Chapter 5

Competitiveness of the Indian Auto Component Industry: An Empirical Study

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1 Introduction

India has begun to attract significant attention as a manufacturing destination, following the ascent of China's manufacturing industry. The next wave of off-shoring is likely to take place in the skill intensive industries and India has a clear advantage over other Asian countries in the manufacturing segment. The changing demographics of the developed and developing world are the other important factors in favor of India. Various demographic related studies have revealed that, while the ageing population in the developed world is driving the manufacturing jobs to the developing countries, amongst the low cost manufacturing destinations including countries like China, Brazil and Russia, India is expected to have the largest percentage of young working age population leading up to 2050. In this context, the current study focuses on the Indian automotive industry, which is termed as "sunrise sector", and which plays a pioneering role in the Indian industry and is contributing to more than 5% of the Indian GDP since 2005-06. Although the Indian auto component exports constitute approximately 20% of their sales, they are still very small compared to annual global auto component sales, which are in excess of $750 billion. The economic reforms of 1990's, which relaxed many policy restrictions to induce competition and reduce inefficiencies, have played a very crucial role in bringing the auto sector to its current status. However, there is still a great potential for improvement through policy interventions, especially in terms of infrastructure, technological and financial support, customs and excise duties, through Free Trade Agreements with regional markets etc. India's attraction as a sourcing hub has increased further due to the recent financial meltdown of global markets, especially in the developed economies. As a result, the multinational corporations (MNCs) from North America and Europe are looking towards India for synergies in terms of not only production related activities, but also development activities. Most of the global MNC Original Equipment Manufacturers (OEMs) and their follow sourcing Tier-1 suppliers

have already established operations in India and are seriously exploring the options to increase the share of global sourcing from India in the near future.

Therefore, the Indian auto industry has the potential to emerge as one of the largest in the world. Presently, India is second largest two wheeler market in the world, fourth largest commercial vehicle market in the world and, eleventh largest passenger car market in the world. The last five years have been exceptionally good for the car industry wherein sales of passenger vehicles grew at a Compounded Annual Growth Rate (CAGR) of 9.95% domestically (refer to Table 1) during the period 2005–2009, while exports grew at a CAGR of 19.12% during the same period. The launch of the Tata Nano (US$2,250 car) is set to revolutionize the industry, not just in India but internationally.

Table 1: The Indian Automobile Production Trends during 2003-2009

Category	Passenger Vehicles	Commercial vehicles	Three Wheelers	Two Wheelers	Grand Total
2002-03	723,330	203,697	276,719	5,076,221	6,279,967
2003-04	989,560	275,040	356,223	5,622,741	7,243,564
2004-05	1,209,876	353,703	374,445	6,529,829	8,467,853
2005-06	1,309,300	391,083	434,423	7,608,697	9,743,503
2006-07	1,545,223	519,982	556,126	8,466,666	11,087,997
2007-08	1,777,583	549,006	500,660	8,026,681	10,853,930
2008-09	1,838,697	417,126	501,030	8,418,626	11,175,479

Source: SIAM

The annual production of the Indian auto component industry has reached US$19.1 billion in 2009 from US$3.2 billion 10 years back, as one may note from Table 2. The exports have also increased significantly, from a mere $578 million in 2002 to US $ 3,800 in 2008. The investments in the auto component industry are also on the rise, as may be noted from the table 2 below.

Table 2: The Indian Auto component Production Trends during 2002-2009

Indian Auto Component Industry			
Year	**Investment (US $ MLN)**	**Production (US $ MLN)**	**Exports (US $ MLN)**
2001-02	2,300	4,470	578
2002-03	2,645	5,430	760
2003-04	3,100	6,730	1,274
2004-05	3,750	8,700	1,692
2005-06	4,400	12,000	2,469
2006-07	5,400	15,000	2,873
2007-08	7,200	18,000	3,615
2008-09	7,700	19,100	3,800

Source: ACMA

Local OEMs constitute around 60% of total sales in the segment, with exports and the aftermarket contributing approximately 20% each to the sales. The total number of auto component producers in India is approximately 2,500 and are divided into organized sector and unorganized sector. Out of 2,500 players, only 500 players constitute the organized sector and contribute to more than 70% of total auto component production. Table 3 below gives the market share of the organized sector, and as one may note, the top 35 companies have a market share of 56% in the organized sector.

