Organization Science
Vol. 17, No. 5, September–October 2006, pp. 637–656
ISSN 1047-7039 | EISSN 1526-5455 | 06 | 1705 | 0637

DOI 10.1287/orsc.1060.0202

When and How Does Business Group Affiliation Promote Firm Innovation? A Tale of Two Emerging Economies

Sea-Jin Chang
School of Business Administration, Korea University, Sungbukku Anamdang, Seoul, Korea 136-701, schang@korea.ac.kr

Chi-Nien Chung
Department of Management and Organization, NUS Business School, National University of Singapore, Singapore 117592, bizccn@nus.edu.sg

Ishtiaq P. Mahmood
Department of Business Policy, NUS Business School, National University of Singapore, Singapore 117592, bizipm@nus.edu.sg

Using a comparative institutional perspective, we explore whether business groups' roles in facilitating affiliate firms' innovation varies by country and time period. We compare the innovativeness of firms affiliated with business groups to that of independent firms in two emerging economies: South Korea and Taiwan. On average, business group affiliates outperform independent firms in South Korea, but not in Taiwan, and in the early 1990s, but not in the late 1990s. The existence of alternative institutional infrastructures for innovation might explain these differences. Groups' abilities to share technological knowledge and financial resources among affiliates enables them to create value by promoting innovation in emerging economies, but groups' diversification might inhibit individual affiliates' innovativeness.

Key words: business groups; innovation; comparative institutional perspective; emerging economies

Theories of economic growth suggest that developing countries can start catching up, which occurs when a developing country narrows the gap in productivity and income vis-à-vis developed countries by borrowing these nations' technology through reverse engineering, foreign direct investment, or licensing (Gerschenkron 1962, Abramovitz 1986). As a developing country catches up, however, and its economy approaches the technological frontier, it becomes more difficult for that country to maintain growth by borrowing other nations' technology. This paradox occurs not only because advanced countries might not be willing to share their technology any longer, but also because the technologies themselves become too complex to be reverse engineered. To sustain growth under such circumstances, developing economies need to become innovators rather than imitators (Kim 1997). In recent decades, some newly industrialized economies have done just that by shifting their bases of competitive advantages from low-cost inputs, such as cheap labor, to technology and brands (Hobday 1995, Porter and Stern 2003).

One organizational form, the business group, has influenced the development of many emerging economies. Several scholars, using mostly anecdotal evidence, suggest this form may have aided significantly the imitator-to-innovator transition (Kim 1993, Amsden and Hikino 1994). Others argue that business groups can create value by substituting for institutions that are taken for granted in developed countries (Leff 1978, Khanna and Palepu 1997). It is unclear, however, when and how business groups have facilitated such innovation.

One way to address this question, which the innovation literature has generally ignored (Coriat and Weinstein 2002), is to examine the interaction between organizations and their institutional infrastructure. More specifically, this literature has not indicated how institutional infrastructures might moderate the innovativeness of different types of organizations. The possibility that they do moderate innovativeness is consistent with the comparative institutional perspective, however, which provides a way to understand the interactions between organizations and institutions over time (Hamilton and Biggart 1988, Dobbin 1994, Orru et al. 1997, Guillén 2001). For instance, Hall and Soskice (2001) argue that distinct institutional setups, such as coordinated economies in which firms generally use nonmarket modes of coordination to organize their activities and liberal competitive economies in which firms use markets to organize their endeavors, are conducive to different types of innovation. This perspective complements the perspective offered by some scholars of national innovation systems, who observe that each country is unique in the types of innovation-supporting institutional infrastructures and the types of innovative organizations that it has (Nelson 1993). The possibility that the ideal type of organization may vary across institutional contexts has important implications for emerging imitator economies that are trying to become innovators.

Given the research gaps described above, we explore the following questions: First, to what extent do business groups contribute to affiliate firms' (henceforth, affiliates) innovation across countries that have different institutions, and how do business groups' impacts on innovation change over time as these institutions evolve? This question sheds lights on an understudied issue in the innovation literature: How does the efficacy of a particular organizational form as an innovation agent vary across different institutional contexts? Second, we consider which of the mechanisms used by business groups actually promote affiliates' innovation. By exploring this issue, our study complements research into how a business group's structure affects its affiliates' financial performance.

To address these questions, we adopt the comparative institutional perspective. We examine the impact of business group affiliation on individual firm innovation in South Korea and Taiwan, which have transitioned from imitation to innovation, despite their different institutional environments. Our approach answers the calls for work that examines the interactions between organizations and institutions in innovation research. It also highlights how business groups' role as a microeconomic agent for economic growth may evolve as an country goes through different stages of development.

Business Group as an Innovation-Supporting Organizational Form

Institutional Infrastructure for Innovation

The extant innovation literature focuses either on organizations or institutions; it rarely considers the interaction between the two (Coriat and Weinstein 2002). The organization-focused approach looks primarily at the effects of firms' internal structures (e.g., organizational design, modes of coordination, incentive mechanisms, and labor relations) on innovation. This approach suggests that to innovate, an organization needs to have financial and human resources—and an appropriate organizational culture—which enables the organization to search for novel information and ideas. An organization must carry out trials of the technology it is mastering and create new skills and operational routines (Lall 2000). It also requires access to a constant flow of ideas that can be recombined to create new ideas (Schumpeter 1934, Weitzman 1998) and an organizational architecture that makes it possible to innovate not just once, but continuously (Brown 1991). Similarly, new economic growth theory emphasizes how knowledge spillovers across firms inspire further innovation (Romer 1990). Organization theory also emphasizes networks and social capital as conduits of knowledge flow and catalysts for innovation (Saxenian 2000, Powell et al. 1996). This approach opens the black box of the firm but risks treating firms as closed systems and technological innovation as the result only of what occurs inside the firm.

Conversely, the institutional approach suggests that a country's innovativeness is determined largely by the institutional context in which innovation agents, primarily firms, operate. It defines institutions broadly but focuses particularly on formal systems such as rules, laws, and regulations; and informal systems such as norms of behavior, conventions, and self-imposed codes of conduct; as well as enforcement mechanisms, which structure human interaction to reduce uncertainty in exchange and provide incentives (North 1990, Campbell 2004). Researchers who study national systems of innovation argue that each country has a unique combination of organizations and institutional infrastructures for innovation. Some scholars focus on a limited set of institutions, such as governmental labs, research institutes, and universities that produce and diffuse scientific and technological knowledge (Nelson and Rosenberg 1993). Others adopt a broader view of institutions and consider financial systems, how industrial relations are organized, the state's structure, legal frameworks, and the customs and cultures embedded in a society (Lundvall 1992, 2003; Edquist 1997). The institutional approach views the firm as passive, reacting only to macrosocial conditions. It highlights the external contingencies that affect firms' innovativeness, but ignores interfirm variation in innovativeness.

The lack of attention to the interaction between institutions and organizations hinders a better understanding of the multilevel mechanisms that generate innovation. We believe the incidence of business groups allows us to examine this interaction. By studying the effects of group affiliation on firm innovation, we hope to clarify the institutional conditions under which the business group becomes a driver of innovation. In addition, we explore the organizational characteristics through which the group form promotes affiliates' innovation to further identify which organizational features may facilitate innovation under specific institutional arrangements. We focus on institutions that are relevant for firm innovation. We use *institutional infrastructure for innovation* to denote the set of systems that allocates financial and technological resources and facilitates the flow of ideas that are directly related to firms' innovativeness.

Business Groups as Innovation-Supporting Institutions

Business groups can be defined as a set of legally independent firms, operating in multiple sectors, that are linked to each other through persistent formal (e.g., equity) and informal (e.g., family) ties (Granovetter 1995, Khanna and Rivkin 2001). These features distinguish business groups from other organizational forms such as holding companies, strategic alliances, and conglomerates and have pivotal implications for individual firm innovation. Because of their persistent ties, member firms within business groups usually coordinate strategies, behavior, and resources to a greater extent than subunits inside holding companies do; the latter are typically self-reliant and are evaluated in financial terms. These ties are often embedded in preexisting social structures such as families, kinship, and ethnicity that provide norms and a moral basis for within-group coordination and transactions (Granovetter 2005). The shared norms and morality embedded in these ties reduce transaction costs and facilitate intragroup transfers of resources. These characteristics also make business groups different than strategic alliances, in which partners use legal contracts to negotiate with each other and incur high transaction costs. Business groups are also distinct from conglomerates such as General Electric. Although both business groups and conglomerates participate in multiple industries, business groups seldom buy and sell group affiliates (Davis et al. 1994).

By substituting for market institutions that are nonexistent or malfunctioning, business groups may play an important role in emerging economies (Leff 1978, Khanna and Palepu 1997). We believe that, given within-group coordination and internal transactions, business group affiliation can increase an affiliate's innovativeness by giving it access to group-level resources, especially capital, technology, human talent, and complementary products and services (Mahmood and Mitchell 2004). First, unlike firms in advanced economies that lack enough internal cash flow, firms in emerging economies with cash-flow problems have difficulty raising external capital. The internal capital market within a business group may function as a de facto venture capitalist and allocate financial resources for innovative opportunities more effectively than outside investors can. Affiliates may also enjoy low capital costs because they can raise external capital at reduced rates and more easily than independent firms can, due to the former's lower bankruptcy risks (Khanna and Yafeh 2005).[1]

Second, firms in emerging markets need to create technological linkages with firms in advanced economies (Hobday 1995). Weak property rights in many emerging markets, however, keep firms from negotiating enforceable, arms-length contracts. Fearful that their intellectual property will be expropriated, firms from developed economies hesitate to license technology in emerging economies. Business groups—because they fear that one affiliate's infringement of intellectual property will affect all their affiliates negatively—protect property rights and enforce contracts more efficiently than their independent counterparts do (Khanna and Palepu 1999, Amsden and Hikino 1994, Kock and Guillén 2001). Thus, foreign providers of technology are more likely to work with affiliates that are known to honor contracts than they are to work with independent firms. Moreover, because affiliates have better access to government privileges, financial capital, research facilities, and talent, foreign firms may benefit more from providing technological knowledge to them.

Third, because markets for technology are inherently incomplete because of threats of expropriation, business groups can substitute for these markets in emerging economies. Knowledge transfer and sharing is easier among affiliates within the same business group (Encaoua and Jacquemin 1982) than it is among unrelated firms. Zander and Kogut (1995) showed that less codifiable and more complex knowledge is more difficult to transfer between firms. They also demonstrated that, due to this difficulty, firms often hire workers away from other firms to facilitate knowledge diffusion. Similarly, Szulanski (1996) and Hansen (1999) found multilevel hierarchical organizations had difficulty transferring knowledge between their subunits. Conversely, business groups allow their affiliates to share technological knowledge.

Business groups can also use internal labor markets to facilitate the sharing of technological knowledge among affiliates. In places where scientific talent is scarce, groups can improve affiliates' innovativeness by incubating this talent. They can incur the fixed costs of setting up an infrastructure to develop this talent and amortize the expenses across all their affiliates. For instance, Samsung Group set up research institutes for which its individual affiliates share research and development (R&D) budgets. Groups can also facilitate affiliate firm innovation by developing efficient internal labor markets that move scientific personnel among affiliates. To foster such talent and develop internal labor markets, groups sometimes concurrently serve as research institutes, engineering universities, and vocational schools. By doing so, they counteract the inefficiency of the external labor market in their economies.

