated for both diagonal-based densities (binary indices increase from 0.006472 to 0.266990) and off-diagonal based densities (binary indices from 0.000005 to 0.000278).

Computing density indices based only on those actors who are involved in the development of at least one new drug in the year of observation leads to different results (Table 4). Valued density indices actually decrease over the period, from 625 to .008, as do binary indices from .375 to .005. Results are similar for diagonal-based densities, which decrease from 1 to 0.724, as do off-diagonal based binary indices, from 0.167 to 0.002.

Taken together, the results for relational scale at both the organizational and network levels lead to several descriptive conclusions. First, the increase in the relational activity observed is directly correlated with an increase in the number of compounds developed. Furthermore, as the overall network density increases, the new product development process appears to be distributed across the whole network, rather than clustered around a few actors. This distributed growth in the activities of the whole set of actors occurs as a result of each active actor over the years not increasing its direct relational set. In other words, the aggregate number of collaborations in the network increases, as does the number of actors involved, but the number of collaborations in which a single actor is directly involved does not. On the contrary, it remains fairly stable.

Relational scope

Considering what we have just observed about network scale, it is particularly important to analyze the scope of these relationships and their evolution within the observed networks. Results from the scale-based organizational trends should be related to the relational scope of each actor along the years.
We find that the average values for the proximity prestige index (Table 4) are low in all years, especially if we consider that its interval of variation lays between 0 and 1 (values closer to zero indicate a smaller influence domain for that actor and a greater distance between that actor and those to whom he is related). Results for our sample are consistent with a relational set that increases in overall size, but through a distributed local (organization-level) network structure. This is also confirmed by both the standard deviation and the coefficients of variation that, as measures of dispersion, reflect a relatively concentrated distribution of the individual values for the proximity prestige index.

In contrast, we cannot rely on direct measures, such as the mean or variance, to compare power prestige indices (Table 4) because each distribution is expressed in a metric that has been generated by the mathematical procedure used to compute individual values. We therefore compute the coefficient of variation, dividing the standard deviation by the mean for each year. Consistent with the other results, the variation of the power index across the organizations decreases during the year, indicating a more distributed relational set to which each organization belongs. Over time, therefore, the networks increase in size, but do not show any tendency towards a concentrated structure polarized around few influential actors. Instead, the overall relational set grows in a distributed fashion.

**Structural patterns of interaction**

The final set of results addresses network behavior and patterns of interaction in terms of sub-group structure and its role in promoting indirect contact. Our results show that the numbers of both 2- and 3-clans increase constantly over the period, in both absolute and relative terms. The number of 2-clans, calculated as three-years moving averages, increases from 1 in 1986 to 20 in 1993, while the number of 3-clans increases from 1 in 1986 to 16 in 1993.

If we equalize the average prestige of two years (i.e., t1 and t2), we can calculate the ratio between the variation of the sum of geodesic distances and the squared variation (cardinality) of the influence domain. In other words, if we consider the average actor in terms of prestige in year t2, the edges (relationships) that actors entering his influence domain set up are likely to go toward other actors. This is consistent with the results showing an increase in both 2- and 3-clans.

These patterns can be appreciated from Figures 1 and 2, which graphically convey how the number, scope and structure of interorganizational ties increase through a wider and distributed participation by different actors over time. Rather than polarizing around a few influential actors who become nodes or a set of nodes, the network shows a widespread set of activities, wherein each organization’s relational set tends to remain rather limited in terms of direct ties at any given time.
DISCUSSION

The results of the longitudinal analysis on organizational networks choices and overall network structure reveal a dual emerging structure. Network-level results show clear year-on-year increases in all measures of scale and scope over the observed period. In terms of scale, more organizations are involved, more new products introduced, and more collaborations undertaken. These trends are also reflected in network density, which increases dramatically over the nine years, holding network size constant. Aggregate scope also increases because new actors are not limiting their interactions to a small set of organizations, but are interacting with a much more diverse set. Results for the structural pattern of interaction corroborate this finding, showing that the number of clans increases without an emergence of a few nodes. The network is increasingly dense but distributed, rather than forming a core-periphery structure.

