Technological Capability Building in the Automotive Industry: Comparing China with South Korea

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Abstract: Why has China developed a huge automotive market without building up autonomous technological capability? While comparing China with South Korea's experience, we argue that this phenomenon has to be understood in the context of a misleading and ineffective policy regime and a fragmented political structure, which in turn are associated with a disincentive market environment (sizable but unsophisticated demand) and China's ongoing systemic restructuring that has so far been oriented toward management fragmentation.

Keywords: China versus Korea; automotive industry; technological capability.

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1 Introduction

In the global automotive sector, China has drawn increasing attention as the fastest growing market. The Chinese automotive industry, riding on China's economic restructuring and open policy, has experienced dramatic growth during the past 20 years. China's output of motor vehicles doubled in the period between 2001 and 2005, and the country jumped from being the eighth largest automotive producer in the world in 2001 to become the third biggest national automotive producer and market in 2005. According to the Chinese Automotive Industry Association, domestic vehicle production rose to more than 7 million units in 2006 (Guangzhou Daily, 2007). However, a few independent domestic manufacturers (e.g., Chery and Geely) aside, global auto firms, that is, multinational companies who have established manufacturing facilities through joint ventures (JV) with Chinese firms, have dominated the growing Chinese auto industry. While the Chinese partnering companies have shared the profits the industry has generated, they have not been able to develop the skills to launch their own competitive brands (Farrell, Gao, & Orr, 2004). Besides the foreign alliances, twenty-some domestic carmakers share about 4 percent of the market. The lack of technological capability in this latter category has shown in their struggle to enter into the competitive North American market. While the newly announced alliance between Chrysler and Chery could result in the first Chinese-made vehicles being imported to North America, analysts are cautioning "that the first wave of Chinese build vehicles are likely to face skepticism from American consumers concerned about safety and quality." (Krolicki 2007). As a recent example, European auto distributor Karel has just cancelled its sales agreement with Huachen, another best-known Chinese auto manufacturer with autonomous technologies, because the company's product failed ADAC crash tests (Wei, 2007). It is from such a perspective that China is a *large* automotive country, but not a *strong* automotive country (She, 2006). Recently, the failure of Chinese auto makers in developing their own technological capability has been publicly recognized and forced local manufacturers, independents as well as JV partners, to commit their efforts to developing indigenous technological competence (Bradsher, 2006). China's experience is in sharp contrast to that of South Korea (hereafter Korea), a formidable competitive force alongside Japan. Emerging only in the 1960s, Korea has progressed rapidly, building its auto industry to five auto manufacturers having a combined global annual sales of more than 5 million units in 2009, a comparable level of production to that of the Chinese auto industry. The difference is that in the seemingly similar industry-building effort, including international technology transfer (TT), Korean auto makers have achieved a relatively high level of self-reliance in design technologies, while Chinese auto firms remain largely dependent upon foreign counterparts in key technologies.

What accounts for the differences in technological capability building and the different results of TT in Korea and China? While there have been heated debates among practitioners, management scholars have been less attentive to the issue. In a comparative analysis of Korea versus China, Huang (1997) considers the two "coordination failures" in the Chinese auto industry: failure to invest at socially optimal levels and failure in excessive investment. The conclusion is that a decentralized bureaucratic structure is responsible for the fragmentation of automotive manufacturing in China. In a recent study, Zhao, Anand, and Mitchell (2005) suggest that the government's intent of importing advanced technologies through IJVs has been compromised by MNCs' relatively centralized R&D efforts. Concerned about unintended leaking, foreign partners tend to be tight about key knowledge in dealing with Chinese partners,

which could be one of the reasons why R&D intensity in these IJVs is very low compared to that in MNCs. Existing research has rarely considered the behavior of the Chinese government and individual firms, wherein technological activities would ultimately take place (Teech, 1993). Especially, it remains unclear why the Chinese government's technology transfer mandates, through measures such as formation of IJVs, have not been fully met.