Fourth, intragroup ties are especially useful for pooling and sharing knowledge when there is no well-developed external network of firms or clusters to rely on. Developed economies generally possess robust pools of supporting and interrelated businesses such as suppliers and distributors. Complementary firms augment a firm's innovativeness by providing access to skills, equipment, and customers (Afuah 2000). By contrast, this infrastructure is much weaker in emerging economies, and business groups in such locales tend to vertically integrate or diversify into related businesses to develop an equivalent infrastructure (Khanna and Rivkin 2001). These ties let affiliates gain detailed knowledge of a technology's strengths and weakness, as well as knowledge of what improvements and innovations might yield significant payoffs, because those knowledges usually reside with the customers and suppliers who use the technology (Nelson and Rosenberg 1993).

Institutional Contingencies for Business Group Effects

These benefits occur when specific deficiencies in the institutional infrastructure for innovation exist. The comparative institutional perspective sheds light on the circumstances under which group affiliation can benefit affiliates' innovativeness because it conceives countries as operating on a complex set of variables that differs from one country to another. Different institutional contexts encourage distinct forms of business and market organizations to be established, and any changes in these environments will affect the characteristics of the firms and markets that have developed in tandem with them (Hamilton and Biggart 1988; Whitley 1992, 1999; Hollingsworth et al. 1994; Dobbin 1994; Orru et al. 1997; Guillén 2001). Biggart and Guillén (1999), for example, illustrate how specific configurations of firms and institutions, when combined with distinctive trajectories of development, have resulted in different areas of specialization in the automobile industry in Argentina, Korea, Spain, and Taiwan.

From this perspective, different institutional infrastructures for innovation encourage distinct forms of business organizations to adopt certain structures and strategies. These differences may cause variation across countries and over time in the types and characteristics of organizations that are most conducive to innovation. Business groups' role in facilitating affiliates' innovativeness might thus depend on both the country and period in question, as these parameters are configured uniquely for each country and change over time.

When institutional infrastructures for innovation are well established, group affiliation might not help a firm to innovate. For example, access to internal capital markets will be less critical when alternative sources of capital such as venture capital and specialized stock markets for high-tech firms (e.g., NASDAQ in the United States) are more developed. More efficient markets for technology transfer and greater availability of government research facilities and universities will also lessen the benefits of groups' internal technology market. Generally speaking, the better established the institutional infrastructures for innovation, the fewer the benefits that group affiliation will provide. Thus, we expect that the effect of group membership on affiliates' innovation is moderated by how extensively the institutional infrastructure for innovation is developed.

Hypotheses

In this section, we develop hypotheses to test our proposition in two ways. We focus on the individual firm as the innovation agent and consider the business group as a type of innovation-supporting organization that facilitates the flow of resources and ideas that are directly related to individual affiliates' innovativeness. In Hypotheses 1 and 2, we compare the innovativeness of group affiliates vis-à-vis independent firms. Because institutional infrastructures for innovation vary across countries, our proposition implies that the benefits of group affiliation are greater in countries where institutional infrastructures for innovation are weaker. We also hypothesize that the benefits of affiliation within a country decline as institutional infrastructures for innovation develop.

Hypothesis 1 (Across-Country Variation). *In a country* where *the institutional infrastructures are weak, the innovativeness of group affiliates is higher than that of independent firms.*

Hypothesis 2 (Within-Country Variation). When *the institutional infrastructures in a country are weak, the innovativeness of group affiliates is higher than that of independent firms.*

Because we also wish to understand how group affiliation benefits firms' innovation, we untangle within-group contingencies. Specifically, we examine how the internal market functions of business groups, such as internal capital and technology markets, promote affiliates' innovativeness. First, we argue that business groups' internal capital markets can substitute for poor external capital markets. The larger and richer the internal capital markets, the greater the positive impact of group affiliation; affiliates are thus more innovative. Second, we believe access to groupwide technological knowledge is an intangible resource that benefits affiliates' innovation. When a firm's other affiliates are actively innovating, the focal firm can benefit from their technological knowledge.

Yet we also argue that the innovation-promoting effects of affiliation depend on how developed the institutional infrastructures for innovation are. For instance, in a country that has a relatively efficient external capital and technology market at a given time, a group's internal capital and technology market will not significantly aid the innovativeness of the group's affiliates. We expect internal capital and technology markets will significantly aid affiliates only when institutional infrastructures for innovations are weak.

Hypothesis 3. *The profitability of other affiliates in the same group contributes to an affiliate's innovativeness when institutional infrastructures for innovations are weak.*

Hypothesis 4. *The technological knowledge held by other affiliates in the same group contributes to an affiliate's innovativeness when institutional infrastructures for innovations are weak.*

Although business groups can contribute to affiliates' innovativeness by sharing financial and intangible resources, those groups might differ greatly in their ability to realize this potential. We believe a group's diversification strategy can affect its ability to tap its internal markets.[2] Evidence from U.S. conglomerates shows that unrelated diversification is likely to hurt affiliates' innovativeness, as it discourages risk taking and promotes free riding (Teece 1996). Unrelated diversification leads corporate executives to shift their attention away from strategic objectives such as R&D and toward financial objectives such as profitability (Hoskisson and Hitt 1988). Although financial controls make it easier for top executives in diversified firms to compare financial performance across different lines of business, they also induce divisional managers to have a short-term orientation, be risk averse, and thus invest less in R&D. Hitt et al. (1996) found a negative relationship between financial control and innovation and a positive relationship between strategic control and innovation. This result suggests that unrelated diversification at the group level may hinder affiliates' innovativeness.

Nonetheless, the detrimental effects of unrelated diversification might not exist in every country or at all times. When capital markets are less efficient, the potential benefits of unrelated diversification (e.g., risk spreading) might reduce some of the downside of unrelated diversification. Conversely, if external capital markets are more efficient, unrelated diversification's negative effects will be more pronounced.

HYPOTHESIS 5. *If a business group uses an unrelated diversification strategy, its affiliates' innovativeness is lower when institutional infrastructures for innovation are strong.*

Data and Methods

Empirical Context: Korea and Taiwan

South Korea and Taiwan—henceforth Korea and Taiwan—are our empirical context. Until the 1980s, their competitive advantage was based on low-wage, high-quality labor. Since then, however, both countries have lost this advantage to emerging economies such as Indonesia and mainland China. Wages in both economies increased sharply, and indigenous firms had to upgrade their technology to stay competitive. Korean and Taiwanese organizations became very innovative by the 1990s, ranking 4th and 3rd, respectively, in terms of the number of U.S. patents granted to foreign inventors in 2003. We hence focus on the period 1991–1999.

Yet Korea and Taiwan had different institutional infrastructures for innovation. In Taiwan, a specialized over-the-counter (OTC) stock market for high-tech firms, modeled after NASDAQ, was established in 1988, several years earlier than its Korean counterpart began operating. Second, other innovation-supporting institutions such as public research institutes, universities, and venture capital firms were more developed in Taiwan than they were in Korea (Kim 1993, Hou and Gee 1993). Third, relative to Korea, Taiwan's manufacturing sectors had strong collaborative networks between established affiliates and small independent firms that acted as subcontractors for larger affiliates (Amsden 1991, Shieh 1992). Fourth, Taiwan had more active government agencies than Korea did. Its government set up research institutes to carry out key R&D. These institutes shared their output with the private sector (Wade 1990). Both UMC (United Microelectronics Corporation) and TSMC (Taiwan Semiconductor Manufacturing Company), two of the most innovative Taiwanese semiconductor firms, were spun off from ITRI (Industrial Technology Research Institute), another such institute.

The Taiwanese government set up the venture capital industry in the late 1980s and sometimes acted as a venture capitalist (Amsden and Chu 2003). In addition, it set up a science park that made it easier for small independent firms to conduct R&D by providing these firms with access to various innovation infrastructures.[3]

Unlike Taiwan's government, the Korean government's direct intervention in innovation activities has been limited mainly to the information technology sector. The KOSDAQ, a stock exchange for technology and startup firms, was created in 1996; Korea's venture capital market was almost nonexistent before 2000. In addition, through their OEM (original equipment manufacturing) relationships with small-and medium-sized businesses, multinationals have been more important in Taiwan than they have been in Korea (Amsden and Chu 2003).

Business groups have long been prominent in both Korea and Taiwan. Large business groups such as Hyundai, Samsung, LG, and SK in Korea and Formosa, Far Eastern, Cathay, and Tatung in Taiwan have many affiliates and contribute substantially to the gross national product (GNP). Table 1 shows that the top 30 business groups in Korea, known as *chaebols*, and the top 100 Taiwanese business groups, known as *jituanqyie*, are significant players in the nations' economies. The proportions of the aggregated sales of *chaebols* and *jituanqyie* to their nations' GNP peaked at 97.6% in 1997 and 55.6% in 1998, respectively.[4] *Chaebols* and *jituanqyie* differ, however, in several ways. *Chaebols* were on average larger, more diversified and leveraged, and more centrally controlled. Because Taiwan's government used tax incentives to favor new establishments, Taiwanese groups are more numerous and much smaller than Korean groups (Cheng 1990, Fields 1995, Chung 2001, Chang 2003). The average assets of the top 100 groups in Taiwan as of 1996 was 70.2 billion new Taiwanese dollars (NT$) (roughly US$2.1 billion), while the asset base of their top 30 counterparts in Korea was 10.1 trillion won (roughly US$11.9 billion). Individual affiliate firm size, calculated as the average assets of Korean affiliates in 1996, was 1,486.6 billion

Table 1 Description of Sample

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Korea									
Total number of firms in the top 500 firms sample	304	361	367	367	365	378	329	251	218
Number of group affiliated firms in the top 500 firms sample	190	195	200	201	197	202	198	173	149
Number of independent firms in the top 500 firms sample	114	166	167	166	168	176	131	78	69
Average assets of group affiliate firms in the top 500 firms sample (billion won)	691.8	774.1	851.1	1,022.6	1,277.1	1,486.6	1,916.7	2,268.8	2,328.9
Average assets of independent firms in the top 500 firms sample (billion won)	517.6	471.9	533.4	611.5	735.4	837.1	1,193.1	1,723.1	2,128.6
Sales of top 30 groups aggregated (trillion won) [A]	143	166	187	226	290	337	406	416	387
National GNP (trillion won) [B]	214	238	265	303	348	386	416	443	482
Percent [A/B]	66.8	69.7	70.6	74.6	83.3	87.3	97.6	93.9	80.3
Average number of affiliates of top 30 groups	11.8	11.9	12.9	13.7	13.2	14.8	15.7	14.2	13.4
Average assets of top 30 groups (billion won)	3,947	4,504	5,242	6,424	7,975	10,070	12,171	13,616	13,579
Average unrelated diversification indices of top 30 groups	1.19	1.19	1.27	1.28	1.28	1.30	1.33	1.12	0.98
Average related diversification indices of top 30 groups	0.14	0.15	0.16	0.17	0.17	0.21	0.22	0.19	0.14
Taiwan									
Total number of firms in the top 500 firms sample	357	360	373	401	396	393	367	400	392
Number of group affiliated firms in the top 500 firms sample	138	132	128	165	154	149	128	190	176
Number of independent firms in the top 500 firms sample	219	228	245	236	242	244	239	210	216
Average assets of group affiliate firms in the top 500 firms sample (billion Taiwanese dollars)	7.7	8.8	9.8	10.3	12.6	15.0	19.7	20.5	25.1
Average assets of independent firms in the top 500 firms sample (billion Taiwanese dollars)	2.6	2.7	3.1	3.4	5.1	4.8	6.5	5.6	6.8
Sales of top 100 groups aggregated (billion Taiwanese dollars) [A]		1,872		2,678		3,350		4,853	
National GNP (billion Taiwanese dollar) [B]		5,460		6,455		7,540		8,731	
Percent [A/B]		34.3		41.5		44.4		55.6	
Average number of affiliates of top 100 groups		9.17		10.21		11.19		13.62	
Average assets of top 100 groups (billion Taiwanese dollars)		33		50.2		70.2		115.2	
Average unrelated diversification indices of top 100 groups		0.78		0.77		0.75		0.76	
Average related diversification indices of top 100 groups		0.17		0.19		0.17		0.19	

Note. Average number of group affiliates and average assets in Korea did not include any financial affiliates, while the Taiwanese counterpart comprises data of financial affiliates.

won, roughly US$1.8 billion, much more than that of their Taiwanese counterparts (15.0 billion NT$, roughly US$0.4 billion). This difference reflects many of the largest Korean firms' participation in the heavy equipment and chemical industries, which required sizable capital investments. Furthermore, coordination among *chaebol* affiliates is more centralized than it is among their Taiwanese counterparts. The control in *chaebols* is so thorough that Biggart (1990) describes the *chaebol* president as a patriarch and the management system as patrimonialism. Member firms of Taiwanese *jituanqyie* depend more on informal ties such as family connections and friendships among the firm's leaders, who Hamilton and Kao (1990) dubbed the inner circle.