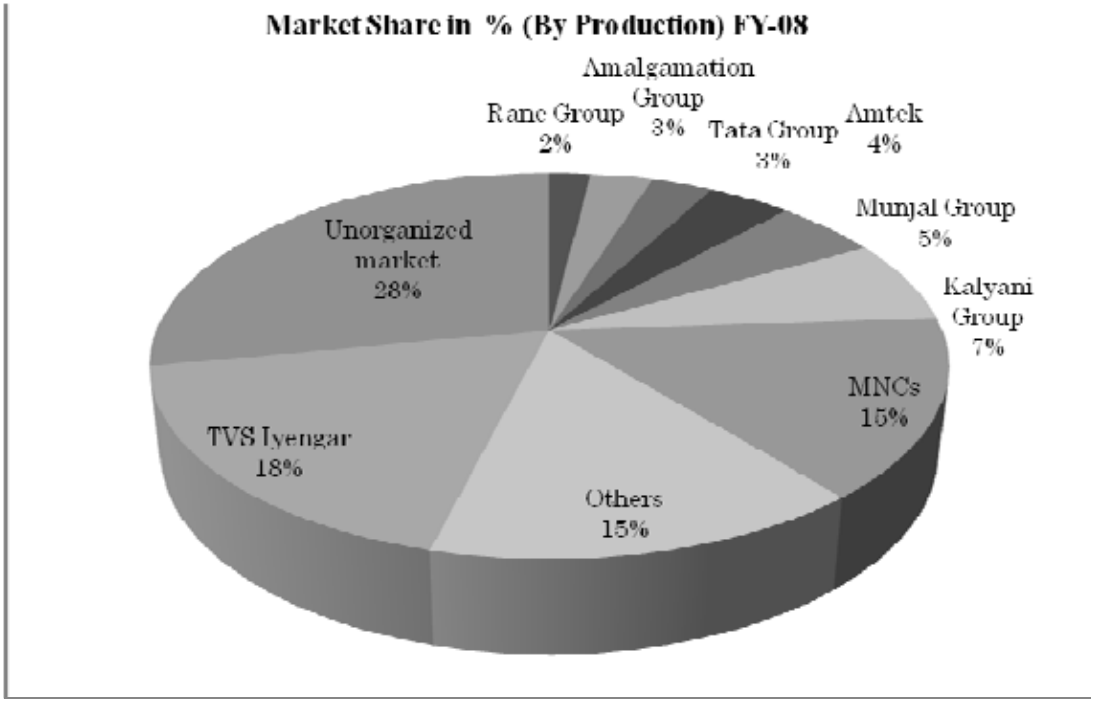
Table 3: Share of component players based on the size of the company in 2008

Share of component players based on the size of the company (FY-08)		
Revenue	Number of companies	Market Share
More than US$110m	35	56
US$22m to US$110m	69	37
US$11m to US$22m	33	5
Less than US$11m	288	2

Source: CRIS INFAC

The organized sector is dominated by large Indian business groups, which contribute to 43% of the total production while MNCs and others contribute 15% each (Ernst & Young 2009), as can be noted from Figure 1. Most of the domestic component manufacturers belonging to the business groups have well established operations and have been serving the domestic OEMs in various segments, such as passenger vehicles, commercial vehicles and two and three wheeler segments.

