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Strategic Adaptation to Deregulation in the Indian Auto Components Industry

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1. Introduction

A key concept in strategic management is that a firm's performance is determined by the alignment or "fit" between its external environment and its internal resources, capabilities and organizational practices (Miles and Snow 1994; Schendel and Hofer 1978; Siggelkow 2002; Venkatraman and Camillus 1984; Zajac, Kraatz and Bresser 2000). When a firm's environment changes, however, this alignment or fit is compromised and its performance will suffer until it adapts and reconfigures itself to effect a new fit with its changed environment. A number of studies have explored this phenomenon of strategic adaptation, especially in the context of industry deregulation (e.g., Haveman 1992; Goll, Johnson and Rasheed 2006; Reger, Duhaime and Stimpert 1992; Smith and Grimm 1987).

Strategic adaptation is likely to be difficult for most domestic firms, given core rigidities (Leonard-Barton 1992) and strong inertial forces against change. This would especially be true when environmental change is systemic, sudden and, hence, extreme or "avalanche-like" (Suarez and Oliva 2005). One instance of such extreme environmental change is that faced by firms in emerging or transition economies subsequent to economic liberalization or privatization.

In closed, highly regulated environments, the government and regulatory bodies exercise control over all aspects of the industry environment and the key to survival is not so much strategic planning for economic efficiency as the ability of the firm to develop appropriate political and social strategies to manage its relationship with the government and regulatory bodies (Mahon and Murray 1981). When the environment changes significantly after economic liberalization or industry deregulation, however, this fit that so painstaking had been forged is destroyed. Governments and regulatory bodies cease to be buffers against market forces and accordingly, there is a shift in emphasis to efficient operations from the maintenance of social goals. Firms are forced to adopt unfamiliar forms of governance and operate under new and evolving institutional mechanisms (Peng and Heath 1996). In addition, entry by multinational firms may occur bringing in sophisticated technological and managerial capabilities that domestic incumbents typically lack. These significant changes in their environment may necessitate domestic firms

to "re-orient" themselves by making simultaneous changes to their strategies, structures, technologies, systems and organizational practices/routines (Suarez and Oliva 2005; Tushman and Romanelli 1985).

A number of studies (e.g., Hatum and Pettigrew 2006; Peng and Heath 1986; Suarez and Oliva 2005; Uhlenbruck, Meyer and Hitt 2003) have explored how firms adapt to their new, open, intensely competitive environments subsequent to deregulation in Western countries or large-scale privatization or liberalization within emerging economies in Eastern Europe, Latin America and Asia. A key question, however, is whether insights gained on firm-level strategic adaptation from these studies are equally applicable to the case of mixed economies such as India that have undergone liberalization.

Such mixed economies are different from centrally planned and communist economies in several ways. For instance, India was a democracy with a predominantly closed, inward-looking and centrally planned economy till the early 1990s. Nevertheless, side-by-side, India had a large private sector and several key trappings of a market economy including private property rights, a well developed (though glacial) legal system and a stock market. Even though the deregulation of several industries began in a small way in the 1980s, significant liberalization of the economy occurred only during the early 1990s. Since then, however, the scope and pace of liberalization has been tentative, with progress being made in "fits and starts" due to pressures typical in a democratic political system.

In such a setting, domestic firms may have the opportunity and time to adapt to their new environment, given the relatively narrow scope and slow pace of change (White and Linden 2002; Reger, Duhaime and Stimpert 1992). At the same time, however, the evolutionary nature of change and uncertainty over timing of specific changes may make it difficult for them to forge an optimal alignment or fit with their environments. Given these conflicting tendencies, how may firms adapt strategically to their evolving environments and what may the performance consequences of such strategic adaptation be? This research question is the focus of our study.

To answer this question, we study the evolution of the auto components industry in India during 1992-2002, a period during which the downstream auto industry was deregulated significantly along with the liberalization of the wider Indian economy. Our exploratory analysis reveals that the acquisition of

technological competences is but a necessary first step for domestic firms. For long-term survival and performance, domestic firms need to leverage their newly acquired technological competences to forge close, preferential relationships with their buyers (i.e., downstream firms) and embed themselves irrevocably in the domestic and global supply chains.

The remainder of our paper is organized as follows: In Section 2, we present a brief background on the Indian auto components industry and develop hypotheses on strategic adaptation and the consequences of such adaptation for the performance of domestic auto components firms subsequent to economic liberalization. In Section 3, we discuss our methods and data. Then, in Section 4, we present the results of our analysis. We conclude in Section 5 by discussing the limitations and key implications of our study.

2. The Auto Components Industry in India

2.1. Industry Background

Our primary focus in this paper is the auto components industry in India, but we also briefly describe the downstream auto industry to provide context to developments in the auto components industry. The auto components industry in India is an appropriate setting for exploring strategic adaptation by firms subsequent to economic liberalization and industry deregulation in a mixed economy. Before 1991, the auto industry, and by association, the auto components industry was subject to tight government control. A policy of import substitution and indigenous content requirements (upto 95%) led global automakers such as Ford and GM to exit India in the 1950s (D'Costa 1995) and the primary emphasis of domestic automakers shifted to producing commercial vehicles. During this highly regulated period, a significant portion of the auto components industry was reserved by the government for small, privately owned firms (termed small scale industries). Domestic automakers were required to purchase a number of components from these and other independent auto components firms (Singh 2004). Consequently, the auto components industry became very fragmented with low production volumes, low technological intensity and low quality consciousness. With time, however, regional clusters anchored by

skilled labor formed around key domestic automakers and a few relatively large auto components firms emerged to constitute what became known as the "organized sector" of the industry (Tewari 2001)[1].

The creation in 1982 of Maruti Udyog Limited (MUL), a joint venture between the Indian government and Suzuki Motors of Japan, for manufacturing cheap, small cars heralded the first tentative steps by the Indian government to deregulate the Indian auto and auto components industries. In the mid-1980s, the government permitted domestic automakers to form joint ventures with foreign (mostly Japanese) automakers for the manufacture of commercial vehicles. The government also permitted domestic firms to set up new units, add capacity and enter into technical/financial collaborations with global automakers and components firms. During this decade, prompted by the indigenous content requirement imposed by the government and the appreciating yen, MUL and the Japanese joint ventures began to develop domestic supplier networks by offering assistance and promoting links and joint ventures between domestic suppliers and their traditional suppliers in Japan (Okada 2004). This resulted in the auto components industry – at the least, the immediate supply chains of MUL and the Japanese joint ventures in the commercial vehicles segment – adopting lean manufacturing and other advanced practices to become relatively modernized (Tewari 2001). By 1990-91, mirroring the growth of the downstream auto industry, the auto components industry had grown to $1.49 billion in sales (of which the "organized sector" contributed approximately $1.15 billion) from just $80 million in 1980-81 (Singh 2004).