Korea and Taiwan began liberalizing economically and politically in the late 1980s. Institutions adjust slowly, however, because existing processes, cultural frames, and social beliefs constrain change.[5] In Korea, for instance, real improvement in the institutional infrastructure for innovation occurred only in the late 1990s, after Korea fell prey to the Asia financial crisis in 1997. During the crisis, 13 of the top 30 *chaebols* were technically bankrupt (Chang 2003). Korea received a large support package from the International Monetary Fund, which demanded that the Korean government enforce conservative lending policies, better corporate governance, and simplified mergers and acquisitions (M&A) procedures. As the Korean economy recovered from the crisis, Korean capital markets changed. The KOSDAQ grew rapidly, and the Korean venture capital industry emerged.[6]

Although Taiwan was not directly affected by the Asia crisis, it underwent several changes during the 1990s that significantly altered its institutional landscape. First, its OTC market became much larger and more efficient (*The Economist*, 1997). Second, the share of investments in startups as a portion of total venture capital outlays rose from 13.3% in 1995 to 32.8% in 2000 (Amsden and Chu 2003).[7] These developments made it easier for small and independent firms to get capital for innovation. In addition, the first Taiwanese investment bank, the Industrial Bank of Taiwan, was established in 1998 to provide necessary capital and professional M&A consultation to smaller firms. With respect to labor markets, the first professional headhunter for managerial and technical talent, the 104 Job Bank, was set up in 1996. These intermediaries greatly increased the efficiency of the high-end sector and the labor market. Finally, the share of R&D in Hsinchu Science Park as a portion of Taiwan's total R&D rose from 4.6% in 1989 to 18% in 1998, suggesting that being small or independent, or both, was no longer an obstacle to innovation in Taiwan.

To the extent that business groups provide an alternative to institutional infrastructures for innovation, the benefits of group affiliation are probably higher in places where these infrastructures are less developed. We thus expect that business groups contribute more to affiliate firms' innovation activities in Korea than they do in Taiwan. We also expect that because the institutional infrastructures for innovation were more developed in both countries by the late 1990s, the benefits of group affiliation were lower during the late 1990s. We hence use 1995 as the cut-off point to divide our sample years, 1991–1999, into two periods. Period 1 designates years 1991 to 1995, and Period 2 designates years 1996 to 1999.[8]

Data

Because we are interested mainly in comparing the innovativeness of affiliate and independent firms, as well as innovativeness among group affiliates, we used the top 500 manufacturing firms based on annual sales in each country as our initial sample. We employed this criterion for several reasons. First, this list is more inclusive than are alternative samples, such as a sample of listed companies.[9] For Taiwan, 82% of the listed manufacturing firms are included in the top 500 sample for our sample period. In contrast, 21% of the top Taiwanese 500 firms are listed on the main board of the Taiwanese Stock Exchange.[10] Second, many large innovative firms in both countries were unlisted. For example, TSMC, one of the most innovative Taiwanese firms, was listed only in 1994. Third, it was difficult to collect financial information about small firms, most of which were unlisted. Fourth, although affiliate firms are generally larger than independent firm, the top 500 sample is not biased against independent small firms; as shown in Table 1, during the period 1991–1999 group firms constitute only slightly more than 50% of our Korean sample and less than 40% of our Taiwanese sample.

For Taiwan, we used the *Largest Corporations in Taiwan* (LCT) by China Credit Information Service (CCIS), which is the oldest and most prestigious credit-checking agency in Taiwan and an affiliate of Standard & Poor's. It publishes financial information about the largest firms in the manufacturing sector and is the most reliable (and practically the only) data source for large, unlisted companies. We collected Korean firms' financial information from the Korea Information Service (KIS) database. KIS is a leading credit-rating agency in Korea, equivalent to Standard & Poor's or Moody's. The KIS corporate profiles and financial information database includes annual information on all listed companies and unlisted companies with assets of more than 6 billion won (referred to as statutory audited companies). Because some firms go in and out of the top 500 listing each year, we selected only firms that appeared in the top 500 list at least two years during our study period. We also dropped firms that went bankrupt or technically bankrupt.[11] We also dropped several observations that had missing information. Our sample of firms ranged between 218 and 378 in Korea and between 360 and 419 in Taiwan. The numbers in our sample of Korean firms became smaller after the crisis in 1997 because many went bankrupt.

We then identified the group affiliations of the firms in our sample. If we defined business groups generically as organizations with more than two affiliates, each country would have many business groups. There are, however, well-accepted definitions of business groups in each country by which data on groups are organized (Khanna and Rivkin 2001). The Korean government annually identifies the 30 largest business groups according to asset size in nonfinancial sectors and publishes a listing of their affiliates under the Act for Monopoly Regulation and Fair Trade Promotion (known as the Fair Trade Act) in order to block anticompetitive behavior. The Act defines *chaebols*' affiliates as those for which "either more than 30% of whose issued shares are owned by one person, his relatives, or a company controlled by him, or whose management such as appointing its officers is substantially affected." For Taiwan, our major data source is the biennial directory, *Business Groups in Taiwan* (BGT), which compiles data on the top 100 *jituanqyie* as based on biennial annual sales data provided by CCIS. This directory is the most comprehensive and reliable source for *jituanqyie* and has been used in previous studies (Hamilton and Biggart 1988, Claessens et al. 2000, Khanna and Rivkin 2001). It constructs the database of business groups by examining the overlaps of shareholders, directors, auditors, or decision makers with the focal firm who have a substantial proportion of shares held by other group members. Because the BGT database is biennial, Taiwanese data are available only for the financial years of 1990, 1992, 1994, 1996, and 1998. We therefore used the preceding even-numbered year's data for the odd-numbered years for Taiwan.

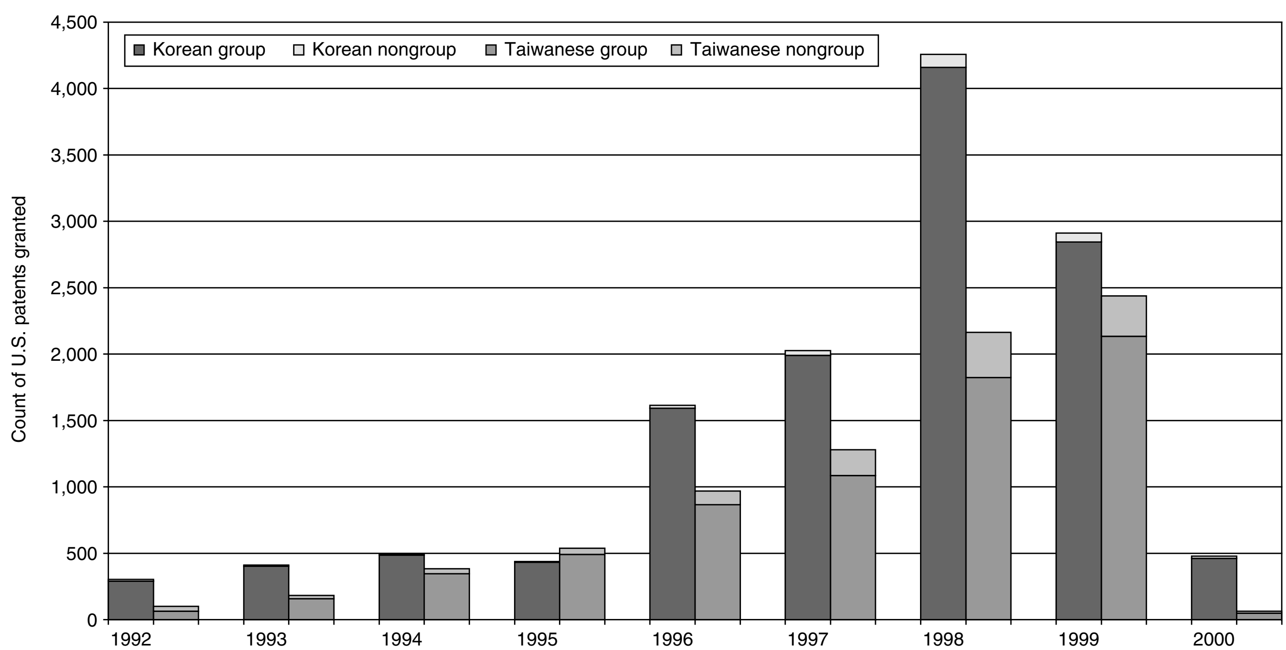
Although the operational definitions used by the Korean government and CCIS are different, they share some important criteria for defining business groups, including common shareholders and common administrative coordination; affiliates are legally independent, but they can share financial, physical, and technological resources with other affiliates. Our classification of business group membership as belonging to the top 30 *chaebols* or the top 100 *jituanqyie* is a conservative test for our hypotheses of positive group effects because of the many smaller business groups in Korea and Taiwan whose affiliates may be classified as independent firms in this study.

Measures

We measured innovation in terms of the number of successful U.S. patent applications submitted by our sample firms. We preferred U.S. patents to local patents because we wanted to compare the relative innovation of Taiwanese firms to that of Korean firms. Differences in local patenting laws and institutions made it difficult for us to use local patents to compare innovation across countries.[12] We collected U.S. patenting information for our sample from the (NBER) U.S. patenting databases (Hall et al. 2001). We included only patents that were granted by 2001. Figure 1 shows the number of patents by Korean and Taiwanese firms, respectively, during 1992–2000.[13] There is a gradual rise in patenting during this period, and affiliate firms generate more patents than independent firms do in both countries. Also, independent Taiwanese firms appear to be more innovative than their Korean counterparts.