At the organizational level, however, we find considerable homogeneity among actors in terms of both scale and scope-related strategic choices, leading to a very distributed network without the dominance of a few actors over others. Moreover, their behavior remains very consistent over the nine years of our study. These are captured directly by our findings for relational scale (number of new products and partners) and scope (prestige indices), and can be inferred from the findings for structural patterns of relationships (clans). First, there is little variation over time and across organizations in terms of the number of new products they introduce (around 1 per year in which an organization is active) or the percentage of products introduced based on inter-organizational relationships (35-40%). Furthermore, each organization maintains a relatively constant number of relationships at any one time (averaging 1.5), but any new relationships are also with partners who have the same, relatively small number of ongoing relationships (reflected in the emergent distributed clan structure).

In the following paragraphs we link these results to the characteristics of the decision makers responsible for the development of a network strategies and the changing institutional landscape they faced in the period observed.

Managers’ incentive structure and strategic network choices

As described earlier, many—but not all—institutional elements of the Chinese and pharmaceutical industry environments were in flux during the period studied. Property rights continued to be held by an undefined set of bureaucratic actors, although those related to intellectual property (i.e., new product and process technology) were gradually allowed to be exercised by organizations. Decision-making responsibility clearly shifted from industrial bureaus
to the top managers of organizations. Top managers were also given more decision-making authority in terms of scope and power to implement strategic decisions, although they remained subject to intervention by numerous political and bureaucratic stakeholders with diverse interests vis-à-vis the organization. Top managers were allowed and increasingly encouraged to undertake additional functional roles (i.e., R&D, manufacturing) in their organizations. At the same time, they were presented with an expanded list of performance goals, including not just scale of functional output and employee welfare provision, but also tax revenue generation and both new technology development and exploitation (as new processes or products). Finally, the primary mechanism that governed interorganizational relationships under central planning—trilateral governance by industrial bureaucracies—was removed and not adequately substituted by new or existing mechanisms, whether informal or formal (e.g., contract laws and judicial enforcement).

Top managers not only had to deal with external stakeholders’ varying degrees of intervention in strategic decisions, but they were also personally subject to several of these stakeholders for their career paths. During this period (and even now, for top positions), managers were assigned to positions in SOEs and research organizations, with appointments managed by a specialized bureaucracy and approved by both the Chinese Communist Party as well as the relevant industrial bureaucracy. Because they typically occupied top positions for only a few years before being transferred to their next position, these managers placed priority on making choices that represented the lowest risk of meeting performance objectives in the shortest time. That this risk-aversion resembles that usually associated with bureaucracies is not surprising, given the dominance of the management structure and cognitive legacy of the central planning era.

What was the resulting incentive structure and evaluation of options for the top managers of these organizations, and did that change significantly over the period studied? Evaluating their alternatives in light of their organizational context and the institutional environment we have described, top managers were highly constrained in their options. First, avoiding new and uncertain activities by not introducing any new products proactively became increasingly untenable, primarily from a legitimacy-seeking rationale. The central government and industrial bureau had made this a clear priority for organizational and managerial performance evaluation, seeing it in terms of its central objective of economic growth. The government was also providing financial support (tax incentives, project-based subsidies) and administrative support (loosening intellectual property rights control, establishing technology markets).

Given the imperative to introduce new products, the top managers had a series of decisions to make. First, could and should they rely on their internal resources and capabilities to introduce new products, or should they somehow access resources and capabilities in other organizations? On one hand, they were functionally dependent on other organizations. The functional
specialization of Chinese SOEs was a result of China having implemented the Soviet model of industrial structure in the pharmaceutical and many other industries. The result was that these organizations were by design weak or completely inexperienced in other functional areas (White, 2000). Research organizations had no expertise in full-scale engineering or production, nor did manufacturers have significant R&D capabilities. Although a range of government policies and programs starting in the mid-1980s provided some incentives and support for organizations to diversify into other value-chain activities, top managers were only beginning to respond during the 1990s.