The objective of the current study is to provide a comprehensive understanding of Chinese auto firms' technological innovation behavior. To attain this objective, we benchmark China's experience against that of Korea as a successful example in building autonomous technological capability. It is difficult to construct a perfect timeframe for the comparison since the augmentation of indigenous auto industries in the two countries were at different times. The end point for both countries is 2005, when the automotive industry in each country exceeded 5 million units. But the starting point is different: it is the early 1960s for Korea, whereas it is the late 1970s for China. The early 1960s witnessed Korea augmenting industrialization and starting its drive toward the status of a developed economy (Kim, 1997). Although China started automotive manufacturing at an earlier time, its progress was effectively disrupted by the turmoil of the two-decade Cultural Revolution until 1978, when the country re-emerged with a renewed agenda to modernize its economy. Also, the development of the passenger car sector was not a factor in the government's automotive industry plan prior to the early 1980s. Finally, this was also the time when China gained unprecedented access to a variety of possibilities for international technology transfer (Harwit, 1995), the same possibilities received by their Korean counterparts in the early 1960s. As mentioned earlier, international technology transfer has been an important ingredient in both countries' industry development effort.

Besides offering managerial and policy implications to China and other developing countries with similar concerns, this comparative historical approach provides an opportunity to advance existing international business theories (Jones & Khanna, 2006). Our analysis is limited to the passenger car sector of China's automotive industry, wherein the phenomenon "development without technological capacity buildup" is most prominent. However, for convenience, we will use the term automotive industry throughout the paper. In the section that immediately follows, we review relevant theories and literature to set up a theoretical framework. We then compare experiences of the auto industry in China to that in Korea. We use secondary data, complemented by our interviews with Chinese executives in the auto industry. Following Teece, Pisano, and Shuen (1997), we start this comparison with a close look at what happened at the firm level and then examine determinants of the firms' technological activities. Finally, we discuss the lessons from the comparative study and conclude with theoretical and practical implications.

2 Theoretical framework

2.1 Economic development and technological capability

Early economic theory suggests that most national GDP growth can be attributed to technological progress (Solow, 1957). For some authors, the economic miracle in East Asia during the 1980s has proved to be the pivotal role of technological development in economic growth (Kim & Nelson, 2000). While many authors assume the central role of technological innovation in economic development, nations may vary their level of emphasis on technological capability building in the economic development process. Note that there are

two different theories with regard to the experiences of these emerging economies. The accumulation theory suggests that development is largely accounted for by the investment in physical and human capital, and that technological advancements are more or less the by-products of economic development. On the other hand, the assimilation theory emphasizes technological learning and innovation alongside investment in physical and human resource investment (Kim & Nelson, 2000). A comparative analysis, however, suggests that such divergent views may reflect different experiences across countries. Some countries, such as Korea, assumed a deliberate national strategy to upgrade domestic technological capabilities, whereas other countries, such as Brazil, opted for massive manufacturing expansions with a parallel increase in "technological sophistication" (Kaze, 2000, p. 308). While comparing newly industrialized economies in Asia, Lall (2000) found differences in the levels of local technological capabilities concurrently developed with economic growth. Existing literature thus suggests that the experience of technology capability building may differ across countries in their effort toward development of a particular industry. The next question is: What determines a country's attention, energy, and strategic actions devoted to technological competence building during economic development?

2.2 Choices of nations

When considering the deliberation and intensity of technological learning as it varies across nations, most authors focus on institutional environments, especially in the policy regime. Much has been written on the role of trade policies in creating incentives for national technological activities. For example, evidence shows that an export orientation is normally a better strategy than import-substitution for building technological competence (Lall, 2000). However, there are more fundamental incentives that affect a nation's policies with regard to technological activities (Lall, 1992). According to Porter (1990), the nature of local demand (e.g., buyer sophistication and competition intensity) affects product development and quality management. The size of the domestic market also influences the kinds of technological activities that are likely to be taken. For example, large countries can foster capabilities in more scale-sensitive activities than smaller countries (Murphy, Schliefer, & Vishny, 1989). In such a case, the government of a large country may adopt an import-substitution policy by focusing on the buildup of manufacturing capacity. This choice seems natural to a developing economy, given their priorities in the areas of industrialization and employment. However, an underdeveloped market also entails lower requirements with regard to technological sophistication and quality. As such, the inward-oriented import substitution policy will not create as much of an incentive for intensive technological activities as an export-driven policy.