Significant deregulation of the auto industry occurred in earnest only in 1991-92, as part of the wider liberalization of India's economy. Multinational automakers were allowed to enter the Indian market and set up majority-owned ventures (Singh 2004). Technology licensing and transfer were

[1] The "organized sector" of the Indian auto components industry comprised medium and large auto components firms that sold their products to at least one major domestic automaker. By contrast, the "unorganized sector" comprised small, privately owned firms (i.e., small scale industries) that supplied relatively inferior quality components primarily to the aftermarket.

allowed and encouraged; moreover, automakers were allowed to import components or, with an equivalent export commitment and appropriate licenses, even completely knocked down (CKD) kits. Between 1992 and 1997, many global automakers such as Daewoo, Daimler, Ford, Honda, GM, Peugeot and Toyota entered the Indian market, primarily through joint venture assembly operations with domestic incumbents. The new entrants also encouraged their global Tier 1 suppliers such as Delphi and Visteon to enter the Indian market through wholly owned subsidiaries or joint ventures with domestic firms.

In 1997, the Indian government required new multinational entrants to establish manufacturing operations (as opposed to just assembly) in India and imposed an aggressive indigenization schedule of 50% in the first three years rising to 70% by the fifth year (Tewari 2001). Due to these requirements, new multinational entrants could no longer rely just on imported components or CKDs, but had to also undertake vendor development efforts to develop local sources of components. With time, the Indian auto components industry began to resemble the global auto supply chain, with the formal stratification of suppliers into various "tiers" (Okada 2004). The multinational components firms that had entered the Indian market and the relatively sophisticated domestic auto components firms such as the TVS Group companies became Tier 1 suppliers. Below Tier 1, however, stratification was not as formal as in the global auto supply chain. Also, given the relatively small demand and the presence of only about 400 components firms in the "organized sector", domestic components firms began serving several auto makers. These firms had to locate small units closer to their buyers and also had to enter into multiple joint ventures or technology licensing arrangements. These aspects imposed constraints on the potential for scale economies and learning/spillovers for domestic components firms.

By the late 1990s, three major auto clusters had emerged in India, one in the North (Delhi/Gurgaon), a second in the West (Pune) and a third in the South (Chennai). Rising demand led to significant increases in production volumes along with the quality and variety of models offered. Notwithstanding, the Indian auto industry still lagged in size behind Korea, China and Brazil among the emerging economies. The Indian auto components industry was commensurately small at $5.4 billion in

2002-03 (ACMA 2006); in comparison, Delphi's global sales in 2002 exceeded $27 billion (Delphi annual report 2002).

In 2002, the Indian government announced a new auto policy seeking to make India a major player in the global market for small cars and an Asian hub for auto components. Under this policy, the government further deregulated the auto and components industries by removing indigenization requirements and licensing for CKD kits, permitting 100% foreign ownership, and offering incentives to encourage domestic R&D and production. These developments prompted many multinational automakers and components suppliers to increase their ownership/control of joint ventures or to set up wholly owned subsidiaries in India, in preference to licensing arrangements with domestic suppliers. The free-trade agreement signed in 2004 with Thailand presented opportunities for Indian auto components firms, while also increasing the threat of competition from imported components from ASEAN countries.

In sum, the Indian auto and auto components industries evolved through at least three phases since deregulation in 1991. The first phase from 1992-1997 may be considered the transition phase from a closed industry environment to one that was more open and competitive, especially with the entry of multinational firms and expansion by domestic automakers. The 1997 auto policy announced by the Indian government heralded a second phase of evolution resulting in the rationalization of industry structure. A third phase began in 2002-03 with further deregulation under the new auto policy of 2002 and the free-trade agreement with Thailand. The primary emphasis of this third phase was on tighter integration of the Indian auto and components industries with the regional and global markets. Lacking access to reliable data on firm strategies and operations at the regional and global levels, we will not include an analysis of this third phase in our study. Instead, we will explore strategic adaptation by domestic components firms and the performance implications of such adaptation only during the first two phases, i.e., during the 1992-1997 period and the subsequent 1998-2002 period.

Hypotheses on strategic adaptation and performance implications

What strategic re-orientations would domestic firms in the Indian auto components industry have to undertake to make the transition from a protected, closed industry environment to an open and

intensely competitive environment? What shifts in strategic behaviors would they have to make as the downstream auto industry evolved subsequent to liberalization? And, what would the implications of these shifts be for firm performance? To develop reasonable hypotheses on these questions, it would be useful to examine certain characteristics and trends specific to the auto industry.

Automobiles are complex products that are assembled from hundreds of components and sub-assemblies. Some components are standard and can be used interchangeably in models manufactured by different automakers. Many key components and sub-assemblies, however, are specific to an automaker or even to particular platforms or models made by an automaker. It was typical for Western automakers to make many of these key components and sub-assemblies in-house (Monteverde and Teece 1982). After the Japanese automakers demonstrated that outsourcing of even complex components and the development of close, long-term relationships with key suppliers yielded considerable benefits (Cusumano and Takeishi 1991), Western automakers also began to outsource key components to selected suppliers. They attempted to forge "voice" rather than "exit" relationships with these suppliers (Helper 1991), despite experiencing difficulties with such relationships (Mudambi and Helper 1998). In addition, to minimize the transactions costs and to leverage scale economies, Western automakers rationalized their respective supply chains by adopting the Japanese practice of parallel sourcing from a small set of suppliers (Mudambi and Helper 1998).

When multinational automakers enter newly open emerging economies, they typically introduce existing or derivative models instead of developing a new model from scratch. Also, as testing and qualification of components are costly and time-consuming, automakers entering new markets persist with their traditional suppliers instead of developing local sources (Humphrey 2003). Either, they import CKDs and key components from their traditional suppliers or, in the presence of high import tariffs and local content requirements, encourage their traditional suppliers to follow them into these new markets.

Given the above trends in the global auto industry, an Indian auto components firm faces two challenges in making the transition from a regulated industry environment to one that is open and intensely competitive. First, it needs to develop buyer-specific or co-specialized technological assets and

expertise – for instance, customized design, engineering and production resources and managerial competences – to gain business from automakers, especially the new, multinational entrants. Also, it needs to create relational ties with automakers to become an intergral part of their respective domestic (or even global) supply chains. We consider each of these challenges, in turn.

Buyer-specific technological expertise. One constraint that domestic firms face in developing buyer-specific technological expertise is that their existing competence levels are low after a long period of enforced isolation from new technologies and world markets. The quickest way for domestic firms to obtain buyer-specific technological expertise would be to just license technologies from or engage in technical collaborations with global automakers or components firms. At least at the beginning (i.e., immediately after deregulation) when demand is uncertain and their knowledge of the domestic market sketchy, these global firms may have an incentive to license their technologies or enter into collaborative arrangements with domestic firms instead of setting up riskier wholly-owned subsidiaries.

For the domestic firms too, technology licensing is a quick and relatively cost-effective way to upgrade their technological competences. Over time, as these firms become involved in manufacturing components using the licensed technologies, they can accumulate buyer-specific technological know-how, build the required complementary assets and slowly develop their absorptive capacities (Cohen and Levinthal 1990; Kogut and Zander 1992; Rosenberg 1982). In turn, such enhanced absorptive capacities can potentially spawn a virtuous circle by enabling these firms to seek and assimilate even more sophisticated technologies in the future.