We identify group membership by a dummy variable, Group Dummy, which is 1 if a firm is affiliated with a group and 0 otherwise. We measure both group and firm resource levels with two-year moving averages of time $t-1$ and time t, to predict a firm's innovativeness at time $t+1$. Thus, we used values for explanatory variables from 1990 to 1999 to calculate a two-year average prior to patent application, and our dependent variable runs from 1992 to 2000. For example, we used

Figure 1 Trends of Patents by Korean and Taiwanese Firms, 1992–2000



firm- and group-level information in 1990 and 1991 to predict a firm's successful patent applications in 1992. We used a two-year average because patent applications are likely to correspond to R&D activity during the two years preceding the patent application (Greve 2003). Because Taiwanese group-level information is available only for even-numbered years, we used the closest preceding even-numbered year's data in the preceding two-year interval. To assess the profitability of other affiliates in the same group, we measured Affiliate Profitability of the weighted average of return on assets (ROA) for all other affiliates in the same group, while using the assets averaged at time $t-1$ and time t as a weighting factor. To measure other affiliates' stocks of technological knowledge, we created Affiliate Patents Stock, which is the total number of patents owned by all other member firms within a group in the same two-digit standard industrial classification (SIC) industry since 1991.[14] Because economically useful knowledge depreciates as other firms imitate, personnel move, and machines wear out,[15] we used a 20% depreciation rate (δ) to calculate the level of technological stock over time and then log-transformed this number. To avoid a log transformation of zeros, we added the nominal value 1 to the stock of patents before the log transformation. For group-level unrelated and related diversification, we used an entropy measure for Group Unrelated Diversification and Group-Related Diversification (Palepu 1985) as the average of time $t-1$ and time t. Because the SIC systems are different in these countries, we used two-digit SIC codes, which define industries more broadly, to make our classifications comparable.[16]

We also included several firm-level control variables. We measured Firm Size by total firm assets (in thousands won in Korea and in millions in New Taiwanese dollars, both of which were log-transformed) as the average of time $t-1$ and time t. For firm finances, we adopted Firm Profitability as ROA as the average of time $t-1$ and time t. To control for differences between young and old organizations, we defined Firm Age as the years at time t since the firm was established. To control for the ability to raise funds from external equity markets, we created a dummy variable, Listed, to code whether a firm was publicly listed and checked the corresponding years of the directories of listed companies, published by the Korean and Taiwanese stock exchanges. To control for a firm's own technological bases, we created Firm Patent Stock, which is the total number of patents owned by a firm since 1991. As we did for affiliate patent stock, we adopted a 20% depreciation rate and used log transformation.

Model and Estimation

We use patents as our measure of innovation performance. Poisson regression and the negative binomial regression model, a variant of the former that can account for heteroscedasticity (Hausman et al. 1984, Cameron and Trivedi 1986, Gurmu and Trivedi 1994), are standard models that can handle count-based data. Let the patent output of a firm i at time $t+1$, $Y_{i,t+1}$, and $X_{i,t}$ denote a vector of explanatory variables. Thus, if $Y_{i,t+1}$ follows a Poisson distribution, the mean patent output for firm i, $\lambda_{i,t} = \mathrm{E}(Y_{i,t+1})$, would equal the variance $\mathrm{V}(Y_{i,t+1})$. The negative binomial model allows for heterogeneity in the mean function and thereby relaxes the variance restriction in Equation (1).

$$\lambda_{it} = \mathrm{E}(Y_{i,t+1}) = \mathrm{V}(Y_{i,t+1}) = \exp[X_{i,t}\beta]. \quad (1)$$

Our initial screening of the data suggested several characteristics that required us to perform further econometric treatments to handle these data properly. First, the conventional technique for controlling unobserved firm heterogeneity with random effects (Hausman et al. 1984) is not applicable to our research setting. An important feature in panel data is unobserved heterogeneity of firm i, η_i, that persists over time. In general, the unobserved firm heterogeneity factors are correlated with the explanatory variables, η_i, that is, $\mathrm{E}(x_{it}\eta_i) \neq 0$, and therefore standard random effects estimators will be inconsistent. Alternatively, the fixed effects model requires at least one observation for firm i to be nonzero (Greene 2003, p. 747). Because only 108 Korean firms and 149 Taiwanese firms applied for at least one U.S. patent during our study period, the fixed effects model is not applicable in our setting.

Second, our sample firms upgraded their technological capabilities; their U.S. patent patterns are nonlinear and increasing (see Figure 1). Knowledge-intensive resources are subject to increasing return to scale (Arthur 1996). As firms accumulate technological knowledge, they can generate more patents while tapping their existing patent stocks. Thus, the standard econometric assumption that the innovation process is independent over time would not hold. Our model needs to handle dynamic feedback, where the past histories of patenting help determine current outcomes.

Third, our dependent variable, the count of U.S. patents, had a preponderance of zeros. Of the subset of firms that filed for at least one patent, most did not apply for a patent every year. As a consequence, only 320 of 2,940 observations in the Korean sample and 371 of 3,439 observations in the Taiwanese sample are not zero. Consequently, the standard Poisson or negative binomial models that handle zero and nonzero outcomes in one model cannot adequately describe the data.

We used several techniques to handle these problems. First, we incorporated a firm's own presample information as a surrogate for the firm fixed effects (Blundell et al. 1995, Cincera 1997, Cameron and Trivedi 1998, Blundell et al. 2002). Blundell et al. (1995) developed a way to use a presample of information for a dependent variable as a surrogate for permanent unobserved firm heterogeneity. In firms' efforts to innovate, the main source of unobserved heterogeneity is the different technological knowledge stocks with which firms enter our sample.

One plausible way to measure firms' inherent capacities to develop and commercialize new products and processes is to examine our sample firms' histories of innovation prior to 1991. Thus, we adopt the Presample Mean of a firm's innovations during 1980–1990 to measure that firm's permanent unknown heterogeneity directly.

$$\text{Presample Mean } (\text{PSM}_{i,\,\text{presample}}) = \left(\sum_{1980-1990} Y_{i,t}\right) \Big/ 11. \qquad (2)$$

Blundell et al. (2002) proved that estimators that use presample means generate consistent estimators and demonstrated with Monte Carlo simulations that they outperform alternative estimation methods such as quasidifferenced generalized method of moments ones.[17]

Second, we incorporate a firm's own stock of patents at time t as a way to characterize dynamic feedback. Past success in technological innovation influences the probability of current success. Introducing dynamics into our model by using a count variable is not straightforward because the conditional mean is required to remain positive. Including functions of the lagged dependent variable in the exponential function can also be problematic. We thus included the past stock of a firm's own patents by applying a 20% depreciation rate (δ) and taking a log transformation.[18] We added a value of 1 to the stock of patents to avoid log transformations of zeros. The Firm Patent Stock ($G_{i,\,t}$) is the depreciated sum of a firm's own past innovation, and is defined by

$$\text{Firm Patent Stock, } G_{i,\,t} = Y_{i,\,t} + (1-\delta)G_{i,\,t-1}. \qquad (3)$$

Because our study period starts in 1991, G_{it} becomes (without taking log transformation) $G_{i,\,1991} = Y_{i,\,1991}$, $G_{i,\,1992} = Y_{i,\,1992} + (1-\delta)Y_{i,\,1991}$, and so on. We thus can write our patent performance model as

$$\text{E}(Y_{i,\,t+1}) = \exp(X_{i,\,t}\beta + \theta_1 G_{i,\,t} + \theta_2 \text{PSM}_{i,\,\text{presample}}). \qquad (4)$$

Third, we adopted the zero-inflated Poisson or zero-inflated negative binomial (ZINB) regression model to handle the preponderance of zeros in the dependent variable (Mullahy 1986, Lambert 1992, Greene 2003). The ZINB method separates two regimes where a zero outcome may be generated. In one regime (Regime 1), the patent outcome is always zero (some firms never patent). In the other regime (Regime 2), the usual Poisson or negative binomial process is at work (some firms might generate a zero outcome in one year but not in another year).

$$\begin{aligned}\text{Prob}(y_{i,t+1} = 0 \mid X_{i,t}, G_{i,t}, \text{PSM}_{i,\,p}) &= \text{Prob(Regime 1)} + \text{Prob}(y_{i,t+1} = 0 \mid X_{i,t}, G_{i,t}, \\ &\qquad \text{PSM}_{i,\,p}, \text{Regime 2})\text{Prob(Regime 2)}\end{aligned}$$

$$\begin{aligned}\text{Prob}(y_{i,t+1} = 1 \mid X_{i,t}, G_{i,t}, \text{PSM}_{i,\,p}) &= \text{Prob}(y_{i,t+1} = y \mid X_{i,t}, G_{i,t}, \text{PSM}_{i,\,p}, \text{Regime 2}) \\ &\quad \cdot \text{Prob(Regime 2)}, \quad \text{where } y = 1, 2, 3.\end{aligned}$$

This model estimates a binary model that predicts the likelihood of Regime 1 or Regime 2 with a set of explanatory variables and then runs the Poisson or the negative binomial process. Greene (2003, pp. 779–780) demonstrates that ZINB outperforms alternative formulations. Vuong (1989) formulated a test statistic that assesses whether the ZINB model or a regular negative binomial regression model is more appropriate. Applied to our data, the Vuong statistic suggests that regime-splitting models are better, suggesting that our data suffer from excess cases of zeros.

In addition, we control for the possibility that firms within a group share certain group-specific attributes, where error terms across firms in a group may correlate with each other. We addressed this problem by explicitly allowing clustering within our ZINB models for the possibility of correlations among firms within groups, but not across groups. Our analysis of affiliates shows regression results that allow error terms across firms in the same group to correlate with each other.

Results

We first present estimates of models pertinent to Hypotheses 1 and 2, comparing the group affiliation effects across two countries and over two time periods. In this model, we explore whether or when affiliates outperform independent firms. The first set of models does not, however, indicate how group affiliation influences firm innovation. Thus, we restrict our second set of analyses to affiliates for cases in which group-level resources and diversification strategy variables are available and explore why some affiliates are more innovative than others.

Group versus Nongroup Comparison

Given the institutional differences between Korea and Taiwan, we show the results for each country. Table 2 shows descriptive statistics for the two data sets in the two countries. Table 3 shows the ZINB models for Korean and Taiwanese firms, separately, to compare the innovation performance of affiliates vis-à-vis independent firms.[19] The Vuong statistic was significant in all models, indicating the ZINB models were appropriate.

In Table 3, Models (1) and (5) are the baseline results for Korea and Taiwan, respectively, without a firm's own patent stock variable. Group affiliation was positively significant in Model (1) and remained so for Korea after we included a firm's own stock variable in Model (2). Conversely, group affiliation was insignificant in Models (5) and (6) for Taiwan, whether we included a firm's own patent stock variable or not, suggesting affiliation