On the other hand, although critical complementary resources may reside in other organizations, the mechanism for accessing those without being subject to opportunistic behavior by the other organization was not clear. First, under central planning, scanning and maintenance of knowledge about the location of useful resources had been the responsibility of the industrial ministries, not the functional organizations. Scanning for and maintaining such knowledge represented a new set of skills for these organizations and their top managers. Second, even if they located relevant resources and capabilities in other organizations, their experience in initiating interorganizational relationships was limited to satisfying the need, under the practice of an inefficient central planning system, to source additional inputs outside official plan quotas. More importantly, however, there was no dependable mechanism to govern the transactions between organizations. Even as the industrial bureaucracies were gradually reducing their responsibility and activities in this role and allocating that strategic action to top managers, those managers also realized that China’s new and incomplete commercial law institutions (contract law and its enforcement) were not adequate insurance against an opportunistic partner.

From a manager’s perspective, conversely, being successful in leading firms with strong product innovation capabilities had several implications. First, by meeting a fundamental parameter of the government’s evolving policy goals and performance criteria, the manager and organization would gain legitimacy in the eyes of the political bureaucracy. This, in turn, would help attract subsequent funds, obtain fiscal incentives, improve one’s career path, and so forth.

Trends in network behavior at both the organization and industry levels suggest that top managers responded to these mixed incentives by pursuing a combination strategy. Rather than following a pure outsourcing or pure internal strategy, we find that they implemented a combination of the two.

As a result, total collaboration in the industry increased along with the number of new products developed, but all organization-level indices of relational scale remain stable along the whole period observed. Both research organizations and manufactures seemed to have converged on a common set of choices from the beginning of the period. The average value of an edge, that
is the average “quantity of information” exchanged through an established link with another actor, also remains stable over the years. The same occurs for the average number of projects (development of new products) a single firm is involved in. Top managers are clearly pursuing growth, but always rely heavily on internal activities, a rational response given the uncertainty they faced in the changing institutional context and their lack of familiarity with initiating and managing collaborative relationships.

Although strategic collaboration are an important means for gaining resources, learning, and thereby competitive advantage, it also entails inherent coordination costs and risks of opportunistic behavior as each partner tries to maximize its own individual interests instead of collaborative interests (Das and Teng, 2000; Park & Ungson, 2001). Partners’ choice and selection procedures to minimize such costs and risks become a specific competence to reduce intra-alliance rivalry (Baum et al, 2000), develop trust-based relationships (Ireland et al, 2002), and overcome cultural distance between partners (Pangarkar & Klein, 2001).

The risk-averse nature of SOEs managers highlighted by public choice theory and illustrated by empirical studies in Western countries is also clearly a factor in Chinese managers’ choices regarding relational scope. Proximity Prestige indexes computed at the individual organization level to capture the scope of each actor’s relational domain show low and stable values along the years. Each organization, therefore, strikes a balance between the number of partners with whom it collaborate and their relative distance. Yet, as the decreasing values of the Status Prestige index confirm, these strategies are diffused and rather homogeneous among all organizations, as no dominant partner emerges over time. Once more, we observe the emergence of a network that, even if increasing in its overall size, does not collapse in a concentrated structure focused on few dominant actors. Instead, managers are systematically spreading out their linkages. Collaboration costs and risks are distributed intentionally to capture associated growth opportunities and while limiting a manager’s exposure to uncertainty.