2.3 Modes of international technology transfer

According to neoclassical theory, innovation and technological change are exogenous and often associated with international technology transfer (TT). Indeed, technologies imported from developed countries provide the most important initial input into technological innovation in developing countries (Lall, 2000). However, different modes of TT are differentially associated with the levels of learning effectiveness. In auto manufacturing, a developing country can choose between incoming foreign direct investment (FDI) and the market in facilitating TT (Maxcy, 1981). Generally, FDI or *internalized modes* of TT are very efficient for transferring know-how that involves the attainment of a

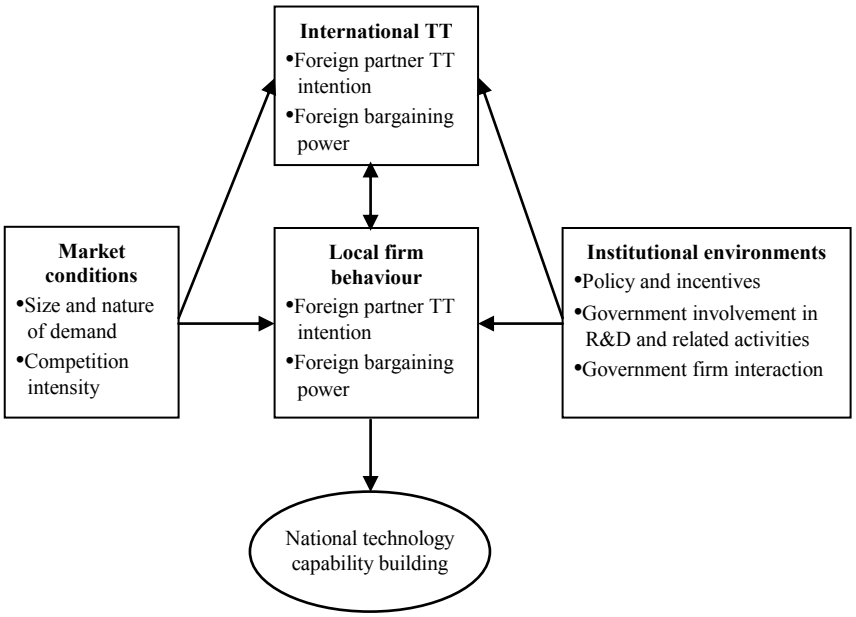
minimum level of operational capability, but less so for transferring know-why, that is, the ability to understand the principles of the technology. In contrast, licensing or other arm's-length *externalized modes* of TT are more effective for generating local know-why, but may be more expensive in the short term for accessing know-how, and they do not allow access to those new technologies that are not for sale (Ivarsson & Alvstam, 2005). Know-how-oriented learning is important as it allows a developing-country firm to quickly reap the benefit of starting manufacturing without the costs of "reinventing the wheel." Know-why-oriented learning tends to be more costly and risky, yet allows the firm to select more efficiently the new technologies they need, adapt and improve them more effectively, and develop autonomous innovative capabilities (Nelson, 1993).

2.4 Technological activities within firms

Though macroeconomic variables in the development process have received the most attention, technological transfer and innovation ultimately take place within business firms (Teece, 1993). National technological capabilities develop when individual firms accumulate technological capabilities at the micro level (Kim & Nelson, 2000). Business historians have long associated national competitive advantage with the development of specific organizational capabilities and the institutions that utilize these capabilities (Chandler, 1990). To account for the circumstances under which local innovation is strong, some authors argue for an effective national innovation system with property rights and rule of law as key elements (Gwartney & Holcombe, 1999) as well as a positive cultural and social environment (Audretsch & Thurik, 2002). The emerging literature on organizational learning has quickly accumulated a stock of knowledge on why and how individual firms engage in learning and innovation. For instance, parallel to the macro-level concern with incentive regime (Lall, 1996), the management scholars (e.g., Hamel, 1991) identify an articulated learning intention as a critical antecedent to effective learning. Indeed, learning involves conscious decisions and deliberate activities, rather than the mere accumulation of production experience (Ivarsson & Alvstam, 2005). According to the dynamic capability view, a firm's competence and capabilities rest fundamentally on organizational processes, market positions, and paths (Teece et al., 1997). Informed by this view, firms in emerging economies may catch up and even overtake counterparts in the developed world by selecting better processes and paths, given constraints from industry dynamics (Teece, 2000). While Western-derived theories, including the dynamic capability view of the firm, are relatively silent with respect to institutional context, research on organizational learning and innovation should give more weight to factors embedded in such contexts, including corporate governance. For example, recent research suggests that conditions in family-controlled business, such as concentration of ownership and longer managerial tenure, allow the owners the discretion, incentive, knowledge, and resources to engage in long-term investment activities, including knowledge creation (Miller and Le Breton-Miller, 2004). However, the assumption that the development of private entrepreneurship serves as a profit-motivated agent of technological change is not universally held. State control and institutional discriminations against private entrepreneurs remain a facet of life in much of the developing world (Peng, Stanislav, & Shekshnia, 2001).