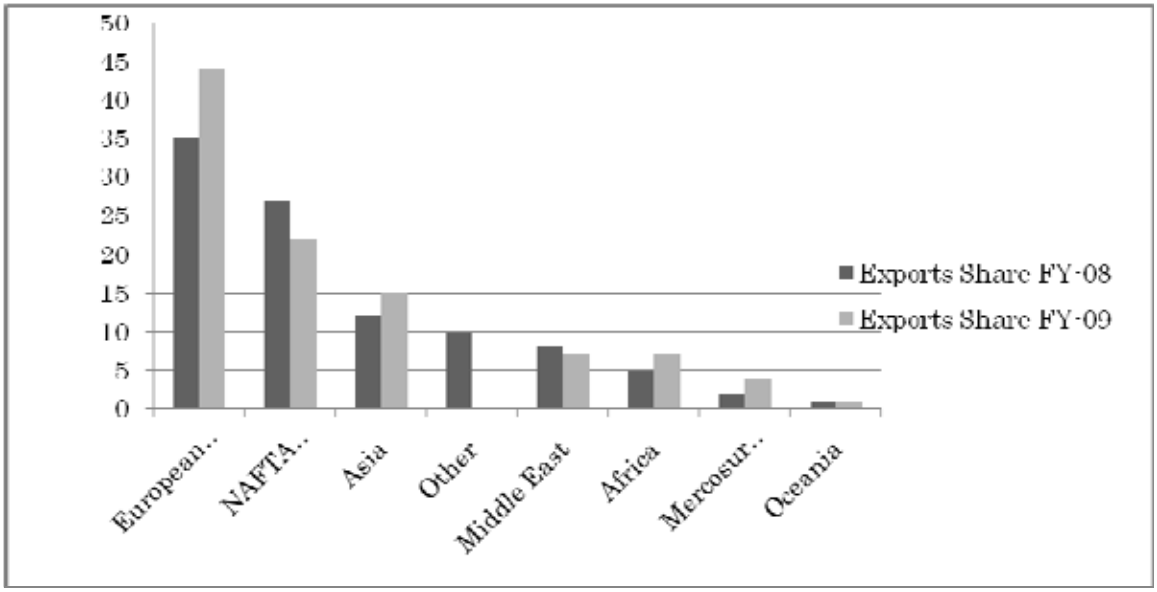
Figure 1: Market Share of various auto component groups in India



Source: CRIS INFAC

The total auto component exports from India grew at a CAGR of 24% in the period FY05-09 to reach US$3.8 billion in the year 2008-09. Approximately 80% of the component exports in 2009 were to global OEM/Tier-1 market, while the remaining 20% went to the replacement market requirements. This break-up was quite different from a decade ago when only 35% of the exports were catering to the OEM requirement, while the remaining was going into the replacement market sales (IBEF, 2008). This shift from majority exports servicing the replacement market to OEM markets in the developed countries signifies the shift in quality levels and technical capabilities of the Indian auto component products, since the requirements of global OEM quality and technical standards are quite stringent, especially in the developed markets. Approximately 66% of the Indian component exports are to the European and North American markets, as one may note from Figure 2, which further substantiates the growing quality and technical capabilities of the Indian component industry.

Figure 2: Share of Component Exports to various regions across the globe



Source: CRIS INFAC & ACMA

Note: Mercosur countries include Brazil, Argentina, Paraguay, Uruguay and a few other South American nations

The fact that one third of the components made in India today are engine parts as can be noted from Table 4 below (ACMA 2009) also stands as a testimony towards the growing product complexity levels manufactured in the Indian auto component industry.

Table 4: Share of specific component segments in the Indian auto component industry

Product Break down by Value (FY-08)	
Component	Percentage
Engine Parts	31
Drive Transmission Units	19
Body & Chasis	12
Suspension & Breaking Parts	12
Equipments	10
Electrical Parts	9
Others	7

Source: ACMA

According to the Automotive Mission Plan of the Indian government, auto component production worth US$20 to 25 billion is expected to be outsourced to India by 2015. This would require an additional investment of US$15 billion. The domestic companies are investing more than US $6 billion to take advantage of the upcoming opportunities. One of the main reasons for global players eyeing India as an export base and making investments is the availability of cheap and skilled labor and good quality raw material at a low price.