The changing institutional landscape and the emergence of an isomorphic network

One fundamental criterion that may affect each of the decisions discussed above is a decision-maker’s preference for differentiated versus mimetic behavior. The results from our analysis, and the implicit definition of risk held by top managers of these organizations, suggest that mimetic isomorphism is an accurate description of the dominant logic. Empirically, we find that the organizations are extremely homogenous in terms of their strategic behavior: number of products developed at any point in time, proportion of internal versus interorganizational development, and number of interorganizational relationships entered into at any point in time. Furthermore, these behaviors are consistent over the observed period, in spite of the considerable
changes introduced during this period of China’s transition from central planning to a more market-oriented business system. Mimetic behavior is also consistent with the institutional environment in this context. In a bureaucratic system, following the majority may be legitimate and, more importantly, adequate defense if the chosen strategy fails.

Clan measurements reflect the outcome of such behavior at the network level; in this case, a very distributed structure of exchange activity within the network. The increasing average number of clan members also reflects a growing, connected network that differs from the star-like structure that is more common in other contexts. Since our analysis takes into account an organization’s total work in a given year, it’s important to underline that clans observed in a year are typically formed through collaborations on different products. Applying the notion of weak connectedness, the results suggest an important role for indirect contacts in allowing spill-over effects among firms along both spatial (actors linked in a given year) and temporal (actors linked longitudinally) dimensions. In this way, even without developing a core-periphery structure, the resulting network of relationship allows each organization to have a more complex set of potential partners for future collaboration.

This evolutionary pattern starkly differentiates the Chinese pharmaceutical industry network from the pattern found in developed economies. In those contexts, typically a few firms will come to dominate an industry network through both horizontal and vertical integration. In such contexts, sociologists have long recognized the role of markets as selection mechanisms and a force for isomorphism among organizations operating in the same market environment. Isomorphism results from their converging towards the same form that fits the market environment. To this are added the potential impact of institutional pressures towards isomorphism, whether coercive, mimetic or normative (DiMaggio & Powell, 1983).

In the Chinese context, especially during the period of our study, the market did not represent a selection mechanism nor a source of isomorphic pressure. Organizations could not go bankrupt, and critical performance criteria had little to do with market-based competitive outcomes.

Instead, the institutional environment created the context for strategic decision-making. Given the uncertainties of that environment and the simultaneous need to be seen as legitimate, mimetic behavior by choosing and implementing similar—not differentiated—strategies is a manager’s best course of action. While not denying effectiveness-seeking intent on the part of the managers, mimicking behavior also has a strong ritual meaning and confirms institutional legitimacy for the organization and its leaders. It also represents a defense mechanism for coping with the cognitive complexity manifest in the transitioning business system, as well as the incomplete overlap between the locus of discretion and locus of responsibility.
CONCLUSIONS

In this study we have tracked the evolution of interorganizational networks among Chinese research and manufacturing organizations in the pharmaceutical industry. We have linked observed network behaviors at the organizational level to the incentive structure facing top managers. This incentive structure is complex, encompassing both measurable and less-defined goals, such as avoiding failure and achieving legitimacy. It has also been evolving, defined in large part by the specific elements of the institutional environment that have been undergoing fundamental change in this context. We argue that the network behaviors observed represent both a rational and effective strategy, given these decision-makers’ incentive structure.

At the overall network level we find a clear increase in innovative activity (represented by new products developed) achieved through an equally significant year-by-year increase in inter-organizational activities. At the level of individual organizations, however, we find behavior to be consistent across the nine years of our study. Moreover, the organizations are rather homogeneous in their network strategies in terms of both scale and scope of their networks. Therefore, while total interorganizational activity increases, the emerging network remains distributed and not centered on a few dominant organizations.

These results seem counterintuitive on two respects. First, the consistency in organization-level behavior in the midst of major institutional changes seems at odds with what we may expect, since the Chinese transitional environment is usually portrayed as undergoing fundamental changes on its way from central planning to a more market-oriented business system. Indeed, particular elements of the institutional environment have changed dramatically; for example, the role of the industrial bureaucracies in strategic decision-making, organizational mandates, and some of the criteria for organizational and top-manager performance evaluation. The net effect of these institutional elements and their changes, however, had not resulted in fundamentally different behavior in the context and over the period of our study.