In summary, existing literature suggests a conceptual framework (Figure 1) for national technological capability building by taking into account market conditions, institutional environment, international technology transfer, and finally the innovation behavior of the local firms.

Figure 1 Factors influencing national technological capability building



3 Technological activities in the auto industry: comparing China with Korea

3.1 Technology appropriation in industry development

The year 2005 witnessed a milestone for the automotive industry in both Korea and China, when auto production in each country exceeded 5 million units. However, there is a fundamental difference between the two countries: whereas automobiles made in Korea have enjoyed a reputation for quality and innovation and thus experience success in competitive overseas markets (Hyun, 1995), automobiles made in China are dominated by brands owned by MNC auto makers, and indigenous Chinese brands are considered low in quality and have difficulty entering the international marketplace, especially the competitive North American market (Zhong, 2006).

In developing their automotive industry, both China and Korea have taken advantage of technology transfer from advanced countries, an approach adopted by most less developed countries in their drive toward industrialization (Kim & Nelson, 2000). According to the model of the technology appropriation process, less developed countries normally follow a consecutive path to develop their technological capacity as they create and grow an indigenous automotive industry. Apparently, this has been the case in Korea. Amsden and Kang (1995) observed that the Korean automotive industry progressed from complete knock-down (CKD) manufacturing to mass production of a single model, and finally to the export of a wide range of models. According to Kim (2001, 2003), Korean auto firms have sequentially built three different technological abilities – absorptive, explorative, and innovative, through three consecutive stages, namely duplicative imitation, creative imitation, and innovation. In Hyundai's example, about half of its car models were designed using autonomous technologies. In contrast, it seems that the technical capacity of China's automotive industry is still wandering in the stages of "production in scale" and partly in "adapted model production," and applying duplicative rather than

creative imitation ability. Although the country has had similar experience through CKD and model adaptation, so far it has achieved little success in the development of a complete, independent technological capacity. Currently, Chinese auto makers have developed certain improvements in body designs over previous models. However, they do not have mature, high-level development capacity for the whole passenger car and product platform, based on independent intellectual property. As a result, they are dependent upon MNC IJV partners in product and technological innovations, and lack the decision-making power on product development and choice (Zhang, & Zeng 2007). Today, although passenger cars "made in China" account for 95% of the Chinese market, those that are competitive and independently owned by the Chinese auto makers are few.

3.2 Firm strategy and technology transfer

What has happened in the Chinese auto companies to prevent them from developing independent design technologies during this industry's phenomenal growth? A comparison with their Korean counterparts immediately points to the fact that, whereas Korean auto firms adopted an independent development strategy, Chinese auto makers have operated as international joint venture (IJV) partners, hoping to acquire advanced technologies from MNC partners. Progressing through reverse engineering, assimilation, and eventual independent design, for example, Hyundai obtained foreign technologies in unpackaged form through license agreements with numerous international firms (Lee, 2000). Since the technologies did not come from one particular foreign source, Hyundai was able to maintain independence from MNCs (Kim, 1997). In this regard, Daewoo Motors, another Korean auto maker, offers an interesting contrast. Constrained by its joint venture with GM, the company was late in approaching the global market and reaping technological assets on imported capital goods (Lee, 2000). In comparison, most passenger cars' assemblers in China are IJVs. Automobiles manufactured by the IJVs have topped the list of national brands and taken a lion's share of the fast-growing Chinese market. While the Chinese IJV partners have shared the financial outcomes from an ever-expanding auto industry, the technologies that are used to design the cars remain largely controlled by the MNC partners.