Table 2 Summary Statistics

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
a. Summary statistics on all Korean sample firms ($N = 2{,}940$)													
1. U.S. patents	5.52	71.16	1.00										
2. Firm size	19.79	1.10	0.20	1.00									
3. Firm profitability	1.20	3.11	0.09	−0.03	1.00								
4. Age	26.40	12.73	0.02	0.23	0.04	1.00							
5. Listed	0.64	0.48	0.05	0.21	0.10	0.44	1.00						
6. Firm patent stock	0.31	0.98	0.48	0.47	0.09	0.05	0.13	1.00					
7. Group dummy	0.58	0.49	0.06	0.33	−0.14	−0.06	−0.16	0.17	1.00				
8. Presample mean	0.07	0.56	0.59	0.24	0.08	0.02	0.08	0.63	0.09	1.00			
b. Summary statistics on all Taiwanese sample firms ($N = 3{,}439$)													
1. U.S. patents	2.17	22.39	1.00										
2. Firm size	8.32	1.06	0.19	1.00									
3. Firm profitability	6.31	8.52	0.12	−0.04	1.00								
4. Age	20.97	10.82	−0.06	0.36	−0.09	1.00							
5. Listed	0.50	0.50	0.07	0.48	−0.03	0.37	1.00						
6. Firm patent stock	0.35	0.93	0.43	0.36	0.11	−0.02	0.10	1.00					
7. Group dummy	0.40	0.49	0.04	0.46	−0.08	0.28	0.22	0.10	1.00				
8. Presample mean	0.02	0.10	0.04	0.13	0.05	−0.03	0.05	0.09	0.05	1.00			
c. Summary statistics on group-affiliated companies in Korea ($N = 1{,}705$)													
1. U.S. patents	9.39	93.25	1.00										
2. Firm size	20.09	1.10	0.23	1.00									
3. Firm profitability	0.83	2.89	0.14	0.02	1.00								
4. Age	25.72	12.43	0.03	0.35	−0.01	1.00							
5. Listed	0.57	0.49	0.08	0.36	0.05	0.42	1.00						
6. Firm patent stock	0.46	1.21	0.50	0.47	0.16	0.06	0.19	1.00					
7. Affiliate profitability	0.69	1.66	0.00	−0.07	0.15	−0.06	−0.12	0.03	1.00				
8. Affiliate patent stock	0.60	1.52	0.24	0.15	0.15	−0.08	0.06	0.47	0.09	1.00			
9. Group unrelated diver.	1.51	0.42	0.04	0.04	0.06	−0.22	−0.19	0.11	0.11	0.23	1.00		
10. Group related diver.	0.22	0.14	0.01	−0.01	0.09	−0.15	−0.13	0.04	0.13	0.11	0.33	1.00	
11. Presample mean	0.11	0.74	0.59	0.26	0.13	0.03	0.12	0.65	0.07	0.41	0.06	0.01	1.00
d. Summary statistics on group-affiliated companies in Taiwan ($N = 1{,}360$)													
1. U.S. patents	3.30	30.55	1.00										
2. Firm size	8.92	1.07	0.17	1.00									
3. Firm profitability	5.50	7.66	0.13	0.01	1.00								
4. Age	24.67	11.16	−0.09	0.31	−0.04	1.00							
5. Listed	0.64	0.48	0.06	0.36	−0.00	0.35	1.00						
6. Firm patent stock	0.46	1.04	0.47	0.35	0.16	−0.07	0.00	1.00					
7. Affiliate profitability	3.61	8.43	−0.09	−0.05	0.12	−0.02	−0.10	0.02	1.00				
8. Affiliate patent stock	0.31	1.03	0.19	0.13	0.05	−0.18	−0.04	0.34	0.06	1.00			
9. Group unrelated diver.	0.82	0.46	−0.16	0.14	−0.08	0.14	0.06	−0.18	0.05	−0.24	1.00		
10. Group related diver.	0.26	0.28	0.06	−0.03	0.08	−0.13	−0.07	0.13	0.10	0.14	−0.28	1.00	
11. Presample mean	0.02	0.13	0.04	0.18	0.06	−0.05	0.09	0.12	0.00	0.21	−0.10	0.07	1.00

benefited firm innovation in Korea, but did not do so in Taiwan, thus confirming Hypothesis 1.

Models in (3), (4), (7), and (8) examine how the relative importance of group affiliation within a given country varies over time. To test Hypothesis 2, we compared estimates for Models (3) and (4). Group affiliation positively affected individual firm innovation in Period 1 (i.e., patents filed during 1992–1996) but not in Period 2 (i.e., patents filed during 1997–2000) in both nations. A t-test of coefficients between Periods 1 and 2 shows the difference in the group dummy coefficients was significant for both Korea and Taiwan.[20] These results suggest the benefits of group affiliation declined as institutional infrastructures for innovation developed, supporting Hypothesis 2.

Firm size, firm profitability, and listing on stock exchanges were positively significant in most models, underlining the importance of financial resources for innovativeness. Firm age was negatively significant for Taiwan, suggesting younger firms in Taiwan conducted more innovation than did older ones, which was not true for Korean firms. Inclusion of a firm's own stock was positively significant in all the models, substantially boosting chi-square statistics over the baseline models, suggesting that firms with higher stocks of technological knowledge generate more patents, confirming the dynamic nature of innovation. The presample mean vari-

Table 3 Comparing Patents Performances of Group-Affiliated Firms and Independent Firms (ZINB)

	Korea				Taiwan			
	(1) Full sample without patent stock	(2) Full sample with patent stock	(3) Period 1 with patent stock	(4) Period 2 with patent stock	(5) Full sample without patent stock	(6) Full sample with patent stock	(7) Period 1 with patent stock	(8) Period 2 with patent stock
Firm size	0.97	0.22	0.14	0.20	0.97	0.44	0.42	0.50
	(0.09)***	(0.07)***	(0.13)	(0.08)*	(0.08)***	(0.09)***	(0.14)**	(0.13)***
Firm profitability	0.08	0.11	0.24	0.05	0.06	0.06	0.07	0.06
	(0.03)**	(0.03)***	(0.05)***	(0.04)	(0.01)***	(0.01)***	(0.02)***	(0.01)***
Firm age	0.01×10^{-1}	−0.01	0.02	−0.01	−0.08	−0.08	−0.13	−0.05
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)***	(0.01)***	(0.01)***	(0.01)***
Listed dummy	0.66	0.23	0.60	0.43	0.40	0.58	1.16	0.43
	(0.23)**	(0.19)	(0.30)*	(0.31)	(0.19)*	(0.18)***	(0.28)***	(0.24)†
Firm patent stock		0.89	1.17	0.83		0.46	0.19	0.50
		(0.06)***	(0.13)***	(0.06)***		(0.05)***	(0.11)†	(0.07)***
Group dummy	2.13	0.58	1.31	0.24	0.04	0.15	0.77	−0.12
	(0.36)***	(0.20)**	(0.34)***	(0.24)	(0.18)	(0.16)	(0.26)**	(0.22)
Presample mean (80–90)	1.81	0.01×10^{-1}	−0.11	−0.01	−0.78	-0.03×10^{-1}	−0.28	−0.78
	(0.23)***	(0.06)	(0.11)	(0.07)	(0.45)†	(0.39)	(0.55)	(0.64)
Constant	−22.08	−5.72	−6.57	−4.71	−6.84	−3.12	−2.62	−3.94
	(1.89)***	(1.43)***	(2.55)**	(1.69)**	(0.71)***	(0.74)***	(1.08)*	(1.08)***
Log likelihood	−1,644.43	−1,452.63	−576.36	−853.41	−1,947.92	−1,783.96	−665.79	−1,095.86
Log likelihood ratio *chi*-sq. (d.f.)	436.31 (6)	633.04 (7)	233.06 (7)	421.32 (7)	282.80 (6)	401.29 (7)	148.45 (7)	257.37 (7)
N	2,940	2,940	1,764	1,176	3,439	3,439	1,887	1,552
Vuong statistic	5.02***	5.97***	2.90**	5.15***	5.82***	7.53***	4.97***	5.35***

Notes. †$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

able (measured on the basis of patenting activity over 1980–1990) that we included to control for unobserved firm heterogeneity became insignificant when the firm patent stock variable (measured on the basis of patenting outcome since 1991) was introduced, due to a high correlation between the two variables in the Korean sample.[21] Overall, the results in Table 3 confirm our proposition that group affiliation benefits firms' innovativeness when institutional environments are weak.

Within-Group Comparison

Table 4 shows models that compare innovativeness among affiliates. It suggests how business groups' internal capital and technology markets and diversification strategies influence affiliates' innovativeness. Consistent with the reasoning laid out in our hypotheses, we expect affiliates that belong to groups with larger pools of internal markets are likely to be more innovative and that unrelated diversification at the group level may distract affiliates from innovating. We also believe the benefits of internal markets are stronger in Korea than they are in Taiwan and stronger in Period 1 than they are in Period 2. Similarly, we expect the effects of unrelated diversification to be stronger in Taiwan than they are in Korea and to be stronger when external innovation-supporting institutions are stronger.

Table 4 includes other affiliates' profitability and patent stock and the group's diversification strategy, which affects an affiliate's innovativeness. The Vuong statistic was significant in all models, indicating the ZINB model is appropriate. In Models (1) and (5), affiliate profitability had no impact on a focal firm's patents. In Models (2)–(4) and (6)–(8), we included an interaction term between a focal firm's profitability and affiliates' profitability to look for an interaction effect. This term was negatively significant in Korea in Period 1, suggesting that a group's internal capital market might benefit a focal firm's innovativeness when its own profitability is low but its affiliates are profitable, thus enabling poorly performing or unprofitable firms to continue investing in innovative activity. The internal capital market might not benefit affiliate firm innovation in Period 2 in Korea because external capital markets improved substantially after the financial crisis in 1997, and it became more difficult to cross-subsidize other affiliates because of tighter monitoring of intragroup transactions. These results partially support Hypothesis 3. On the other hand, the interaction term was significant for Taiwan in the full sample, but insignificant in subperiods.

The affiliate patent stock variable was positively significant in Models (1) and (2), suggesting that in Korea

Table 4 Comparing Patents Performances among Group-Affiliated Firms (ZINB)

	Korea				Taiwan			
	(1) Full sample without interaction	(2) Full sample with interaction	(3) Period 1 with interaction	(4) Period 2 with interaction	(5) Full sample without interaction	(6) Full sample with interaction	(7) Period 1 with interaction	(8) Period 2 with interaction
Firm size	0.16 (0.10)†	0.15 (0.10)	−0.11 (0.20)	0.15 (0.09)†	0.48 (0.16)**	0.57 (0.19)**	0.44 (0.23)†	0.69 (0.48)
Firm profitability	0.10 (0.07)	0.09 (0.06)	0.45** (0.14)	0.02 (0.03)	0.04 (0.02)*	0.06 (0.01)***	0.07 (0.02)***	0.03 (0.02)*
Firm age	−0.01 (0.01)	−0.01 (0.01)	0.02 (0.02)	−0.01 (0.01)	−0.09 (0.01)***	−0.10 (0.01)***	−0.12 (0.02)***	−0.07 (0.02)***
Listed dummy	0.35 (0.21)†	0.36 (0.21)†	0.85 (0.40)*	0.77 (0.25)**	0.68 (0.32)*	0.80 (0.29)**	1.53 (0.47)***	0.69 (0.49)
Firm patent stock	0.87 (0.08)***	0.87 (0.08)***	1.32 (0.18)***	0.81 (0.07)***	0.29 (0.11)*	0.20 (0.14)	−0.12 (0.11)	0.53 (0.26)*
Affiliate profitability	−0.02 (0.04)	−0.04 (0.05)	0.25 (0.19)	−0.03 (0.04)	−0.03 (0.02)	0.04 (0.02)*	−0.02 (0.07)	−0.01 (0.04)
Firm profitability* Affiliate profitability		0.01 (0.03)	−0.09 (0.04)*	0.01×10^{-1} (0.01)		-0.05×10^{-1} $(0.01 \times 10^{-1})^{***}$	0.05×10^{-1} (0.04×10^{-1})	-0.02×10^{-1} (0.02×10^{-1})
Affiliate patent stock	0.07 (0.03)*	0.06 (0.03)*	−0.10 (0.06)†	0.09 (0.05)†	−0.09 (0.10)	−0.07 (0.10)	−0.40 (0.14)**	−0.02 (0.13)
Group unrelated diversification	0.10 (0.33)	0.12 (0.30)	0.47 (0.44)	0.10 (0.30)	−1.29 (0.40)***	−1.14 (0.41)**	−1.86 (0.45)***	−0.38 (0.79)
Group related diversification	−0.30 (0.86)	−0.43 (0.95)	−1.79 (1.10)	−0.21 (1.14)	0.17 (0.48)	−0.08 (0.43)	−0.56 (0.51)	0.36 (0.42)
Presample mean (80–90)	−0.02 (0.05)	−0.03 (0.05)	−0.15 (0.07)*	−0.05 (0.09)	−0.24 (0.40)	−0.42 (0.55)	−0.87 (0.47)†	−0.63 (0.94)*
Constant	−4.10 (1.83)*	−4.00 (2.00)*	−1.29 (3.46)	−3.98 (1.99)*	−1.96 (1.34)	−2.74 (−1.87)†	−0.06 (1.94)	0.53 (4.09)
Log pseudo-likelihood	−1,155.27	−1,155.07	−461.43	−667.04	−765.93	−757.68	−274.20	−460.69
Wald *chi*-sq. (d.f.)	3,621.71 (10)	9,183.75 (11)	19,323.61 (11)	12,800.41 (11)	398.43 (10)	705.68 (11)	306.39 (11)	532.97 (11)
N	1,705	1,705	983	722	1,360	1,360	717	643
Vuong statistic	5.19***	5.21***	3.79***	4.76***	6.25***	6.52***	4.31***	4.06***

Notes. (1) $^{\dagger}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. (2) These models incorporate the restriction on error terms that observations are independent across business groups but not so within the same business groups. Vuong-statistics in these models were calculated without this restriction.

affiliates of groups in which other affiliates generated a large pool of related technological knowledge were more innovative. This variable was, however, insignificant for Taiwan, where there was a better-developed market for technology transfers, supporting Hypothesis 4. The subperiod analysis of Korean affiliates shows the affiliate patent stock variable was weakly negative in Period 1 and weakly positive in Period 2, suggesting the internal technology market became more functional in the second period. The same subperiod analysis in Taiwan showed affiliate patent stock was negatively significant in Period 1 but insignificant in Period 2. In Taiwan during Period 1, most patents obtained by highly innovative groups came from one or two focal firms. Other affiliates in these groups did almost no patenting. This divergence might explain why affiliate patent stock was negative in Taiwan in Period 1, as the negative association might have been driven by the combination of high focal firm innovation and low affiliate innovation. As other affiliates began to patent, the negative association went away. We thus found only weak support for Hypothesis 4.