One explanation may be a lag between institutional changes and an impact on decision-making and observed behavior, or that some changes are not very salient in the particular context we studied. Similarly, in the face of such uncertainty, one reaction could be for decision-makers to stick with familiar choices and behaviors. An alternative and not necessarily contradictory explanation may rest in the interaction among institutional elements. Different institutional elements and changes in them may, in terms of net effect on the incentive structure, cancel each other out.

The second seemingly counterintuitive result is the distributed rather than core-periphery network structure that emerges over time as additional organizations become active in the network.
This pattern is in stark contrast to findings in developed market economies in which the selection process among an initial set of firms leads afterwards to a scenario with few big enterprises dominating an industry. However, our study in this transition economy context has drawn attention to, for example, the role played by the particular nature of the decision makers, the specific institutional pressures to which they are subject, the intricacy of institutional goals, and the persistence of pre-reform features that are still shaping an environment in which market forces and supporting institutions are not firmly established. These elements combine to create a complex incentive structure that is also changing in uncertain ways. Mimetic behavior may be the most effective strategy in such an environment.

This highlights a fundamental argument we are making; namely, the complexity of incentive structures—multiple interests as well as constraints—can be used to define and evaluate the “effectiveness” of a particular network strategy. In other words, we are proposing a subjective evaluation of effectiveness, made relative to how it satisfies the incentive structure facing a particular decision-maker, in addition to the more common approach that is independent of the decision-maker and often based on a single criterion. This is in line with the fundamental proposition of scholars who argue that there are multiple rationalities that can lead to alternative but equally rational outcomes (e.g., Weber, 1930 in Redding, 2002:227). Identifying rather than denying these alternative rationales and incentive structures could enrich strategic analyses comparing managerial choice and sources of performance differences among organizations.
REFERENCES


<table>
<thead>
<tr>
<th>Legal system: Commercial law development and enforcement</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>None/minimal</td>
<td>Commercial law enacted, but incomplete, largely untested and unpredictable enforcement.</td>
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<table>
<thead>
<tr>
<th>Organizational asset property rights</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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<tbody>
<tr>
<td>“State-owned”, control claimed by multiple bureaucratic actors.</td>
<td>“State-owned”, control claimed by multiple bureaucratic actors.</td>
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<tr>
<th>Technology property rights</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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<tbody>
<tr>
<td>State-owned; rents from use and transfer cannot be claimed by organization.</td>
<td>State-owned, but rents from use and transfer can be claimed by the organization. Technology markets/auctions from late 1980s.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Organization finance</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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<tbody>
<tr>
<td>Central government budget allocations nearly 100%, direct or via bank “loans”; no capital markets; no excess cash flow.</td>
<td>Central government budget allocations still major portion; several national, long-term programs provide project-based subsidies for technology development, R&amp;D activities in manufacturers, and technology transfer from research institutes to manufacturers.</td>
<td></td>
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<tr>
<th>Possibility of SOE closure due to “failure” (bankruptcy, etc.)</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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<tbody>
<tr>
<td>None.</td>
<td>None.</td>
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<table>
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<tr>
<th>Organization mandate</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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<tbody>
<tr>
<td>Functional specialization (basic research, industrial/applied research, manufacturing, distribution); welfare service provision for employees.</td>
<td>Functional specialization, but manufacturers encouraged to develop R&amp;D capabilities, and research institutes encouraged to assist manufacturers in adopting new technology; welfare service provision for employees.</td>
<td></td>
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<tr>
<th>Performance criteria: Organizations</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting central plan targets; increase scale of operations (fixed assets) and outputs (production volume, production value, sales).</td>
<td>Removal of central plan targets, but evaluation based on scale measures (assets, volume, sales) and tax revenues. Also new evaluation based on development of new technology and introduction of new products.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Performance criteria: Top managers</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
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</thead>
<tbody>
<tr>
<td>Same as organization-level; also, no failures/mistakes.</td>
<td>Same as organization-level; also, no failures/mistakes.</td>
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<tr>
<th>Locus of strategic decision-making discretion</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
</tr>
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<tbody>
<tr>
<td>Industrial bureau, Personal Bureau (all personnel appointments), city and provincial government, CCP</td>
<td>Top managers, industrial bureau, Personal Bureau (top manager appointments), city and provincial government, CCP.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Locus of strategic decision-making responsibility</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial bureau (SPAC), Central Planning Commission, top managers</td>
<td>Top managers.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trust</th>
<th>Mid-1980s</th>
<th>Early/mid-1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>No institutional-based trust at individual or organizational levels; interpersonal trust among small set of others.</td>
<td>No institutional-based trust at individual or organizational levels; interpersonal trust among small set of others.</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 2