The core of technological capability is tacit knowledge (Nelson & Winter, 1982), which is particularly true in automotive manufacturing (Gallagher, 2003). Thus, the inability of Chinese firms to acquire technologies from MNCs seems contradictory to the conventional wisdom that joint ventures may offer better opportunity, compared to licensing, for example, to acquire tacit knowledge, since joint ventures involve human interaction. However, learning effectiveness in joint ventures is determined by the intensity of a partners' learning intent and control structure (Hamel, 1991). At this technological trajectory, the position and strategy of the technologically advantageous partners also play an important role. At GM's Shanghai plant, there is no indication of a strong intent toward stronger technological capabilities on the part of the Chinese, nor is the U.S. partners' motivation to transfer technologies. The lack of motivation to transfer technology from Western JV partners is not surprising, since they built the plant in China mainly to occupy the market. "We are here to make money, not to do training. If it's worth it, we can do some training while making money," admitted a senior manager at DaimlerChrysler's China unit (Gallagher, 2003). In Ford's case, it sounds like a conspiracy that the Chinese partner did not ask for more advanced technologies, whereas the U.S. partner felt no obligation to transfer them (Gallagher, 2003). Finally, whenever the Chinese partner shows an intent to acquire technological know-how from the MNC partner, the power

imbalance impedes their learning effectiveness. Ironically, despite their majority equity position in the IJV, Chinese partners are always in a weaker position with regards to technology transfer in the auto industry (Zhong, 2006). Both inadequate R&D investment and shortage of skilled employees prevent them from effectively absorbing core technologies through IJVs (Xiong, 2007). In summary, the failure of the Chinese auto industry in taking advantage of technology transfer through IJVs leads to two broad questions, concerning Chinese auto makers' disincentive and inability to become innovative.

3.3 Incentive to learning and innovation

Most authors credited Korea's success in developing its auto industry to Korean firms' strong drive toward technological learning, as an entrepreneurial response to government policies and regulations, including export targets and incentives, price control, trade protection, and restriction of FDI (Hyun, 1995; Kim, 2001). Export targets and incentives forced the industry to lift both its technology and quality to meet the requirement in advanced foreign markets; price controls encouraged the industry to develop its efficiency by cost cutting; restricting FDI and the import of technology brought the industry an advanced technical base while maintaining management control; and trade protection helped prevent its "infant industry" from the assault of foreign makers. Importantly, all these measures were implemented with threats as well as promises, thus constructing a kind of crisis that effectively pulled and pushed Korean auto makers into a mode of active learning and innovation (Kim, 1997). The Chinese government has also taken measures to protect its emerging auto industry and had a goal of acquiring advanced technologies from the outside world. The key difference is China's domestic orientation versus Korea's export orientation. Unlike Korea, which has a limited domestic market, China enjoys the largest untapped market for automotive products. Because the general policy of exchanging markets for technology was translated into the firms' practices in dealing with MNC auto makers, export targets have never been seriously negotiated and implemented. Import tariffs and local-content-requirements technology helped to create a protected market, but the protection has not led to an environment that pushes for technological innovations on the part of its domestic players. Instead, these measures allow MNC-dominated IJVs to enjoy high returns without concerning themselves with outside competition, which in turn diminishes the interest in improvement efforts (Farrell et al., 2004).

Then how about competition among IJVs, since literally all major MNC auto makers have entered China through IJVs? When the first IJVs (American Motors and VolksWagen) entered China in the middle of 1980s, the market was wide open. Even today, when competition has become increasingly visible, the car ownership per capita is still low compared to that of developed countries (Dargay, Gately, & Sommer, 2002). The low GNP determines the level of demand and therefore the technological sophistication of automobiles demanded by Chinese consumers. Thus, the government's publicized agenda for technology transfer has not been translated into concrete requirements with regard to FDI regulations in the auto industry, and Chinese IJV partners have not shown genuine interest in learning and innovations (Gallagher, 2003). Since the development in China's automotive sector is mainly to meet its domestic requirement, its recent growth has a close correlation with China's GDP growth (Advisory, 2005). The large population base offers tremendous domestic market potential, with current car ownership at about 0.5 cars per 100 people, compared to 50 to 80 cars per 100 people in the developed countries (Fulcheri, 2005). This market potential, combined with a protected environment and a limited number of players, has offered the Chinese auto manufacturers a supplier