2 The transformation of the Indian auto industry

Traditionally, Indian commercial vehicle makers such as the Tata Motors and Mahindra & Mahindra have been following the strategy of vertical integration, in similar lines to the western automakers. However, Suzuki, a Japanese company, which made an entry into the Indian automobile industry as a Joint Venture (JV) partner with the Indian public sector enterprise Maruti in the mid 80's garnered a majority share of passenger car segment, through government regulatory support and long term relation building with suppliers. Following Suzuki's tradition back home, the JV outsourced most of their component requirement to suppliers when they began operations in India. They bought some of their own suppliers from Japan, especially for safety critical parts and technology intensive parts. However, for standard parts, they began developing local suppliers, many a time as a JV with Suzuki or the follow sources of Suzuki. For example, out of a total of 500 odd companies in the organized auto component sector in India, around 110 firms were set up between 1983 and 1990 and out of 404 suppliers of Maruti, 58 depend on Maruti for more than 90% of their sales (Okada, 2004). Thus Maruti played a significant role in establishing a strong quality conscious component supply chain in India, which was very loyal to Maruti-Suzuki. Consequently, the Maruti-Suzuki partnership enjoyed dominant market share in the compact car segment since its entry into the Indian auto market to till date, despite the entry of many global auto majors and domestic assemblers like Tata Motors into this segment (Parhi, 2005). Over time, even the more vertically integrated domestic assemblers saw the merits in outsourcing; took advantage of the more established vendor base and began outsourcing their component requirements.

However, relaxation of regulatory norms in favor of more competitive market environment in the mid 90's changed the structure of auto industry in India. Removal of the entry barriers, in terms of industrial licensing, capacity restrictions, import restrictions on technology and finished goods etc. weakened Maruti-Suzuki's market power. In the

quest for survival and newer markets, many global assemblers made an entry into the Indian auto industry, along with their supply partners such as Delphi, Denso, and Visteon etc. Proliferation of newer models at a rapid pace from the established global players like Toyota, Ford, GM and the Korean automaker Hyundai etc. in the Indian market increased the need to develop new products rapidly, at a lower cost to survive in the market. The global automakers made use of existing global products and supply chains to introduce a wide variety of products. These new assemblers were able to take advantage of the presence of their follow sources in India as well as had access to a quality conscious and low cost local supplier base. They began sourcing more technology intensive and safety critical parts from follow sources and labour intensive parts from local suppliers. Components with economies of scale are imported from global single source suppliers. Over time, Indian suppliers (e.g. Sundaram Clayton, manufacturer of radiator caps), who could prove their capabilities on various counts like quality, delivery reliability and low cost etc. became single source suppliers to global OEMs (GM).

Another point to make note of in this context is, although Indian market has a great potential for growth - being the second largest populated country - the entry of multiple auto majors with a wide variety of product offerings has resulted in low sales volumes with little scale economies for most of the models. Despite the low volumes, most of these new entrants decided to continue operations in India, and in fact, many of them are launching new models and some are even setting up technology and development facilities in India. One of the major factors that has renewed the interest of these global OEMs and their follow sources in India and has subsequently enabled their break-even in the Indian market is the capability of the Indian auto component industry in meeting the OEM needs at various levels, despite low volumes.

2.1 Capability Development in the Auto Component Industry

India today has the maximum number of Deming award winning firms outside Japan, with 15 out of the total 19 Deming companies coming from the auto component industry, as can be seen from Table 5 below. Out of these fifteen, two firms also received Japanese Quality Medal. These quality initiatives have significantly contributed to the growth of the industry, with global companies preferring to source component requirement from Indian companies rather than Chinese companies, due to the higher quality standards in India (interviews with MNC executives).