Nevertheless, most domestic firms may face difficulties in assimilating and gainfully employing the licensed technologies due to their low initial absorptive capacities and lack of prior familiarity with sophisticated production practices. Here, the requirements imposed by the government as the price for open market access – for instance, local content requirements and high tariffs on import of components/subassemblies – may work to their advantage by forcing automakers and global components firms to invest time and effort in transferring tacit or sticky technological knowledge/skills. Not only would technology licensing enable domestic auto components suppliers to do business with the new

entrants, but it also would increase their attractiveness as suppliers to domestic automakers that have to compete by offering comparable, sophisticated products.

Even though technology licensing may enable domestic firms to upgrade their technological expertise rapidly during the initial transition period, it may not be sufficient to ensure sustainable long-term performance. For instance, domestic firms that invest in technology licensing may begin to consider this as a substitute to internal R&D (cf. Narayanan 1998). With time, they may become dependent solely on external technologies and be confined to the role of contract manufacturers till such time that they lose their low-cost status. Therefore, it is critical for firms in emerging economies, to undertake internal R&D and develop domestic competence in technology development (Bell and Pavitt 1997; Kumar and Siddharthan 1994). Such internal R&D would increase their absorptive capacities (Cohen and Levinthal 1990), enabling them to develop know-why and know-what, two dimensions of knowledge that are essential for new product development and innovation (see Garud 1997; Kim 1998; Kogut and Zander 1992; Zahra and George 2002).

Immediately after deregulation occurs, however, domestic firms would not have either the ability or the incentive to invest significantly in internal R&D. Any effort at internal R&D would focus primarily on adapting licensed technologies to suit local requirements (cf. Narayanan 1998). Unlike global components firms, domestic firms in most emerging economies are small, focus on only one (or a few) components and cater to limited domestic demand. Therefore, they do not benefit from any scale/scope economies from their R&D activities. Also, competing demands for scarce financial resources – for instance, capital expenditures to modernize production equipment and processes, development of skilled manpower and routines for improving quality and productivity – may limit their ability to invest significantly in internal R&D. Therefore, we may expect domestic firms to begin investing in internal R&D only after they meet pressing demands and successfully navigate the transition to competing in the new, open industry environment. In other words, internal R&D is not likely to play a significant role in influencing domestic components firms' performance for a significant time period after

deregulation. Indeed, only those domestic firms that perform well, and thereby have slack resources available, are likely to invest in internal R&D.

In sum, we propose:

HYPOTHESIS 1: *Technology licensing by domestic auto components firms will significantly and positively influence their performance subsequent to industry deregulation. Technology licensing would be salient to firm performance especially during the initial phase (1992-1997) subsequent to deregulation.*

HYPOTHESIS 2: *Internal R&D, rather than influencing the performance of domestic auto components firms subsequent to deregulation, would be driven by their past performance.*

Relational ties with automakers. Technology transfer typically involves the sharing of tacit and sticky knowledge across firm boundaries and is a challenging task (Grant 1996). In an emerging economy context, such technology transfer is even more challenging due to the low initial stocks of technological expertise and low absorptive capacities possessed by domestic firms. One way for new entrants to develop domestic sources of supply would be to undertake intensive vendor development efforts. Vendor development efforts typically require the automaker to arrange for the transfer of appropriate technologies to the domestic vendor and then ensure that the vendor develops the technical and managerial competences to produce high-quality components on a consistent and timely basis.

Such technology transfer may be facilitated by the development of strong, relational ties between the automaker and the domestic supplier. This is because strong, cohesive ties and the repeated, frequent interactions they engender – i.e., relational embeddedness – increases the volume and granularity of information flows among partners (Uzzi 1996). In turn, this generates trust and greater appreciation of each other's competences/strengths and facilitates the transfer of tacit knowledge and learning (Hagg and Johanson 1983; Kale, Singh and Perlmutter 2000; Larson 1992). Over time, a virtuous circle is initiated wherein increasingly relation-specific investments make it possible for partners to recognize new opportunities for collaboration and, thereby, strengthen existing ties (Gulati and Garguillo 1999). In

addition, firms can benefit from indirect ties that partner firms have with other parties (Gulati and Garguilo 1999; Uzzi 1996).

Even though relational ties can facilitate knowledge sharing and transfer for mutual benefit, they entail considerable investment of resources, time and effort on the part of automakers to develop and maintain. Therefore, these ties exhibit "lock-out effects" (Gulati, Nohria and Zaheer 2000: 210). In other words, the creation of relational ties with one firm (or a set of firms) might preclude ties with other firms thereby locking these firms out of relationships permanently. Especially given the trend of automakers to forge strong relational ties with just a few suppliers globally, such lock-out can have significant consequences for the performance of domestic firms that are not able to gain admittance to the automakers' vendor development initiatives.

Apart from the significant investments required to develop domestic vendors, global automakers may also be wary of opportunism on the part of domestic firms due to the weak intellectual property regimes in emerging economies and a lack of sufficient information on the competence level and reliability of potential partners (Gulati 1995; Kogut 1988). Therefore, domestic firms early on may need to mitigate these concerns by aggressively investing in technology licensing and in developing buyer-specific technological expertise. In addition to credibly demonstrating that they possess "recipient transfer capacity", i.e., the ability to receive and utilize the transferred technologies and tacit knowledge (Martin and Salomon 2003: 363), the development of buyer-specific technological expertise may allay fears of potential opportunism.

In other words, we may expect the development of relational ties to influence domestic firms' performance only in the latter phase of industry evolution (1998-2002), i.e., only after domestic firms have demonstrated their technological proficiency and commitment during the earlier period. Accordingly, we hypothesize:

> HYPOTHESIS 3: *Strong relational ties forged by domestic auto components firms with key automakers will significantly and positively influence their performance subsequent to industry deregulation. Strong relational ties would become more salient to firm*

performance especially during the later phase (1998-2002) of industry evolution after deregulation.

In sum, the deregulation of the downstream auto industry in India occurred in several phases and the performance of domestic auto components firms subsequent to deregulation very likely depended on their ability to adapt dynamically to the evolving policy and industry environment. Accordingly, we hypothesize a strategic shift on the part of domestic firms from just licensing technologies immediately after deregulation to also forging strong relational ties with downstream automakers in subsequent periods. In other words, firms need to be cognizant of both their technical and institutional environments and adapt their behaviors in both. Also, we do not expect internal R&D to play a significant role in enabling domestic firms to make the transition to the new, open industry environment; instead, successful transition and firm performance is likely to drive investments in internal R&D.

3. Data

3.1. Data sources

We abstracted firm-level data for the period 1992-2002 on all Indian auto components firms listed in the *Prowess* database. Prowess, a database maintained by the Center for Monitoring Indian Economy (CMIE), Mumbai, India, contains detailed firm-level data on over 10,000 large and medium-sized Indian firms, comprising all firms traded on India's major stock exchanges and also firms from the central and public sectors (i.e., government-owned firms). The Prowess database covers most of the organized industrial activities, banking and organized financial and other services sectors in India and several studies on India (e.g., Chacar and Vissa 2005; Khanna and Palepu 2000) have used samples abstracted from the Prowess database. We obtained data on technology licensing for our sample of firms from CapEx, which is also a database maintained by CMIE and provides information on new and ongoing collaborations and investment projects in India beginning 1992.