market. However, the lower average consumer income ($3,500–$4,000, although it is increasing dramatically) may afford its consumer only lower-end products. Thus, the supplier market keeps a higher profit in this segment and contributes little, if anything, to developing industry efficiency; a higher growing market (or potential market) drives the domestic makers to catch up to the market share through expanding production capacity, while a lower-end market requirement contributes less initiative or incentive to the local makers to concentrate on the lift of technology capacity. Interestingly, the Chinese auto companies have been able to export with an annual increase of 15 percent since 2001 (Beijing Daily, 2006). However, the exports have largely gone to other, less developed countries, with a similar pattern for Latin American countries that have adopted a "manufacturing culture" (Kaze, 2000). In contrast, Korea, a country with one twenty-fourth of the population of China, has a much smaller domestic market. Given the auto assembly's minimum efficient scale of 0.3 million cars per model (Amsden and Kang, 1995), the imperative for Korean firms to go abroad is translated into government priority toward export (Kim, 2001). Importantly, competing in the international market implies higher standards of quality and thus greater technological capabilities in individual firms.

Finally, it is important to note that the engine of technological capability building in Korea's auto industry is large Chaebols. It is true that a limited domestic market and a clear government policy brought pressures on firms to innovate. However, all these external factors worked only when individual firms entailed an entrepreneurial spirit (Kim & Nelson, 2000). In comparison, the parent companies of the Chinese IJV partners are all from the state sector (SOEs). As is well documented, the performance incentive and managerial discretion of the SOEs are questionable. Evidence has shown that business groups in China, which should include major auto makers, are less dynamic than Korean Chaebols (Lee and Woo, 2001).

3.4 Government and institutional environments

The inability of Chinese auto firms in learning and innovation has to be understood in light of China's institutional environment, especially in the role of the government. In this regard, Korea serves as a contrasting example again. The Korean government has clearly played an active and positive role in shaping the technology capability of its auto industry (Mukherjee and Sastry, 1996; Kim, 2001; Ravenhill, 2005). Besides a national innovation agenda and specific measures to push forward technological learning in Korean firms, the government has also done the following: First, it *consistently* and *effectively* executed and implemented such strategy and measures. Second, the government helped develop an industrial infrastructure conducive to building innovation capability. Besides investing heavily in education, the Korean government was also directly involved in the R&D activities targeted at key industries. Particularly, in the absence of university R&D, the government initially set up the Government Research Institute (GRI) by recruiting overseas-trained South Korean scientists and engineers. GRI accounted for 83.9 percent of the nation's total R&D expenditures and 43.7 percent of the nation's researcher pool in 1970. Third, as mentioned earlier, the government directly interfered in Korean firms' innovation efforts. It is important to note that Korea's industrialization drive in the early 1960s coincided with a strong government. The implementation of an automotive industry policy was centralized; the president was briefed regularly on the progress of major auto makers in indigenous model development (Kim, 1997).

There is a popular belief that the Chinese government runs a distinctive policy to attract foreign inflow of capital and technology in exchange for the domestic market. In the automotive industry, however, a comparison of China to Korea suggests the failure of the Chinese government to push forward on autonomous technological advancement. First, as discussed in the preceding section, its "exchanging technology with market" FDI policy has provided the wrong incentive to Chinese firms, which remain passive in learning and innovation. For example, the document "Industrial Policy of the Motor Industry" issued by the Chinese government in 1994 called for both meeting domestic demand and increasing product development capability at the same time (SETCIPD, 2001). However, the strong emphasis on supplying the domestic market enhanced the import-substitution orientation and contradicted the requirements for building product development capability. Clearly, the government's proclaimed policies concerning technology transfer and innovation are inconsistent (Gallagher, 2003). Second, the government has failed to design and implement policy instruments that directly address market failures in the factor markets for technological learning (Lall, 1992). A prominent example here is targeted and subsidized loans to the local auto industry. This key measure, while proving very useful in Korea's experience, has been made difficult to implement in China due to the IJV situation. Or it was, until very recently, when the government decided to provide policy credits to one of the Chinese auto makers for autonomous R&D purposes (Zhong, 2006). Unlike its Korean counterpart, the Chinese government has never *actually* attached the automotive industry with strategic importance, as it did, for example, with the atomic boom. It has asked the auto industry to be self-supportive, as far as R&D is concerned. To the Chinese government, the main concern with the auto industry is its role in national economic development. Only very recently was a consensus reached that the auto industry should be treated as the leading industry responsible for the growth of many other industries. However, according to a government think tank, this consensus has not been reached as a conclusion to the everlasting debate but as a realization that the auto industry has progressed into such an industry by itself (Chen, Lui, & Feng, 2004). It is thus not surprising that, compared to the Korean government's direct involvement, the Chinese government's lack of investment has left the market's failures regarding national technology infrastructure unaddressed, and has thus weakened the bargaining power of Chinese auto makers.