Finally, unrelated diversification at the group level seems to have a negative effect on affiliate innovation in Taiwan, but not in Korea, supporting Hypothesis 5. Unrelated diversification hurt more in Taiwan, where capital markets are more developed. In many ways, including the existence of a diversification tax, the Taiwan results echo those found in countries with advanced institutional infrastructures. Overall, the models in Table 4 support our proposition that groups' internal markets are more important when external innovation-supporting institutions are weak.

Robustness Check

Our use of U.S. patents to measure firm innovation and our use of top 500 firms for our sample are subject to more scrutiny; it is possible that our context might have biased the results. First, it is possible that our use of U.S. patent data might have biased our results toward firms that are more internationally oriented. Because locally oriented companies might not be interested in obtaining U.S. patents, our focus on U.S. patents to measure

Table 5 Robustness Tests Comparing Patent Outcomes of Group-Affiliated Firms and Nongroup Firms (ZINB)

	Top 500 companies (Dependent variable: Local patents)						Listed companies (Dependent variable: U.S. patents)					
	Korea			Taiwan			Korea			Taiwan		
	(1) Full	(2) Period 1	(3) Period 2	(4) Full	(5) Period 1	(6) Period 2	(7) Full	(8) Period 1	(9) Period 2	(10) Full	(11) Period 1	(12) Period 2
Firm size	0.46	0.60	0.32	0.02	-0.03×10^{-1}	0.03	0.18	0.17	0.18	0.03	-0.02×10^{-1}	0.17
	(0.04)***	(0.06)***	(0.06)***	(0.08)	(0.14)	(0.09)	(0.07)**	(0.15)	(0.08)*	(0.11)	(0.27)	(0.13)
Firm profitability	0.08	0.04	0.10	0.02	0.04	0.01	0.04	0.20	0.03	0.04	-0.03×10^{-1}	0.05
	(0.02)***	(0.02)	(0.02)***	(0.01)*	(0.02)†	(0.01)	(0.05)	(0.13)	(0.04)	(0.01)***	(0.03)	(0.01)***
Firm age	−0.02	−0.01	−0.02	−0.01	−0.02	−0.01	−0.01	−0.04	-0.01×10^{-1}	−0.04	−0.06	−0.04
	(0.00)***	$(0.05 \times 10^{-1})^{**}$	$(0.05 \times 10^{-1})^{**}$	(0.01)**	(0.01)**	(0.01)	(0.01)	(0.02)†	(0.01)	(0.01)***	(0.03)†	(0.01)**
Listed dummy	0.08	−0.06	0.50	0.04	−0.27	0.12						
	(0.10)	(0.13)	(0.15)**	(0.13)	(0.23)	(0.16)						
Firm patent stock	0.55	0.57	0.56	0.94	1.01	0.89	0.84	0.88	0.81	0.86	1.22	0.82
	(0.02)***	(0.03)***	(0.03)**	(0.04)***	(0.10)***	(0.05)***	(0.06)***	(0.16)***	(0.07)***	(0.07)***	(0.24)***	(0.07)***
Group dummy	0.57	0.47	0.54	−0.06	0.69	−0.43	0.97	1.09	0.73	0.42	0.77	0.18
	(0.09)***	(0.12)***	(0.13)**	(0.14)	(0.26)**	(0.20)*	(0.20)***	(0.38)**	(0.25)**	(0.21)*	(0.51)	(0.25)
Presample	0.02×10^{-1}	0.01×10^{-1}	0.07×10^{-2}	−0.04	−0.02	−0.03	0.04	0.08	0.01	−0.40	1.56	−0.79
mean (80–90)	$(0.01 \times 10^{-1})^{\dagger}$	(0.01×10^{-1})	(0.01×10^{-1})	(0.02)*	(0.05)	(0.02)†	(0.06)	(0.12)	(0.07)	(0.87)	(3.81)	(0.91)
Constant	−8.23	−10.66	−6.07	−0.53	−0.86	−0.46	−4.86	−4.25	−4.65	−1.08	−0.29	−3.34
	(0.79)***	(1.07)***	(1.12)**	(0.65)	(1.10)	(0.80)	(1.40)**	(3.22)	(1.61)**	(1.72)	(3.68)	(2.06)
Log likelihood	−5,602.92	−3,066.65	−2,473.82	−1,768.74	−641.94	−1,100.79	−1,277.45	−462.14	−799.04	−975.64	−236.40	−729.44
Log likelihood ratio *chi*-sq. (d.f.)	1,790.01 (6)	1,067.03 (6)	822.32 (6)	583.06 (7)	198.66 (7)	382.60 (7)	588.09 (6)	191.36 (6)	411.92 (6)	334.26 (6)	385.45 (6)	255.30 (6)
N	2,940	1,764	1,176	3,439	1,887	1,552	3,111	1,823	1,288	2,292	945	1,347
Vuong statistic	10.80***	9.01***	8.21***	7.85***	4.54***	6.25***	5.57***	3.45***	4.42***	5.26***	2.38**	4.06***

Notes. $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

innovativeness might not capture all innovations. We addressed this concern by estimating a set of models that use local Korean and Taiwanese patents as a dependent variable, as shown in Models (1)–(6) of Table 5. In these models, the group dummy remained positively significant in Korea, but not in Taiwan, reconfirming our Hypothesis 1. Interestingly, the Korean group affiliation variable remained positively significant in both periods, but the Taiwanese group affiliation variable went from positively significant in Period 1 to negatively significant in Period 2, consistent with Hypothesis 2. Thus, in terms of local patents, affiliates always outperform independent firms in Korea, and affiliates initially did better but then did worse than independent firms in Taiwan, as institutional environments for innovation developed in the late 1990s.

Second, we examined whether our focus on the top 500 Korean and Taiwanese firms might be biased against small, innovative firms. This concern may be more relevant for Taiwan, where small- and medium-size enterprises are important sources of innovation (Mahmood and Singh 2003). To address this issue, we reran our models using a sample of listed firms, as shown in Models (7)–(12) of Table 5. Once again, our results confirmed that group affiliation is important to innovativeness in Korea, but not in Taiwan, where group affiliation is significant only for the full period, supporting Hypothesis 1. There were few intertemporal differences in group affiliation effects in both countries, however, providing no support for Hypothesis 2.

We also performed several sensitivity tests to assess whether our results were driven by a few outliers. For example, we checked whether the negative effect of diversification in Taiwan was driven by outliers such as UMC and TSMC, which are innovative but focused. After controlling for these groups, the results remain unchanged.[22] We also added industry-fixed effects in addition to our firm-fixed effects with presample means. In most regressions that converged, however, industry-fixed effects became collinear with firm-fixed effects and became insignificant. We thus decided not to enter any additional industry-fixed effects in our models. We also checked for endogeneity, because an independent firm that innovates successfully can, become a target for acquisition by business groups, or a firm can choose to become a member of a group, or both. Markets for acquisition were weak in Korea and Taiwan during the period under study, however, and firms in both countries could not possibly choose to affiliate with a particular group. In other words, being an affiliate was not a voluntary decision. Thus, we do not think endogeneity is relevant to our study. Furthermore, our use of panel data with lags, as opposed to cross-sectional correlations, mitigates this problem. In addition, we dropped the data for 1998 and 1999—during which the effects of the Asia crisis were most severe—from our sample to see if our results changed. They did not.

Discussion and Conclusion

This study combined two unique longitudinal data sets of business groups to examine when and how business groups in emerging economies promote affiliate firms' innovativeness. To our knowledge, this study is the first large-scale statistical analysis of innovativeness that uses a comparative institutional framework. For Korea, we found that affiliates are more innovative than independent firms. This result did not hold for Taiwan, where institutional infrastructures for innovation were relatively more developed. We also found that in both Korea and Taiwan the benefits of group affiliation declined as institutional infrastructures for innovation developed. This analysis therefore supports the view that business groups in emerging economies substitute for institutional infrastructures for innovation, which are taken for granted in developed economies (Leff 1978, Khanna and Palepu 1997). This study also supports the comparative institutionalist perspective that the benefit of business group affiliation for firm innovativeness is contingent on a country's institutional environment at a specific time.

The contrast between Korean and Taiwanese business groups' effects on affiliate firm innovation performance might be attributable to several factors. First, Korea lagged behind Taiwan in institutional infrastructures for innovation. Unlike its Taiwanese counterpart, the Korean venture capital market was very small prior to the Asia crisis. Foreign multinationals and the government helped more to transfer technology and spearhead R&D in Taiwan than they did in Korea. The positive impact of group affiliation in Korea reflects *chaebols* being a substitute for institutional infrastructures for innovation.

Second, *chaebols* shared resources among affiliates more extensively than *jituanqyie* did. In a typical business group in Korea, a group chair exercised absolute power over the group's strategic decisions. At his or her command, affiliates contributed financial, human, and technical resources to a project that was deemed strategic to the group. The results show that affiliates benefited from group-level resource sharing. In contrast, such resource sharing was not extensive in *jituanqyie*, which were run more independently by different family members. In this sense, *jituanqyie* are more like coordinated networks, whereas *chaebols* are more like centralized hierarchies (Orru et al. 1991).

Third, our results showed that diversification at the group level negatively affected affiliate firms' innovation performance in Taiwan, where capital markets were more developed than they were in Korea. This result is consistent with findings from research on U.S. conglomerates, which has found that diversification negatively influences innovativeness. It also suggests, however, that these findings need to be qualified because a negative diversification effect was not found for Korea, which had a less-developed capital market.

This study also identified and empirically tested how affiliation affects firm innovativeness. For Korea, we found that group-level financial resources foster the innovativeness of affiliates that had insufficient financial resources. For example, Samsung Semiconductor, the semiconductor venture of Samsung Group in Korea, weathered extended periods of losses in its early years with support from affiliates such as Samsung Telecommunication and Samsung Electronics. When it was nearly bankrupt, it merged with Samsung Telecommunication and then later merged with Samsung Electronics. The impact of sharing group-level financial resources in Korea has dwindled since the Asia crisis, as affiliates are under tighter scrutiny from the financial community and alternative sources of capital are more readily available (Chang 2003). On the other hand, sharing technological resources with other affiliates in the same groups remains an important means for groups to foster affiliates' innovativeness. The market for technology is inherently imperfect because of appropriation problems. Our results suggest that business groups can continue creating value by internalizing the market for technology, but they also suggest that affiliates might not have enough patents in Period 1 to capitalize on the benefits of this market.