Our final sample consisted of 1,271 firm-year observations for the eleven-year period between 1992 and 2002. The auto components firms in our sample accounted for approximately 66% (in the early

years) to 85% (in the latter years) of total annual industry sales reported by the Auto Components Manufacturers Association of India (ACMA).

In addition to the above archival firm-level data on performance, we conducted interviews with senior executives in ten firms in the Indian auto and auto components industries. We ensured that these interviews would yield considerable breadth and diversity of perspectives. Specifically, we interviewed four Tier-1 auto components firms and three Tier 2 auto components firms, and, to get the customers' perspective, we also interviewed three automakers. We interviewed executives at both small and large auto components firms, with the interviewee firms ranging in annual revenues from US$4.9 million to US$275 million and from 136 employees to over 3000. We ensured diversity in firm ownership by interviewing executives at Indian-owned auto components firms, foreign-owned firms, joint ventures and also firms that were part of large business groups. Finally, we ensured that the interviewed firms had a representative customer base – for instance, domestic automakers, multinationals or joint ventures.

Our interviewees at these ten firms were industry veterans, who have spent an average of 20 years in the auto/components industries, and occupied senior positions ranging from Assistant General Manager and Director of Quality to President and Managing Director. Interviews ranged from 1.5 hours to 2 hours each[2]. We began our interviews with broad, open ended questions on the changes that had occurred in the auto and components industries since economic liberalization and industry deregulation in 1991, how these changes had affected their firms' behaviors, industry critical success factors, emerging industry trends, and the potential consequences of these trends for their firms. As an interview progressed, we delved deeper into specific issues such as the firm's behavior with regard to licensing technology, investments in R&D/licensing and the nature of their relationships with upstream/downstream firms. Our intention in conducting these interviews was to gain a broad, diverse perspective on the auto and components industries, and collect qualitative data to supplement and validate our empirical results.

3.2. Variable Definitions

[2] At one Tier 2 firm, the Managing Director provided written answers and clarifications to our questions.

To test our three hypotheses, we measured pertinent variables as follows:

Firm performance (Performance): We measured the performance of domestic auto components firms using return on assets (ROA). As our sample comprised both publicly-traded and privately held firms, we were constrained in our ability to use return on equity (ROE) as an alternative measure of firm performance.

Technology Licensing (Royalties): We measured technology licensing as the royalty expenses reported by domestic auto components firms over their revenues for each year.

Internal R&D (R&D): We measured internal R&D as the domestic firms' respective R&D intensities, i.e., their reported R&D expenses over their revenues for each year.

Strength of relational ties (Tier): We measured the strength of relational ties between domestic components firms and automakers using the Tier system commonly used to categorize suppliers to the auto industry. In this system, auto components suppliers are classified into several tiers, with Tier 1 suppliers dealing directly with auto makers, Tier 2 suppliers dealing only with Tier 1 suppliers and hence being once removed from the auto makers. Accordingly, Tier 1 suppliers' relational ties with auto makers are significantly stronger than those between automakers and lower tier suppliers. As the tier system in the Indian auto industry context became formalized only after industry deregulation and multinational entry, we asked several industry experts to classify the auto components suppliers in our sample into two groups: either Tier 1 or lower tiers. Based on their classification, we created a dummy variable which takes on the value 1 if the firm is classified as Tier 1 and 0 otherwise.

In addition to the above key variables, we also collected data on the following control variables:

Firm size (Size), measured as the log of firm sales revenues in each year.

Firm age (Age), measured as time elapsed since the firm's founding during each year.

Firm's market share (Marketshare), measured as the ratio of the firm's sales revenues and the industry's cumulative sales revenues for each year.

In Table 1, we present the summary statistics on the above variable measures.

Insert Table 1 about here

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4. Analysis and Results

4.1. Models

Our objective was to explore how the strategic choices made by domestic auto components firms in adapting to the post-liberalization industry environment influenced their performance. We hypothesized that technology licensing (especially in the 1992-1997 period) and strong relational ties with downstream automakers (especially in the 1998-2002 period) would significantly and positively influence their performance (Hypotheses 1 and 3). We also hypothesized that firms' internal R&D, instead of influencing domestic firms' performance, would be driven by good performance (Hypothesis 2).

First, to explore the relationship between Internal R&D and Performance, we performed Granger causality tests (Granger 1989) on these variables. The objective of the tests was to find out whether the causal link flowed from internal R&D to firm performance or from firm performance to internal R&D. Results of the Granger causality tests, reported in Table 2, indicate that Performance Granger-causes Internal R&D instead of the other way around. In other words, only those domestic firms that performed well in the previous periods tended to invest in internal R&D. This result offers partial support for our Hypothesis 2.

Insert Table 2 about here

Given the above result, we estimated two separate models. The first model explored the relationships among domestic firms' technology licensing, strength of relational ties with downstream auto makers and their performance:

$$Performance_{i,t} = \beta_0 + \beta_{1,j} Size_{i,t} + \beta_{2,j} Age_{i,t} + \beta_{3,j} Marketshare_{i,t} + \beta_{4,j} Licencing_{i,t} + \beta_{5,j} Tier_{i,t} + \varepsilon_{i,t}$$

……Model 1

Whereas, the second model explored in more detail the role of past performance in driving internal R&D:

$$R\,\&\,D_{i,t} = \beta_0 + \beta_{1,j} Size_{i,t} + \beta_{2,j} Age_{i,t} + \beta_{3,j} Marketshare_{i,t} + \beta_{4,j} Performance_{i,t-1} + \beta_{5,j} Tier_{i,t} + \varepsilon_{i,t}$$

……Model 2

We estimated the above models for the entire 1992-2002 period (Models 1a and 2a) and separately for the 1992-1997 period (Models 1b and 2b) and the 1998-2002 period (Models 1c and 2c). Our intention was to explore whether the relationships changed as the Indian government continued to deregulate the auto/components industries and domestic components firms adapted strategically to these changes. We employed the Fama-MacBeth year-to-year estimation method (Fama and MacBeth 1973), which is commonly used in accounting and finance research. The Fama-MacBeth approach comprises two steps. In the first step, cross sectional regressions are estimated to obtain parameter estimates for each time period. Thus, the parameter estimates are allowed to be different across time-periods. In the second step, the estimates from the cross-sectional regressions are averaged to obtain the final estimates for the coefficients and associated T-statistics. A major benefit of using this procedure in the context of panel data is that it accounts for cross-sectional and serial correlations and enables the investigation of the time-variation of the effects of the regressors on the dependent variable.

In estimating the models, we removed influential observations with studentized residuals greater than three or Cook's D statistic greater than one (Belsley, Kuh and Welsch 1980). White's (1980) test did not reject the assumption of homoskedasticity; therefore, our estimation did not suffer from the problem of heteroskedasticity. We also applied the Belsley, Kuh, and Welsch (1980) diagnostics to check for multi-collinearity. All the condition indices were less than three, well below the suggested cutoff of thirty indicating that multi-collinearity also was not a problem in our estimation.