Table 5: Deming Award winners list in India (1998-2009)

DEMING APPLICATION PRIZE	
Sundaram-Clayton Limited, Brakes Division	1998
Sundaram Brake Linings Ltd.	2001
TVS Motor Company Ltd.	2002
Brakes India Ltd., Foundry Division	2003
Mahindra and Mahindra Ltd., Farm Equipment Sector	2003
Rane Brake Linings Ltd.	2003
Sona Koyo Steering Systems Ltd.	2003
SRF Limited, Industrial Synthetics Business*	2004
Lucas-TVS Limited	2004
Indo Gulf Fertilizers Limited*	2004
Krishna Maruti Ltd., Seat Division	2005
Rane Engine Valves Ltd.	2005
Rane TRW Steering Systems Ltd., Steering Gear Division	2005
Asahi India Glass Limited, Auto Glass Division	2007
Rane Madras Ltd.	2007
Tata Steel Ltd.*	2008
QUALITY CONTROL AWARD FOR OPERATIONS BUSINESS UNITS	
Hi-Tech Carbon GMPD	2002
Birla Cellousic, Kharach-A Unit of Grasim Industries Ltd.*	2003
JAPAN QUALITY MEDAL	
Sundaram-Clayton Ltd., Brakes Division	2002
Mahindra and Mahindra Ltd., Farm Equipment Sector	2007

Note: * Non-auto component firms.

Source: JUSE website: www.juse.or.jp

Many auto component firms have also won awards like the Automotive Component Manufacturers Association of India **(**ACMA) Quality Trophy, Rajiv Gandhi Quality award, Honda's Best vendor award, GM's Supplier of the Year award, GM Saturn Quality Award, Valeo PQA Award etc. The Rajiv Gandhi Quality award is patterned after the criteria of the Malcolm Baldridge Award in the US and the European Quality Award. There are best supplier awards instituted by other MNC and indigenous OEMs, which have been awarded to the Indian suppliers. These awards provide external validation of the changed quality levels in the Indian auto industry.

In the following section we try to characterize the nature of the firms that have won these awards and identify the contributing factors. Based on the existing literature and the insights obtained through expert interviews, the following hypotheses are

formulated with regard to winning of an award. We carry out an empirical analysis to test these hypotheses and present the findings in the discussion section.

3 Factors characterizing the Award winners

Various industry and academic studies have documented that the Indian auto component firms adopted various strategies for process and operations improvement in order to capture OEM supply contracts post liberalization. While most companies went in for ISO certification which was considered mandatory to obtain supply contracts from MNCs (especially European customers), some of them adopted more rigorous quality initiatives such as SPC, TQM, and Six Sigma, and others adopted productivity improvement initiatives like TPM and lean manufacturing etc. These initiatives helped them improve their operations and establish quality standards that are minimum requirements to obtain supply contracts from leading assemblers. Some firms also forged technology joint ventures (JV) and/or licensed technology from the established global Tier-1 suppliers, which helped them in procuring export contracts and supply contracts from the JV partner's customers that have made entry into the Indian market.

ISO 9000 is a set of five worldwide standards that establish requirements for management of quality to ensure that the certified firm has a Quality Management System (QMS) in place which will enable it to meet its publicized quality standards (Elmuti and Kathawala, 1997). More than 90% of the firms in the organized sector of the Indian auto component industry today are certified by the ISO 9000 quality certification, and hence we safely conclude that a minimum quality level has been established across all tiers in the organized sector. We therefore now focus on the impact of various other firm level factors, such as R&D investments, export intensity and position in the supply chain on quality and operational excellence of auto component firms validated through external means such as awards in general and Quality and best supplier awards in particular by the independent agencies or the customers.