RELATIONAL SCALE

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Number of active organizations</td>
<td>25</td>
<td>46</td>
<td>69</td>
<td>90</td>
<td>110</td>
<td>146</td>
<td>185</td>
</tr>
<tr>
<td>Number of drugs introduced</td>
<td>24</td>
<td>49</td>
<td>77</td>
<td>96</td>
<td>111</td>
<td>143</td>
<td>173</td>
</tr>
<tr>
<td>% drugs developed exclusively internally</td>
<td>0.68</td>
<td>0.73</td>
<td>0.60</td>
<td>0.56</td>
<td>0.57</td>
<td>0.61</td>
<td>0.67</td>
</tr>
<tr>
<td>Number of collaborations</td>
<td>11</td>
<td>20</td>
<td>36</td>
<td>58</td>
<td>75</td>
<td>86</td>
<td>112</td>
</tr>
<tr>
<td>Collaboration as % of total development work</td>
<td>0.35</td>
<td>0.30</td>
<td>0.30</td>
<td>0.39</td>
<td>0.43</td>
<td>0.39</td>
<td>0.36</td>
</tr>
<tr>
<td>Avg. number of projects undertaken by an actor</td>
<td>0.96</td>
<td>1.01</td>
<td>1.10</td>
<td>1.08</td>
<td>1.02</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Average value of edge, all edges</td>
<td>1.50</td>
<td>1.51</td>
<td>1.60</td>
<td>1.64</td>
<td>1.57</td>
<td>1.54</td>
<td>1.55</td>
</tr>
<tr>
<td>Average value of edge, off diagonal values</td>
<td>1.54</td>
<td>1.34</td>
<td>1.41</td>
<td>1.53</td>
<td>1.54</td>
<td>1.45</td>
<td>1.43</td>
</tr>
<tr>
<td>Average value of edge, diagonal values</td>
<td>1.46</td>
<td>1.59</td>
<td>1.70</td>
<td>1.70</td>
<td>1.59</td>
<td>1.60</td>
<td>1.63</td>
</tr>
</tbody>
</table>