4.2. Results

Licensing, Strength of relational ties and Performance. We report in Table 3 the results of our estimation of Model 1, i.e., the relationships among firms' technology licensing, strength of ties with downstream automakers and their performance. From Model 1a, which was estimated using data for the

entire 1992-2002 period, we found that both Licensing and Tier (i.e., strength of relational ties with downstream automakers) have positive and statistically significant coefficients. Also, the control variables Size and Marketshare were significantly and positively related to firm performance.

Insert Table 3 about here

During 1992-1997 (Model 1b), i.e., the six-year period immediately after deregulation, Size and Licensing were directly and significantly related to firm performance. These results are not surprising. Only large domestic auto components firms were likely to have possessed the slack resources to tide them through the initial transition period. Furthermore, multinational automakers and components firms entering the Indian market may have used size as a signal of domestic firms' capabilities and stability.

Likewise, domestic firms' aggressiveness in licensing new technologies would also serve as a credible signal of their commitment to become dependable and capable domestic sources of components. Furthermore, the auto industry executives whom we interviewed revealed that most multinational automakers that entered the Indian market insisted that domestic components firms license existing technologies or enter into joint ventures with their traditional supply chain partners. An executive at a technologically savvy domestic components firm stated that domestic automakers were more willing to trust them with components design and development than the new entrants (i.e., the multinational automakers) who were loath to take chances due to the arduous and costly qualification process. However, this executive conceded that technology licensing was a much quicker way for domestic firms to upgrade their technological expertise, especially when new product development would just involve "re-inventing the wheel" on existing, mature, firm-specific technologies and components.

Model 1c reveals an interesting shift in the relationships between the periods 1992-1997 and 1998-2002. Specifically, during 1998-2002, Licensing ceases to exert a significant influence on domestic firms' performance. Our interviews pointed to several reasons for technology licensing ceasing to be a significant determinant of performance during the later (1998-2002) period. First, as licensing was a

necessary condition to gaining business from global automakers, it slowly lost its significance as a differentiating factor among domestic firms. Also, as the Indian auto market (and with it, the auto components market) grew in the mid-nineties, multinational auto components firms such as Delphi and Visteon preferred to enter the growing market through wholly owned subsidiaries or majority joint ventures with domestic firms instead of being content just to license technologies in arms-length transactions. Over time, these two factors increasingly made technology licensing less influential on the performance of domestic firms.

The strength of relational ties with downstream automakers (Tier), rather than licensing, was positively and significantly related to performance during the 1998-2002 period. In other words, all other things being held equal, domestic auto components firms that had managed to become Tier 1 suppliers to automakers enjoyed better performance than their less fortunate counterparts. Given that firms in general prefer to maintain close relationships with a small group of suppliers (Goffin, Lemke and Szwejczewski 2006; Helper and Sako 1995), domestic Tier 1 firms would enjoy assured long-term demand for their products.

Industry executives whom we interviewed confirmed the importance of close relational ties (i.e., Tier 1) with downstream automakers. Tier 1 firms, by virtue of their direct relationships with automakers, gained preferential access to technologies and received “second chances and persistent attention” when they occasionally encountered operational difficulties. As their relationships with automakers matured, Tier 1 firms enjoyed more opportunities and better scope for the absorption of licensed technologies and best practices (cf. Kotabe, Martin and Domoto 2003) and were more likely to become preferred suppliers for new models even on a global scale. Also, executives at Tier 1 firms offered instances in which their firms were able to leverage their erstwhile Tier 1 status with one automaker to “get their foot in the door” at other automakers.

In sum, Models 1b and 1c offer support for our Hypotheses 1 and 3 that technology licensing (especially so during the 1992-1997 period) and strength of relational ties with downstream automakers

(especially so during the subsequent 1998-2002 period) would be significantly and positively related to the performance of domestic auto components firms [3].

Internal R&D and Performance. We present the results of our estimation of Model 2, i.e., firm performance as a determinant of internal R&D, in Table 4. As anticipated from the results of the Granger causality tests (Table 2), we found that performance during the previous period (i.e., t-1) was a significant predictor of domestic firms' internal R&D. That is, the higher was a firm's performance (ROA) during the previous year, the higher was its internal R&D intensity during the current year.

Insert Table 4 about here

Models 2b and 2c reveal further the increasingly dominant role played by past performance in determining domestic firms' propensity to invest in internal R&D. During the 1992-1997 period (Model 2b), only firms that performed well during the previous year or those that enjoyed Tier 1 status tended to invest more in internal R&D during this period. Also, the control variable Marketshare was significantly and positively related to internal R&D during this period. During the subsequent 1998-2002 period (Model 2b), however, firms' performance during the previous year was the sole significant determinant of their internal R&D. The results suggest that Indian auto components firms are shying away from internal

[3] In addition to the above analysis, we also explored how licensing and the strength of relational ties influenced the probability of survival of firms in our sample beyond the 1992-1997 transition period using logistic regression models. We estimated five logistic models, each exploring the determinants of firm survival (i.e., did not fail or was not acquired) for one, two, three, four and five years beyond the 1992-1997 transition period. We found that the strength of relational ties (i.e., Tier 1 status) influenced the probability of survival significantly in all five models, whereas technology licensing ceased to be a significant predictor of survival after just one year subsequent to the 1992-1997 period. These results offer further support for our hypotheses 1 and 2.

R&D, irrespective of their size and relationship with the automakers, unless they can support the investments from previous year's financial performance.

Accordingly, our Hypothesis 2 is supported. Executives whom we interviewed confirmed that most domestic auto components firms lacked the scale, resources, technological expertise or the managerial competence to conduct internal R&D. Any efforts at internal R&D – especially, the development of new or improved components – were confined to key domestic automakers that manufactured components internally or to a handful of domestic components firms that had built sufficient absorptive capacities through prior technology licensing or collaboration in the 1980s. Even at these firms, much of internal R&D was focused on engineering or "the localization of materials and licensed technologies, and incremental improvement of process".

5. Discussion and Conclusion

We examined how domestic firms may adapt strategically to their evolving environments after industry deregulation, and the performance consequences of such strategic adaptation. Our analysis indicates that the first and necessary priority for domestic firms would be to upgrade their technological expertise rapidly through licensing. But, an equally important priority immediately thereafter would be to leverage relationships created by licensing to forge strong relational ties with key buyers, especially the new multinational entrants. Finally, only firms that are performing well – i.e., managed the transition to the open, competitive industry environment successfully – tend to invest in internal R&D.

The context for our study, India, differs from transition economies with a communist or socialist past – for instance, Eastern Europe, Latin America and China – typically studied by researchers. Even before economic liberalization and the deregulation of key industries in the early 1990s, India's centrally planned economy also comprised a large (though stringently regulated) private sector and several key features of a market economy. When industries are deregulated and opened up for global competition, domestic firms in a mixed economy typically do not have to contend with widespread and radical changes to the institutional environments as was the case for privatized firms in transition economies. When such liberalization and industry deregulation occur in phases after a significant first step, it would be

imperative for upstream domestic firms to make strategic shifts in order to survive and perform – from a primary focus on satisfying and co-opting the regulators before deregulation to acquiring technological (and associated) expertise immediately after deregulation and, later, to forging strong relational ties with key buyers. Such strategic shifts require these firms to develop dynamic capabilities, whether these are for acquiring and assimilating external knowledge, the subsequent reconfiguration of their resources or the eventual development of organizational structures and routines for production or product development (Argote 1998; Brown and Eisenhardt 1995; Eisenhardt and Martin 2000; Teece, Pisano and Schuen 1997). Only then can these firms adapt and forge successive "fits" with the evolving industry environment.