Third, the development of China's automotive industry has been accompanied by institutional transformation wherein the power of the central government has been significantly weakened. With its "decentralization"-oriented economic reforms, often the government is not in a strong position to effectively implement an industrialization strategy. Power decentralization on the provincial level has accomplished two things in the Chinese auto industry: made it impossible to develop and effectively implement a national industry policy; and given up a major responsibility to guide and lead investment in the R&D effort to facilitate technological capability building. Seen as a major source of local revenue and employment, auto manufacturing and assembling can be found in any of the Chinese provinces except Tibet. Recent efforts by the central government to consolidate the industry have been ineffective, and many auto firms continue to operate at levels significantly below needed scale economies. The industry's fragmentation has a direct consequence on the way local and foreign auto companies interact. Case studies show that, when negotiating IJV agreements, local governments have had a tendency to make more concessions to MNCs (Peng, 2000). When locally embedded Chinese auto makers bid to win a particular IJV deal, a MNC can easily avoid serious commitment to technology transfer (Farrell et al., 2004). According to Huang

(1997), due to a power shift to the provincial governments, Chinese auto firms have failed to achieve socially optimum levels of investment. In an industry with clear economic-scale requirements, this fragmented structure effectively impedes the building of industry competitiveness. It has been observed that Chinese partners often insist on the setup of R&D centers during the negotiation of joint ventures, but most of these centers have never carried out substantial R&D efforts after their establishment (Holweg, Luo, & Oliver, 2005).

The preceding discussions are summarized in Table 1.

Table 1 Factors influencing firm innovation behavior

Sections	*Features*	*China*	*Korea*
Incentive to be innovative	Domestic market	Large but unsophisticated	Much smaller
	Nature of the firm	SOEs as JV partners	Independent large Chaebols
	Industry structure	Protected from competition	Constructive crisis
Institutional environment	National innovation agenda and specific measures	Ambiguous policy and insubstantial measures	Policies consistent and effectively executed
	Government involvement in R&D	Centralized effort nonexistent	Direct investment
	Government-firm interaction	Weakened due to decentralization	Heavy-handed interference and monitoring
Firm strategy	Organizational mechanism	Intentional joint ventures	Independent development
	Source of technology transfer	From a particular foreign partner	Licenses from different foreign sources
	Strategic orientation	Quantity for domestic market	Quality for export

4 Discussion and conclusion

Our comparative analysis traces the failure of the Chinese indigenous auto industry to develop autonomous technological capabilities in individual Chinese firms, which have not been able to take advantage of potential technology transfer through IJVs with MNC auto makers. The failure of Chinese auto companies to effectively develop an independent technological capability, however, has to be understood in the context of a misleading and ineffective policy regime and a fragmented political structure, which in turn are associated with a disincentive market environment (i.e., sizable but unsophisticated demand) and China's ongoing systemic restructuring that has so far been oriented toward management fragmentation (Boisot & Child, 1988). Important policies as well as theoretical implications have emerged from this comparative analysis.