1 An “edge” is the intersection between a row and column; in the context of this study, the off-diagonal edges represent the number of new products developed between two different organizations, while the diagonal values are new products introduced by an organization alone.
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>All actors</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Valued Density</td>
<td>0.000026</td>
<td>0.000102</td>
<td>0.000157</td>
<td>0.000293</td>
<td>0.000411</td>
<td>0.000445</td>
<td>0.000539</td>
<td>0.000804</td>
<td>0.001102</td>
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<tr>
<td>Binary Density</td>
<td>0.000016</td>
<td>0.000073</td>
<td>0.000110</td>
<td>0.000170</td>
<td>0.000246</td>
<td>0.000291</td>
<td>0.000359</td>
<td>0.000503</td>
<td>0.000710</td>
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<tr>
<td>Diagonal only binary density</td>
<td>0.006472</td>
<td>0.025890</td>
<td>0.051780</td>
<td>0.069579</td>
<td>0.087379</td>
<td>0.097087</td>
<td>0.129450</td>
<td>0.195793</td>
<td>0.266990</td>
</tr>
<tr>
<td>Off diagonal only binary density</td>
<td>0.000005</td>
<td>0.000031</td>
<td>0.000026</td>
<td>0.000058</td>
<td>0.000105</td>
<td>0.000134</td>
<td>0.000149</td>
<td>0.000186</td>
<td>0.000278</td>
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<tr>
<td><strong>Active actors in a given year</strong></td>
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<tr>
<td>Valued density</td>
<td>0.625</td>
<td>0.074</td>
<td>0.027</td>
<td>0.024</td>
<td>0.019</td>
<td>0.014</td>
<td>0.013</td>
<td>0.008</td>
<td>0.008</td>
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<tr>
<td>Binary density</td>
<td>0.375</td>
<td>0.053</td>
<td>0.019</td>
<td>0.014</td>
<td>0.011</td>
<td>0.009</td>
<td>0.008</td>
<td>0.005</td>
<td>0.005</td>
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<tr>
<td>Diagonal-only binary density</td>
<td>1.000</td>
<td>0.696</td>
<td>0.681</td>
<td>0.623</td>
<td>0.593</td>
<td>0.541</td>
<td>0.625</td>
<td>0.611</td>
<td>0.724</td>
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<tr>
<td>Off-diagonal-only binary density</td>
<td>0.167</td>
<td>0.024</td>
<td>0.005</td>
<td>0.005</td>
<td>0.005</td>
<td>0.004</td>
<td>0.004</td>
<td>0.002</td>
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## TABLE 3

**RELATIONAL SCOPE AND STRUCTURAL PATTERNS OF INTERACTION**

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</thead>
<tbody>
<tr>
<td><strong>Proximity Prestige</strong></td>
<td></td>
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<tr>
<td>Mean</td>
<td>0.0016</td>
<td>0.0014</td>
<td>0.0016</td>
<td>0.0016</td>
<td>0.0014</td>
<td>0.0014</td>
<td>0.0014</td>
<td>0.0012</td>
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<tr>
<td>Standard Deviation</td>
<td>0.0000</td>
<td>0.0004</td>
<td>0.0000</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0005</td>
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<tr>
<td>Coefficient of Variation</td>
<td>0</td>
<td>0.28226</td>
<td>0</td>
<td>0.10908</td>
<td>0.27081</td>
<td>0.32447</td>
<td>0.30761</td>
<td>0.28533</td>
<td>0.39644</td>
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<tr>
<td><strong>Bonaich Power Indices</strong></td>
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</tr>
<tr>
<td>Mean</td>
<td>0.003</td>
<td>0.063</td>
<td>0.044</td>
<td>0.082</td>
<td>0.161</td>
<td>0.279</td>
<td>0.249</td>
<td>0.272</td>
<td>0.356</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.05</td>
<td>0.673</td>
<td>0.311</td>
<td>0.397</td>
<td>0.789</td>
<td>1.103</td>
<td>0.927</td>
<td>0.791</td>
<td>1.269</td>
</tr>
<tr>
<td>Number of clans (3-yr moving averages)</td>
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<tr>
<td>2-clan</td>
<td>1.333</td>
<td>3.000</td>
<td>5.667</td>
<td>8.667</td>
<td>12.000</td>
<td>15.667</td>
<td>19.667</td>
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</tr>
<tr>
<td>3-clan</td>
<td>1.333</td>
<td>3.000</td>
<td>5.333</td>
<td>7.667</td>
<td>10.333</td>
<td>12.333</td>
<td>16.000</td>
<td></td>
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</tr>
</tbody>
</table>
FIGURE 1
INTERORGANIZATIONAL TIES, 1988 AND 1994
FIGURE 2

2-CLAN STRUCTURES, 1989 AND 1994