However, these dynamic capabilities are not easy to develop. Here, an important consideration is the pace at which deregulation occurs. In the Indian auto and auto components industries, deregulation occurred in phases – a tentative beginning in the early 1980s, a significant effort in 1991 coinciding with economic liberalization, and progressive fine-tuning of the auto policy during 1997 and 2002. The tentative beginning during the 1980s laid the foundation by introducing a small set of domestic auto components firms to sophisticated technologies, processes and management. Even after significant deregulation in 1991, the imposition of high tariffs on CKDs and components imports, and indigenous content requirements forced new multinational entrants to develop domestic sources for components instead of relying exclusively on their traditional supply chain partners. In other words, the somewhat tentative, "fits and starts" approach to deregulation may actually have given domestic firms the opportunity and, more important, the time to develop requisite capabilities and make the transition to an open, intensely competitive environment.

This is one reason for why the evolution of the auto components industry in India has not mirrored that in Brazil or the Central/Eastern European transition economies. In Brazil, even strong domestic auto components firms have been taken over by multinationals and the remaining domestic firms are confined to supplying the after-market (Zilbovicius, Marx and Salerno 2002). In transition economies in Central and Eastern Europe too, multinational firms had soon become dominant in the auto

and auto components industries subsequent to privatization (Van Tulder and Ruigrok 1998). An exception to this trend is China, where several strong state-owned domestic automotive manufacturers and auto components groups have emerged due to active promotion and policy making by the government (Holweg, Luo and Oliver 2005).

In India, vendor development efforts by new multinational entrants have enabled several domestic firms and joint ventures to significantly improve their quality and adopt more efficient production and management processes. Eventually, multinationals would have less need for local partners as their own experience in the host country increases (Makino and Delios 1996) and may prefer to buy out partners or to establish wholly owned subsidiaries over licensing technologies or forming joint ventures, as they did in other transition economies. Nevertheless, several capable domestic firms such as the TVS Group firms that already have forged Tier 1 relationships will continue to be an integral part of the supply chain[4]. Indeed, executives whom we interviewed at three automakers were unanimous that domestic Tier 1 firms were considerably more flexible – i.e., they could manufacture components for different automakers and for different models – than even the Indian subsidiaries or joint ventures of multinational automakers or auto components firms. Though these executives conceded that improvements had not diffused yet to lower tier firms, they also pointed to several domestic Tier 2 firms that had begun to develop design competences with a focus on the growing export markets for components. Therefore, we

[4] The contrasting experiences of two domestic auto components firms, one in Brazil and one in India, which forged joint ventures with Lucas Industries, UK, support this conjecture. Freios Varga, the Brazilian joint venture with Lucas (formed in 1971) was bought out by the foreign partner after Lucas merged with the Varity Corporation in 1996 (Humphrey and Memedovic 2003). In contrast, Lucas TVS, the Indian joint venture between Lucas and the TVS group of companies, was bought out by the TVS group in 2001 from Varity and is now a wholly-owned Indian Tier-1 supplier to domestic and multinational automakers.

expect that several domestic auto components firms will continue to compete successfully in the Indian auto components market alongside multinationals.

Our interviews with auto and auto components industry executives, however, revealed that only a few domestic firms have leveraged their technology licensing and collaboration arrangements yet to develop competences to a point where they can undertake independent design and new product development. Given that learning through experimentation or first-hand experience (for instance, through internal R&D) is as necessary for firms as observational learning from alliance partners (Uhlenbruch, Meyer and Hitt 2003), firms that rely exclusively on technology licensing may be relegated to lower-tier status within the domestic supply chain. Also, consolidation of the industry is likely to occur, as competition increases from China and ASEAN countries and automakers in India rationalize their domestic supply chain. This may result in clear stratification of firms according to their capabilities and significant performance differences between firms in different strata. Accordingly, considerable heterogeneity is likely among Indian auto components firms.

We should note that our study has several limitations. First, it explores the performance consequences of only a few strategic variables – technology licensing, internal R&D and the strength of relational ties with downstream firms – that firms can choose from. This parsimonious set of variables captures the key dynamics immediately after industry deregulation. However, future research can fruitfully explore adaptation on other strategic dimensions such as human resources management and investments in productivity and quality. Second, it covers a time period of just a decade subsequent to the deregulation of the auto and components industries in India. Since demand growth in the industry after deregulation had not met the initial wildly optimistic expectations, we are cautious about using our findings to make predictions about the future. For instance, a study done a decade hence may find that strong relational ties with buyers alone are not sufficient; in addition, the development of firm capabilities such as internal R&D and product development may become important determinants of domestic firms' performance (cf. Peng 2003; Peng and Luo 2000). Finally, the dynamics related to industry evolution and

strategic adaptation may be different in other industries that have encountered a more rapid or even slower pace of deregulation.

In conclusion, the key contribution of our study is the exploration of shifts over time in the strategic behavior of domestic firms during a period of industry deregulation within a wider process of economic liberalization. We posit that the optimal strategic choices change as deregulation proceeds. We find that narrow capabilities based on imported technologies drive performance in the early phase of deregulation. However, as deregulation proceeds, the development of deeper linkages into the industry supply chain becomes more important for maintaining firm performance. In short, we find that strategic adaptation or fit is longitudinal and dynamic (cf. Zajac, Kraatz and Bresser 2000).

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References

ACMA. 2006. *Indian Automotive Component Industry: Engine of Growth Driving the Indian Manufacturing Sector*. Annual industry report published by the Automotive Components Manufacturers Association (ACMA), India.

Argote, L. 1999. Organizational Learning: Creating, Retaining, and Transferring Knowledge. Kluwer Academic Publishers, Boston, MA.

Bell, M., K. Pavitt, K. 1997. Technological accumulation and industrial growth: contrasts between developed and developing countries. In D. Archibugi and J. Michie (Eds.) *Technology, Globalisation and Economic Performance*. Cambridge University Press, Cambridge, UK.

Belsley, D.A., E. Kuh, R.E. Welsch. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. John Wiley and Sons, New York.

Brown, S.L., K.M. Eisenhardt. 1995. Product development: past research, present findings and future directions. *Academy of Management Review* **20** 343-378.

Chacar, A., B. Vissa. 2005. Are emerging economies less efficient? Performance persistence and the impact of business groups affiliation. *Strategic Management Journal* **26** 933-946.

Cohen, W., D. Levinthal. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* **35** 128-152.

Cusumano, M.A., A.Takeishi. 1991. Supplier relations and management: A survey of Japanese,Japanese-transplant, and U.S. auto plants. *Strategic Management Journal* **12** 563-588.