While technological capability building is considered the driving force in a nation's long-run economic growth, our comparative analysis of automotive industry development in China versus Korea confirms that the link between technological competence and economic development is to certain extent a choice made by the nation. In Korea's case, the development of autonomous technologies was taken as a focal piece in the government's industrialization

strategy. The pressures brought to bear by the government on a significant collection of Korean firms resulted in an independent development strategy and effective competition against firms based in Western industrial countries. In comparison, the government in China opted for an exchange route (market for technology) to acquire advanced automotive technologies. While sharing phenomenal economic returns with their MNC-IJV partners under the government's trade protection, Chinese auto makers have not been actively engaging in technological activities that lead to autonomous competence. Today, while both China and Korea have a growing importance within the global automotive industry, with comparable production volumes, their impacts are nevertheless not the same. With its autonomous technologies and strategic posture, the Korean auto industry has become a viable force in the competitive international marketplace. On the other hand, the Chinese auto industry, with MNC-IJV partners controlling core design technologies, remains largely a battleground for international auto makers, and the lack of independent technological capability has hampered Chinese auto makers' attempts to effectively participate in the global competition. Huang (2003) criticizes China's FDI policy as "selling China" on the grounds that the policy discriminates against indigenous private enterprises and thus sacrifices the long-run viability of the national economy The current study suggests that a government policy that favors IJVs has led to the delay of building national technological capabilities. It is true that FDI through IJVs has accelerated the development of a *national market* for the auto industry. However, it is also true that these tremendous market activities are fueled by *foreign-owned* factors. Given the role of technological advancement in a nation's long-run economic growth potential, we may view the contemporary development of the Chinese auto industry as one without a concurrent buildup of *national industry*.

Directly responsible for China's failure in developing a local technological base while growing its automotive industry has been the choice of IJVs as the mode for international technology transfer. There is a belief that IJVs offer better opportunities for human interaction than licensing (Killing, 1980). Based on the assumption that automotive design involves a great deal of tacit knowledge, IJVs should be a preferred vehicle for acquiring advanced technologies in the auto industry. However, the learning effectiveness of the technology-seeking partner is dependent upon several factors, including the intensity and clarity of the partner's learning intent and the power relations between the partner and the other side of the IJV (Hamel, 1991). In the current case, the Chinese partner did not have a strong and elaborated learning agenda, and its bargaining power was weak and actually has been weakened, due to the government's decision-making decentralization and passivity with regard to national technological infrastructure.

The critique on China's failure of technology competence building may be overstated. Instead, some people believe that the country has been following a natural path that is now directed at more aggressive innovation (Zhong, 2006). Recent announcements of the Shanghai Automotive Industry Corporation (SAIC) and others indicate the awakening of Chinese auto firms with regard to national technology capability development. However, the catch-up in learning is path-dependent (Teece, 2000). With the current level of internationalization in the automotive industry, it is no longer possible for China to exclude foreign investment in developing its national market, as has been done in Korea (Chen et al., 2004). Particularly, since all major Chinese firms are now tied with IJV partners, their independent development efforts will either be consciously obstructed or even challenged by the MNCs on grounds such as intellectual property violations. Some Chinese auto analysts suggest that Chinese auto makers should start making stronger demands for sharing technologies from the

IJV platforms, based on the assumption that MNCs will have to make concessions for fear of being forced out of the lucrative business ventures they've built over the years (Zhong, 2006). However, its newly granted WTO membership has effectively limited China's ability to demand technology transfer from international auto companies. This leaves what is probably the only feasible alternative for Chinese auto makers, that is, to build an independent platform for autonomous technology development. The Korean experience suggests that a strong, determined government can do much to facilitate the creation of an economic and institutional environment toward national technological activities – and therefore a competitive national industry. However, it remains questionable to what extent China could give up its differential treatments toward state-owned versus private firms in the automotive sectors, with two non-state auto makers having most visible indigenous brands at the present time. While the government may be able to make possible consolidations, leading to fewer and larger auto groups in the state sector, the question of whether an entrepreneurial spirit could emerge in these Chinese "Chaebols" will ultimately determine their viability and success in their catch-up game with the competitive global automotive market.

When reading this comparative study, largely drawn on historical evidence, the audience should bear in mind its inherent limitations as research strategy. We compare China to South Korea with a focus on their approach toward technology innovation in augmenting industrial development. However, this reference point is by no means perfect, given the different social, economic, and institutional environments between the two countries. Additionally, the use of historical "facts" will inevitably rely on interpretation. For these reasons, we will have to come up with more convincing statements with complementary methodologies, including mainstream quantitative design or in-depth case studies.

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