This study has important implications for research on business groups and innovation. First, research on business groups focuses mainly on how groups influence firm profitability (e.g., Khanna and Rivkin 2001, Chang and Hong 2000). Our study extends that work by examining a dimension of firm performance—innovation—which is critical to firms' long-term competitive advantage. Furthermore, by theorizing the group as not only an internal capital market but also a knowledge-sharing entity, our research sheds light on a neglected internal market function, the market for technology, in which business groups may play an important role even in developed economies.

Second, by showing how the groups' role in supporting innovation is moderated by institutional setups and the interaction between institutions and group characteristics, our research responds to the call for more work on the interaction between organizations and institutions. Our contributions are twofold. First, we analyzed the institutional mechanisms through which business groups shape their innovation benefits for their affiliates. This focus overcomes the limitation of the organization-focused approach in identifying the dominant innovation agent in various contexts. Second, our results help solve the institutionalists' problem of explaining performance variation among firms that compete in the same context by indicating why and how, within a given institutional context, some organizations are more innovative than others.

This paper also contributes to the literature on national systems of innovation (Lundvall 1992, Nelson 1993). By treating business groups as one component of such systems, we restore an important but ignored insight from early work on national innovation systems, which recognized that business groups can influence innovativeness (Freeman 1987). Although the innovation literature has usually treated interfirm networks (or interaction among firms) as a key characteristic in the system (Lundvall 2003), it has focused only on regional or sectoral networks and ignored interfirm networks such as business groups that are often initiated and maintained by preexisting social structures. This paper hence advances the innovation literature by highlighting a new dimension of interfirm networks. In so doing, it contributes to the comparative institutional perspective by showing there is no one ideal model for transition from imitator to innovator (Whitley 1999, Campbell 2004).

This study has several limitations. First, it did not measure internal coordination and control mechanisms within business groups. Future research should look into elements of business groups' internal structures, such as cross-shareholding, interlocking directorates, buyer-supplier ties, and various incentive systems. Second, it focused on two emerging economies in East Asia that have similar cultural backgrounds. The relative importance of group affiliation effects to individual firm innovativeness should be confirmed in a larger set of countries with more distinct institutional infrastructures for innovation. Third, future studies should examine the impact of ownership structure on individual firms' innovativeness. It would be interesting to explore whether different types of owners, such as families, affiliates (via cross-shareholding), and foreign investors have different preferences toward innovation.

Finally, Korean and Taiwanese institutions might not be completely exogenous to the formation and development of business groups; these groups may affect the evolution of various institutions. This is especially plausible in the years after Korea and Taiwan were democratized in the late 1980s. Business groups may influence regulatory institutions' evolution through election mechanisms and close ties with political elites, as indicated by Fields (1995, pp. 51–62, 85–92). We believe, however, the development and subsequent evolution of institutional infrastructures for innovation is more complicated and involves factors that are exogenous to these groups. For example, Saxenian and Li (2003) described how Taiwan's venture capital industry originated and then flourished in the late 1990s because of its close linkages to Silicon Valley. Initiation or change of institutions can also come from institutional entrepreneurs (DiMaggio 1988), such as the marketing manager for a computer firm who started the 104 Job Bank, the first Internet-based professional headhunter for engineers and managers in Taiwan. A comprehensive understanding of the relationships between institutional infrastructures for innovation and business groups deserves a sustained treatment that is beyond the scope of this paper.[23] We hope future studies will untangle these relationships.

Overall, our study confirms that business groups facilitate innovation, especially when institutional infrastructures for innovation are weak. We demonstrate that a firm's institutional environment systematically affects its innovativeness. Our results highlight why we need to understand how institutional factors, including business groups, help emerging economies become more innovative.

Acknowledgments
The authors thank John Lafkas, Hongjin Zhu, Jordan Siegel, their editor Javier Gimeno, and three anonymous reviewers for helpful comments and suggestions. Sea-Jin Chang is grateful for financial support from the Korea University through the 2002 Faculty Special Research Fund. Chi-Nien Chung is grateful for research support from Asia Research Institute of National University of Singapore in the form of a visiting fellowship. Ishtiaq Mahmood also appreciates financial support from the National University of Singapore Faculty Research Grant. The ordering of authorship is alphabetical; all three authors contributed equally.

Endnotes
[1]Prior to the Asia crisis, affiliates' bankruptcy risk was believed to be lower than that of independent firms (Kim and Hoskisson 1996). The Asia crisis proved this assumption was incorrect. Business group affiliation can reduce a firm's bankruptcy risk, but only when that firm's risk is independent from that of its affiliates. When this risk is systemic (e.g., because of debt guarantees among affiliates) and applies to all affiliates at the same time, this affiliation can amplify risk (Khanna and Yafeh 2005).
[2]In theory, the potential benefits of diversification on innovation include cost spreading (Cohen and Klepper 1996), hedging against R&D risk (Nelson 1959), and more opportunities to transfer disparate technologies across product lines and recombine them in new products (Teece 1980, 1982; Kodama 1986). Nonetheless, research on U.S. firms shows that diversification hurts innovative performance (Hoskisson and Hitt 1988, Hitt et al. 1996).
[3]According to Liu and Liu (1989), 43 of the 80 high-tech companies operating in Hsinchu Science Park were financed by venture capitalists.
[4]GNP is based on value added. It is a way to gauge the business groups' relative importance in each nation.
[5]According to Campbell (2004), how major actors, or institutional entrepreneurs, perceive their problems, generate possible solutions, find opportunities to change, and adopt eventual courses of action is important. He argues that although institutional change is often triggered by exogenous factors such as crisis or war, such shocks can be reinforced by internal friction among actors who feel contradictory incentives and seek new institutional arrangements. During this process, existing institutional processes, cultural frames, and social beliefs constrain the range of options available to these actors. In light of this constraint, he argues that institutional changes tend to be evolutionary rather than revolutionary.
[6]The IMD's World Competitiveness Report, for instance, shows that Korea's institutional infrastructures for innovation have improved. For instance, in venture capital financing, Korea ranked 35th in 1992 and 21st in 1999. Korea's stock market capitalization improved from 24th in 1992 to 17th in 1999. Furthermore, the absolute levels of various infrastructures for innovation in both Korea and Taiwan improved considerably during the 1990s.
[7]The number of venture capital firms grew from 48 in 1996 to 192 in 2000. The amount of venture capital investments increased from US$321 million in 1996 to US$975 million by 2000 (Taiwan Venture Capital Association, http://www.tvca.org.tw).
[8]We also experimented with alternative cut-off points such as 1994 and 1996. Our results are similar.
[9]Khanna and Palepu (2000) pointed out that it might be problematic to use listed firms for studying business groups because only a small portion of affiliates is listed. Thus, using listed firms may bias our results against independent firms. We thus provide robustness tests with the listed firms' sample.
[10]On the other hand, more than 60% of top 500 firms in Korea were listed.
[11]Those firms that fully eroded their equity capital might survive because of debt guarantees by group affiliates. In Korea, many of those technically bankrupt companies went bankrupt only after the crisis.
[12]We show results using local patents in robustness tests. In addition, R&D expenditures may be an alternative indicator of innovation. The absence of a uniform accounting standard and much data on R&D expenditures in the financial statements for the firms in our sample make this measure less desirable in our study.
[13]The figure did not, however, include patents by government agencies or universities. We focus only on the top 500 manufacturing firms. There seem to be fewer patents in 2000 because we included only patents that were applied for in 2000 and granted by 2001.
[14]To the extent that the spillover of knowledge useful for innovation comes from related industries, we include patents by all other member firms within a group in the same two-digit SIC industry.
[15]We experimented with various depreciation rates from 10% to 30%. The results do not vary.
[16]It is possible that a highly diversified independent firm reaps the same benefits of diversification that group affiliates do. However, a close examination of the profile of industry participation in our sample suggests that firms operated mainly within a two-digit SIC industry. In other words, Taiwanese and Korean firms diversified by creating a new affiliate (thereby becoming a business group) rather than by creating a new business division.
[17]As a robustness check, we reran the analyses using a lagged dependent variable to control for unobserved heterogeneity. While the results for this analysis are similar to the ones described below, we prefer the presample mean over the lagged dependent variable, because the latter is not exogenous to the system and therefore is not as desirable a measure as the former.
[18]We experimented with various depreciation rates from 10% to 30%. The results do not vary.

[19]We do not show logit splitting regression models from ZINB, which separate observations whose patent outcome would be always zero (Regime 1 in the usual terminology) from the rest of the sample. These results are available on request.

[20]To the extent that institutional changes are often gradual, we shifted the cut-off year of comparison from 1994 to 1997 to assess how sensitive our results are to how we defined the time periods. The coefficients of the group dummy variables become more positive and significant the closer we move the cut-off year to 1994.

[21]The presample mean in Model (5) was negatively significant, which might reflect the fact that many highly innovative firms in Taiwan did not exist or were young and therefore registered only a few U.S. patents during 1980–1990. We believe a firm's own patent stock variable also helps control for unobserved firm heterogeneity.

[22]Results are available on request.

[23]Following a reviewer's suggestion, we performed a robustness test by calculating an endogeneity-control factor from a pooled sample of Korean and Taiwanese firms, and then plugging it into our regressions. This factor was insignificant in most regressions, and the coefficients of other variables did not change, suggesting that endogeneity does not affect our results.

References

Abramovitz, M. 1986. Catching up, forging ahead, and falling behind. *J. Econom. Hist.* **46** 386–406.

Afuah, A. 2000. Do your co-opetitors' capabilities matter in the face of a technological change? *Strategic Management J.* **21** 397–404.

Amsden, A. 1991. Big business and urban congestion in Taiwan: The origins of small enterprise and regionally decentralized industry. *World Development* **19** 1121–1135.

Amsden, A., W. Chu. 2003. *Beyond Late Development—Taiwan's Upgrading Policies*. MIT Press, Cambridge, MA.

Amsden, A., T. Hikino. 1994. Project execution capability, organizational know-how and conglomerate corporate growth in late industrialization. *Indust. Corporate Change* **3** 111–147.

Arthur, B. 1996. Increasing returns and the new world of business. *Harvard Bus. Rev.* **74**(July–August) 100–109.

Biggart, N. 1990. Institutionalized patrimonialism in Korean business. *Comparative Soc. Res.* **12** 113–135.

Biggart, N., M. Guillén. 1999. Developing difference: Social organization and the rise of the auto industries of South Korea, Taiwan, Spain, and Argentina. *Amer. Sociol. Rev.* **64** 722–747.

Blundell, R., R. Griffith, J. Van Reenen. 1995. Dynamic count data models of technological innovation. *Econom. J.* **105**(March) 333–344.

Blundell, R., R. Griffith, F. Windmeijer. 2002. Individual effects and dynamics in count data models. *J. Econometrics* **108**(1) 113–131.

Brown, J. 1991. Research that reinvents the corporation. *Harvard Bus. Rev.* **69**(January–February) 101–111.

Cameron, A., P. Trivedi. 1986. Econometric models based on count data: Comparisons and applications of some estimators and tests. *J. Appl. Econometrics* **1** 29–54.

Cameron, A., P. Trivedi. 1998. *Regression Analysis with Count Data*. Cambridge University Press, Cambridge, UK.

Campbell, J. 2004. *Institutional Change and Globalization*. Princeton University Press, Princeton, NJ.