D'Costa, A. P. 1995. The restructuring of the Indian automobile industry: Indian state and Japanese capital. *World Development* **23** 485–502.

Eisenhardt, K.M., J.M. Martin. 2000. Dynamic capabilities: What are they? *Strategic Management Journal* **21** 1105-1121.

Fama, E.F., J.D. Macbeth. 1973. Risk, returns and equilibrium: Empirical tests. *The Journal of Political Economy* **81** 607-636.

Garud, R. 1997. On the distinction between know-how, know-what and know-why. In Huff, A., J. Walsh (eds.) *Advances in Strategic Management* 81-101, JAI Press,

Goffin, K., F. Lemke, M. Szwejczewski. 2006. An exploratory study of 'close' supplier-manufacturer relationships. *Journal of Operations Management* **24** 189-209.

Goll, I., N.B. Johnson, A.A. Rashid. 2006. Strategic responses to deregulation and their performance implications in the US airline industry. *Business and Politics* **8(2) Article 2**. Retrieved January 3 2008. http://www.bepress.com/bap/vol8/iss2/art2.

Granger, C. 1989. *Forecasting in Business and Economics. 2nd edition*. Academic Press, San Diego.

Grant, R.M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal* **17**(special issue) 109–122.

Gulati, R. 1995. Familiarity breeds trust? The implications of repeated ties on contractual choice in alliances. *Academy of Management Journal* **38** 85-112.

Gulati, R., M. Gargiulo. 1999. Where do interorganizational networks come from? *American Journal of Sociology* **104** 1439–1493.

Gulati, R., N. Nohria, A. Zaheer. 2000. Strategic networks. *Strategic Management Journal* **21** 203-215.

Hagg, I., J. Johanson. 1983. *Firms in Networks: A New View of Competitive Power*. Business and Social Research Institute, Stockholm, Sweden.

Hatum, A., A.M. Pettigrew. 2006. Determinants of organizational flexibility: A study in an emerging economy. *British Journal of Management* **17** 115-137.

Haveman, H.A. 1992. Between a rock and a hard place: Organizational change and performance under conditions of fundamental environmental change. *Administrative Science Quarterly* **37** 48-75.

Helper, S. 1991. Strategy and irreversibility in supplier relations: The case of the US automobile industry. *Business History Review* **65** 781-824.

Helper, S., M. Sako. 1995. Supplier relations in Japan and the United States: Are they converging? *Sloan Management Review* **36 (3)** 77-84.

Holweg, M., J. Luo, N. Oliver. 2005. *The Past, Present and Future of China's Automotive Industry: A Value Chain Perspective.* Working paper, Center for Competitiveness and Innovation, The Cambridge-MIT Institute.

Humphrey, J. 2003. Globalization and supply chain networks: the auto industry in Brazil and India. *Global Networks* **3(2)** 121–141.

Humphrey, J., O. Memedovic. 2003. *The Global Automotive Industry Value Chain: What Prospects for Upgrading by Developing Countries*. UNIDO Sectoral Studies Series, UNIDO, Vienna.

Kale, P., H. Singh, H. Perlmutter. 2000. Learning and protection of proprietary assets in strategic alliances: Building relational-specific capital, *Strategic Management Journal* **21** (special issue): 217–237.

Khanna, T., R. Lal, E. Manocaran. 2005. *Mahindra and Mahindra: Creating Scorpio*. Harvard Business School case # 9-705-478.

Khanna, T., K. Palepu. 2000. Is group affiliation profitable in emerging markets? An analysis of diversified Indian business groups. *Journal of Finance* **55** 867-891.

Kim, L. 1998. Crisis construction and organizational learning: Capability building and catching-up at Hyundai Motors. *Organization Science* **9** 506-521.

Kogut, B. 1988. Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal* **9** 319-332.

Kogut, B., U. Zander. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science* **3** 383-397.

Kotabe, M., X. Martin, H. Domoto. 2003. Gaining from vertical partnerships: knowledge transfer, relationship duration, and supplier performance improvement in the U.S. and Japanese automotive industries. *Strategic Management Journal* **24** 293-316

Kumar, N., N.S. Siddharthan. 1994. Technology, firm size and export behaviour in developing countries: the case of Indian enterprises. *Journal of Development Studies* **31** 289–309.

Larson, A. 1992. Network dyads in entrepreneurial settings: A study of the governance of exchange processes. *Administrative Science Quarterly* **37** 76–104.

Leonard-Barton, D. 1992. Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal* **13** 111-125.

Mahon, J.F., E.A. Murray. 1981. Strategic planning for regulated companies. *Strategic Management Journal* **2** 251-262.

Makino, S., A. Delios. 1996. Local knowledge transfer and performance: Implications for alliance formation in Asia. *Journal of International Business Studies* **27** 905-927.

Martin, X. R. Salomon. 2003. Knowledge transfer capacity and its implications for the theory of multinational corporations. *Journal of International Business Studies* **34** 356-373.

Miles, R.E., C.C. Snow. 1994. *Fit, Failure and the Hall of Fame*. Macmillan, New York.

Mudambi, R., S. Helper. 1998. The 'close but adversarial' model of supplier relations in the U.S. auto industry. *Strategic Management Journal* **19** 775-792.

Monteverde, K., D. Teece. 1982. Supplier switching costs and vertical integration in the automobile industry. *Bell Journal of Economics* **13** 206-213.

Narayanan, K. 1998. Technology acquisition, de-regulation and competitiveness: a study of Indian automobile industry. *Research Policy* **27** 215-228.

Nonaka, I, R. Toyama, R., A. Nagata. 2000. A firm as a knowledge-creating entity: A new perspective on the theory of the firm. *Industrial and Corporate Change* **9** 1-20.

Okada, A. 2004. Skills development and interfirm learning linkages under globalization: Lessons from the Indian automobiles industry. *World Development* **32** 1265-1288.

Peng, M.W. 2003. Institutional transitions and strategic choices. *The Academy of Management Review* **28** 275-296.

Peng, M.W., P.S. Heath. 1996. The growth of the firm in planned economies in transition: Institutions, organizations, and strategic choice. *The Academy of Management Review* **21** 492-528.

Peng, M.W., Luo. 2000. Managerial ties and firm performance in a transition economy: The nature of a micro-macro link. *Academy of Management Journal* **43** 486-501.

Reger, R.K., I.M. Duhaime, J.L. Stimpert. 1992. Deregulation, strategic choice, risk and financial performance. *Strategic Management Journal* **13** 189-204.

Schendel, D.E., C. Hofer. 1979. *Strategic Management*. Little Brown, Boston, MA.

Siggelkow, N. 2002. Evolution towards fit. *Administrative Science Quarterly* **47** 125-159.

Singh, N. 2004. *Strategic Approach to Strengthening the International Competitiveness in Knowledge Based Industries: The Case of the Indian Automotive Industry*. Discussion paper # 2004-84, Research and Information System for the Non-Aligned and Other Developing Countries (RIS), New Delhi, India.

Smith, K.G., C.M. Grimm. 1987. Environmental variation, strategic change and firm performance: A study of railroad deregulation. *Strategic Management Journal* **8** 363-376.

Suarez, F.F., R. Oliva. 2005. Environmental change and organizational transformation. *Industrial and Corporate Change* **14** 1017-1041.

Teece, D., G. Pisano, G., A. Schuen. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* **18** 509-534.

Tewari, M. 2001. *Engaging the New Global Interlocutors: Foreign Direct Investment and the Transformation of Tamil Nadu's Automotive Supply Base*. Paper prepared for the Government of Tamil Nadu, India, by the Center for International Development, Research and Advisory Project for the Tamil Nadu Government, Harvard University, Boston.

Tushman, M.L., E. Romanelli. 1985. Organizational evolution: A metamorphosis model of convergence and re-orientation. In B. Staw and L.L. Cummings (Eds.) *Research in Organizational Behavior* **7** 171-223. JAI Press, Greenwich, CT.

Uhlenbruck, K., K.E. Meyer, M.A. Hitt. 2003. Organizational transformation in transition economies: Resource-based and organizational learning perspectives. *Journal of Management Studies* **40** 257-282.

Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effects. *American Sociological Review* **61** 674–698.

Venkatraman, N., J.C. Camillus. 1984. Exploring the concept of fit in strategic management. *Academy of Management Review* **9** 513-525.

van Tulder, R., W. Ruigrok. 1998. *European Cross-national Production Networks in the Auto Industry: Eastern Europe as the Low End of the European Car Complex*. Working paper #121, Berkeley Roundtable on the International Economy (BRIE) Working Paper Series.

Veloso, F., R. Kumar. 2002. *The Automotive Supply Chain: Global Trends and Asian Perspectives*. ERD working paper series #3, Asian Development Bank, Manila, Philippines.

White, H. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* **48** 817-839.

White, S., G. Linder. 2002. Organizational and industrial response to market liberalization: The interaction of pace, incentive and capacity to change. *Organization Studies* **23** 917-948.

Zahra, S.A., G. George. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review* **27** 185-203.

Zajac, E., M.S. Kraatz, R.K.F. Bresser. 2000. Modeling the dynamics of strategic fit: A normative approach to strategic change. *Strategic Management Journal* **21** 429-453.

Zilbovicius, M., R. Marx, M.S. Salerno. 2002. A comprehensive study of the transformation of the Brazilian automotive industry. *International Journal of Automotive Technology and Management* **2(1)** 10-23.

	N	Mean	Std. Dev.	Q1	Median	Q3
Performance$_{it-1}$	1,078	0.0586	0.1071	0.0207	0.0629	0.1119
Performance$_{it}$	1,271	0.0519	0.1193	0.0132	0.0577	0.1095
Royalty$_{it}$	1,271	0.0083	0.0239	0.0000	0.0000	0.0086
R&D$_{it}$	1,271	0.0038	0.0103	0.0000	0.0000	0.0024
Marketshare$_{it}$	1,271	0.0085	0.0145	0.0022	0.0045	0.0098
Size$_{it}$	1,271	3.4755	1.1816	2.7000	3.4825	4.2200
Age$_{it}$	1,271	25.8387	19.1329	13.0000	21.0000	35.0000

Variable definitions:

Performance$_{it-1}$ is the return on assets of firm i in year t-1.
Performance$_{it}$ is the return on assets of firm i in year t.
Licensing$_{it}$ is the royalty expenses over sales revenues of firm i in year t.
R&D$_{it}$ is the research and development expenses over sales revenues of firm i in year t.
Marketshare$_{it}$ is the sales revenues of firm i in year t over total industry sales revenues in year t .
Size$_{it}$ is the log of sales revenues of firm i in year t.
Age$_{it}$ is the age of firm i in year t.

Table 1. Summary Statistics (1992-2002)

2.1 Test of Causality from Internal R&D to Performance

Lags	F (1992-2002)	F (1992-1997)	F (1998-2002)
1	2.3543	1.9741	1.1475
2	4.7272	3.9818	2.3121

**, * indicate significance at p< 0.01, p<0.05, respectively.

2.2 Test of Causality from Performance to Internal R&D

Lags	F (1992-2002)	F (1992-1997)	F (1998-2002)
1	39.9029**	11.6643**	23.5199**
2	80.1211**	23.5271**	47.3892**

**, * indicate significance at p< 0.01, p<0.05, respectively.

Table 2. Granger Causality Tests: R&D and Firm Performance

$$Performance_{i,t} = \beta_0 + \beta_{1,j} Size_{i,t} + \beta_{2,j} Age_{i,t} + \beta_{3,j} Marketshare_{i,t} + \beta_{4,j} Royalties_{i,t} + \beta_{5,j} Tier_{i,t} + \varepsilon_{i,t}$$

	Model 1a (1992-2002)		**Model 1b (1992-1997)**		**Model 1c (1998-2002)**	
	Mean coefficients	**T**	**Mean coefficients**	**T**	**Mean coefficients**	**T**
Intercept	-0.0227	-1.70	-0.0013	-0.07	-0.0484	-3.41**
$Size_{i,t}$	0.0166	4.66**	0.0174	4.16**	0.0157	2.38*
$Age_{i,t}$	-0.0001	-0.54	0.0001	1.46	-0.0003	-1.794
$Marketshare_{i,t}$	0.4918	2.79**	0.1235	0.73	0.9337	4.78**
$Royalties_{i,t}$	0.9700	4.53**	1.2888	5.50**	0.5874	1.83
$Tier_{i,t}$	0.0199	2.76**	0.0112	1.32	0.0303	2.65*
Adjusted R^2	0.14		0.15		0.12	
N	1244		583		661	

**, * indicate significance at $p < 0.01$ and $p < 0.05$, respectively.

Table 3. Impact of Technology Licensing and Relational Ties on Firm Performance

$$R\&D_{i,t} = \beta_0 + \beta_{1,j} Size_{i,t} + \beta_{2,j} Age_{i,t} + \beta_{3,j} MarketShare_{i,t} + \beta_{4,j} Performance_{i,t-1} + \beta_{5,j} Tier_{i,t} + \varepsilon_{i,t}$$

	Model 2a (1992-2002)		**Model 2b (1992-1997)**		**Model 2c (1998-2002)**	
	Mean coefficients	**T**	**Mean coefficients**	**T**	**Mean coefficients**	**T**
Intercept	-0.0009	-1.45	-0.0012	-1.51	-0.0007	-0.58
$Size_{i,t}$	0.0004	1.53	0.00008	0.25	0.0008	1.95
$Age_{i,t}$	0.0001	1.77	0.00001	1.98	0.0001	0.43
$Marketshare_{i,t}$	0.0871	3.09**	0.0929	8.59**	0.0802	1.24
$Performance_{i,t-1}$	0.0072	4.62**	0.0078	3.18*	0.0065	4.03**
$Tier_{i,t}$	0.0005	2.49**	0.0007	2.68*	0.0003	0.84
Adjusted R^2	0.20		0.28		0.09	
N	1047		484		563	

**, * indicate significance at $p< 0.01$ and $p<0.05$, respectively.

Table 4. Impact of Lagged Firm Performance on Internal R&D