Chang, S. 2003. *Financial Crisis and Transformation of Korean Business Groups: The Rise and Fall of Chaebols*. Cambridge University Press, New York.

Chang, S., J. Hong. 2000. Economic performance of group-affiliated companies in Korea: Intragroup resource sharing and internal business transactions. *Acad. Management J.* **43**(3) 429–448.

Cheng, T. 1990. Political regimes and development strategies: South Korea and Taiwan. Gary Gereffi, Donald L. Wyman, eds. *Manufacturing Miracles: Paths of Industrialization in Latin America and East Asia*. Princeton University Press, Princeton, NJ, 139–178.

Chung, C. 2001. Markets, culture and institutions: The emergence of large business groups in Taiwan, 1950s–1970s. *J. Management Stud.* **38** 719–745.

Cincera, M. 1997. Patents, R&D and technological spillovers at the firm level: Some evidence from econometric count models from panel data. *J. Appl. Econometrics* **12**(3) 265–280.

Claessens, S., S. Djankov, L. Lang. 2000. The separation of ownership and control in East Asian corporations. *J. Financial Econom.* **52** 81–112.

Cohen, W., S. Klepper. 1996. A reprise of size and R&D. *Econom. J.* **106** 925–951.

Coriat, B., O. Weinstein. 2002. Organizations, firms and institutions in the generation of innovation. *Res. Policy* **31** 273–290.

Davis, G., K. Diekmann, C. Tinsley. 1994. The decline and fall of the conglomerate firm in the 1980s: The deinstitutionalization of an organizational form. *Amer. Sociol. Rev.* **59** 547–570.

DiMaggio, Paul. 1988. Interest and agency in institutional theory. Lynne G. Zucker, ed. *Institutional Patterns and Organizations: Culture and Environment*. Ballinger Publishing, Cambridge, MA, 3–21.

Dobbin, F. 1994. *Forging Industrial Policy: The United States, Britain, and France in the Railway Age*. Cambridge University Press, New York.

Economist, The. 1997. Place your bets. (February 17) 69–70.

Edquist, C. 1997. *Systems of Innovation: Technologies, Institutions, and Organizations*. Pinter, New York.

Encaoua, D., A. Jacquemin. 1982. Organizational efficiency and monopoly power: The case of French industrial groups. *Eur. Econom. Rev.* **19** 25–51.

Fields, K. 1995. *Enterprise and the State in Korea and Taiwan*. Cornell University Press, Ithaca, NY.

Freeman, C. 1987. *Technology Policy and Economic Performance: Lessons from Japan*. Pinter, London, UK.

Gerschenkron, A. 1962. *Economic Backwardness in Historical Perspective*. Belknap Press, Cambridge, MA.

Granovetter, M. 1995. Coase revisited: Business groups in the modern economy. *Indust. Corporate Change* **4** 93–140.

Granovetter, M. 2005. Business groups and social organization. Neil Smelser, Richard Swedberg, eds. *Handbook of Economic Sociology*. Princeton University Press, Princeton, NJ.

Greene, W. 2003. *Econometric Analysis*, 5th ed. Prentice Hall, New York.

Greve, H. 2003. A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Acad. Management J.* **46**(6) 685–702.

Guillén, Mauro F. 2001. *The Limits of Convergence: Globalization and Organizational Change in Argentina, South Korea, and Spain.* Princeton University Press, Princeton, NJ.

Gurmu, S., P. Trivedi. 1994. Recent developments in models of event counts: A survey. Working paper, Department of Economics, Indiana University, Bloomington, IN.

Hall, P. A., D. Soskice. 2001. An introduction to varieties of capitalism. Peter A. Hall, David Soskice, eds. *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage.* Oxford University Press, New York, 1–70.

Hall, P. A., Y. Yaffe, M. Tarajtenberg. 2001. The NBER patent citation data file: Lessons, insights, and methodological tools. Working Paper 8498, National Bureau of Economic Research, Cambridge, MA.

Hamilton, G., N. Biggart. 1988. Market, culture, and authority: A comparative analysis of management and organization in the far East. *Amer. J. Sociol.* **94**(Suppl.) S52–S94.

Hamilton, G., C. Kao. 1990. The institutional foundation of Chinese business: The family firm in Taiwan. Craig Calhoun, ed. *Comparative Social Research*. JAI, Greenwich, CT, 135–151.

Hansen, M. 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Admin. Sci. Quart.* **44**(1) 82–112.

Hausman, J., B. Hall, Z. Griliches. 1984. Economic models for count data with an application to the patents–R&D relationship. *Econometrica* **52** 909–938.

Hitt, M., R. Hoskisson, R. Johnson, D. Moesel. 1996. The market for corporate control and firm innovation. *Acad. Management J.* **39**(5) 1084–1119.

Hobday, M. 1995. *Innovation in East Asia: The Challenge to Japan.* Edward Elgar, Cheltenham, UK.

Hollingsworth, R., P. Schmitter, W. Streeck. 1994. *Governing Capitalist Economies*. Oxford University Press, New York.

Hoskisson, R., M. Hitt. 1988. Strategic control systems and relative R&D investment in large multiproduct firms. *Strategic Management J.* **9**(6) 605–622.

Hou, C. M., S. Gee. 1993. National systems supporting technical advance in industry: The case of Taiwan. Richard R. Nelson, ed. *National Innovation Systems: A Comparative Analysis.* Oxford University Press, New York, 384–413.

Khanna, T., K. Palepu. 1997. Why focused strategies may be wrong for emerging markets. *Harvard Bus. Rev.* **75**(July–August) 41–51.

Khanna, T., K. Palepu. 1999. The right way to restructure conglomerates in emerging markets. *Harvard Bus. Rev.* **77**(July–August) 125–135.

Khanna, T., K. Paueyu. 2000. Is group affiliation profitable in emerging markets? An analysis of diversified Indian business groups. *J. Finance* **55** 867–892.

Khanna, T., J. Rivkin. 2001. Estimating the performance effects of business groups in emerging markets. *Strategic Management J.* **22** 45–74.

Khanna, T., Y. Yafeh. 2005. Business groups and risk sharing around the world. *J. Bus.* **78** 301–340.

Kim, L. 1993. National system of industrial innovation: Dynamics of capability building in Korea. Richard R. Nelson, ed. *National Innovation Systems: A Comparative Analysis.* Oxford University Press, New York, 357–383.

Kim, L. 1997. *Imitation to Innovation: The Dynamics of Korea's Technological Learning*. Harvard Business School Press, Boston, MA.

Kim, H., R. Hoskisson. 1996. Japanese governance systems: A critical review. *Adv. Internat. Comparative Management* **11** 165–189.

Kock, C., M. Guillén. 2001. Strategy and structure in developing countries: Business groups as an evolutionary response to opportunities for unrelated diversification. *Indust. Corporate Change* **10** 77–113.

Kodama, F. 1986. Japanese innovation in mechatronics technology. J. Sigurdson, ed. *Measuring the Dynamics of Technological Change.* Pinter, London, UK, 39–53.

Lall, S. 2000. Technological change and industrialization in the Asian newly industrializing economies: Achievements and challenges. L. Kim, R. Nelson, eds. *Technology, Learning and Innovation: Experiences of Newly Industrializing Economies*. Cambridge University Press, Cambridge, UK 13–68.

Lambert, D. 1992. Zero-inflated Poisson regressions with an application to defects in manufacturing. *Technometrics* **34** 1–14.

Leff, N. 1978. Industrial organization and entrepreneurship in the developing countries: The economic groups. *Econom. Development Cultural Change* **78** 661–674.

Liu, P., Y. Liu. 1989. New technologies, industry and trade—The Taiwan experience. *Indust. Free China* (November) 7–24.

Lundvall, B. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. St. Martin's Press, New York.

Lundvall, B. 2003. National innovation systems: History and theory. Paper presented at National Science and Technology Development Agency–Japan International Cooperation Agency Seminar on Innovation Systems in Asian Economies. September 4–5, Bangkok, Thailand.

Mahmood, I., W. Mitchell. 2004. Two faces: Effects of business groups on innovation in emerging economies. *Management Sci.* **51** 1348–1365.

Mahmood, I., J. Singh. 2003. Technological dynamism in Asia. *Res. Policy* **32**(6) 1031–1054.

Mullahy, J. 1986. Specification and testing of some modified count data models. *J. Econometrics* **33** 341–365.

Nelson, R. 1959. The economics of invention: A survey of the literature. *J. Bus.* **32**(2) 101–128.

Nelson, R. 1993. *National Innovation Systems: A Comparative Analysis*. Oxford University Press, New York.

Nelson, R., N. Rosenberg. 1993. Technical innovation and national systems. Richard R. Nelson, ed. *National Innovation Systems: A Comparative Analysis*. Oxford University Press, New York, 3–22.

North, D. 1990. *Institutions, Institutional Change and Economic Performance.* Cambridge University Press, Cambridge, UK.

Orru, M., N. Biggart, G. Hamilton. 1991. Organizational isomorphism in East Asia. Walter W. Powell, Paul J. DiMaggio, eds. *The New Institutionalism in Organizational Analysis*. University of Chicago Press, Chicago, IL, 361–389.

Orru, M., N. Biggart, G. Hamilton. 1997. *The Economic Organization of East Asian Capitalism*. Sage, Thousand Oaks, CA.

Palepu, K. 1985. Diversification strategy, profit performance and the entropy measure. *Strategic Management J.* **6** 239–255.

Porter, M., S. Stern. 2003. The impact of location on global innovation: Findings from the national innovative capacity. Peter K. Cornelius, ed. *The Global Competitiveness Report 2002–2003*. Oxford University Press, New York, 227–246.

Powell, W., K. Koput, L. Smith-Doerr. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Admin. Sci. Quart.* **41** 116–145.

Romer, P. 1990. Endogenous technological change. *J. Political Econom.* **98** S71–S102.

Saxenian, A. 2000. The origins and dynamics of production networks in Silicon Valley. M. Kenney, ed. *Anatomy of an Innovative Region: Understanding Silicon Valley*. Stanford University Press, Palo Alto, CA.

Saxenian, A., C.-Y. Li. 2003. Bay-to-bay strategic alliances: The network linkages between Taiwan and the U.S. venture capital industries. *Internat. J. Tech. Management* **25** 136–150.

Schumpeter, J. 1934. *The Theory of Economic Development*. Harvard University Press, Cambridge, MA.

Shieh, Gwo-shyong. 1992. *"Boss" Island: The Subcontracting Network and Micro-Entrepreneurship in Taiwan's Development*. Peter Lang Publishing, New York.

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management J.* **17** 27–43.

Teece, D. 1980. Economies of scope and the scope of the enterprise. *J. Econom. Behav. Organ.* **1** 223–247.

Teece, D. 1982. Toward an economic theory of the multiproduct firm. *J. Econom. Behav. Organ.* **3** 39–63.

Teece, D. 1996. Firm organization, industrial structure, and technological innovation. *J. Econom. Behav. Organ.* **31** 193–224.

Vuong, Q. 1989. Likelihood ratio test for model selection and non-nested hypotheses. *Econometrica* **57** 307–334.

Wade, R. 1990. *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*. Princeton University Press, Princeton, NJ.

Weitzman, M. 1998. Recombinant growth. *Quart. J. Econom.* **113**(2) 331–360.

Whitley, R. 1992. *Business Systems in East Asia: Firms, Markets, and Societies*. Sage, London, UK.

Whitley, R. 1999. *Divergent Capitalisms: The Social Structuring and Change of Business Systems.* Oxford University Press, Oxford, UK.

Zander, U., B. Kogut. 1995. Knowledge, market failure and the multinational enterprise: A reply. *J. Internat. Bus. Stud.* **26**(2) 417–427.