Effect of R&D investments on winning awards

Many classical theories on R&D intensity and spillover effects including a number of empirical studies have found that there is a positive association between R&D intensity and technological performance (Arrow, 1962, Levin, 1988 and Bean, 1995). Technological performance in turn helps build right product and process knowledge, higher percentage of good output with lower interruptions due to process and equipment

related problems and ultimately higher service levels to the customers. The R&D investments by the domestic firms before the liberalization were mostly targeted at improving the process capabilities rather than new product development. Better process capabilities give rise to higher percentage of good output and yield and hence lower number of defects and rework, which ultimately improves the quality of the processes as well as products. Therefore, one would expect that R&D investments in process improvement initiatives to contribute to better overall quality and image of the firm and hence increase the probability of getting an award.

Hypothesis 1

Firms with higher R&D intensity are more likely to win an award

Impact of Export Intensity on Quality

Exporting firms become more conscious of technological development in the countries they are exporting to and innovate continuously to keep pace with the world market (Braga and Willmore 1991). The Indian auto component firms with higher export intensity are likely to be better acquainted with the international markets and global technological changes, and hence expected to have acquired more sophisticated technologies when the restrictions on import of technologies were lifted after the reforms of 1991. Firms that upgraded plants and adopted good manufacturing practices in order to obtain export approvals from MNC OEMs as well as the global Tier-1 suppliers are therefore more likely to project better image while competing for the awards. Quality is one of the main criterions to get the export contracts, since the exporting firms need to meet the global quality standards which were at a much higher level than the Indian market. Therefore, exporting firms are likely to place more emphasis on quality of their processes and products, which also help them in getting quality awards.

Hypothesis 2

Firms with higher export intensity are more likely to win an award

Position in the supply chain

Due to the long presence of two wheeler and commercial vehicle segments in the Indian market, the domestic Tier-1 firms from various business groups such as TVS, Rane, Murugappa and Kalyani and independent entities had established products and operations in the Indian market and had developed good knowledge about various customer preferences and local nuances. The local know-how of Tier-1 firms helped them in

attracting the attention of the MNCs who were establishing assembly operations and were looking to source components locally, but were inexperienced in the Indian market. As a result, many foreign OEMs and their follow source Tier-1 companies forged technology joint ventures and close ties with the domestic Tier-1 firms to increase local content in their products as well as to adopt their products to the local requirements. While the technology joint ventures helped the domestic firms to leapfrog into production of new products without reinventing the wheel, the quality standards at competitive costs were a pre-requisite to bag these contracts. Here, the serious TQM efforts of many domestic Tier 1 firms that began in late eighties paved their way to attract MNC attention (Iyer *et al*, 2006)[1]. The qualitative studies and interviews with the OEMs and component firms however reveal that the best practices did not percolate upstream into the Tier 2 firms as much. These findings are not surprising since Tier 2 firms in general are not in direct contact with the OEMs and have very little awareness about the new market opportunities. The Tier-2 firms also do not have access to capital resources, as these firms were typically headed by a technocrat with entrepreneurial instincts but not much managerial capabilities. For a long period of time before the liberalization, these Tier 2 firms have stayed small, in order to benefit from the government subsidies and hence were not in a position to exploit the new opportunities by leapfrogging into the global competition (Kumaraswami *et al*, 2008). Further, Tier 1 firms (who are the customers of Tier 2 firms) themselves being in a state of transformation would not have had the capabilities or the resources to influence Tier 2 significantly. Thus we expect the Tier 1 firms who seem to have implemented effective quality initiatives to be associated with higher probability of winning an award than the tier-2 firms and posit our third hypothesis as follows:

Hypothesis 3

The Tier 1 firms are more likely to win an award than the Tier 2 firms.

[1] Eventually many domestic Tier 1 firms became preferred suppliers, in some cases, sole suppliers of a specific module/component to the MNC OEMs. Sundaram Fasteners, a manufacturer of radiator caps, for example, became single source supplier for General Motors, supplying their entire global requirement from a plant located in Chennai, India, while Bharat Forge caters to the forging requirements of almost all the OEMs in India and abroad and in the process became the largest forging manufacturer in the world.

Impact of Quality awards and other firm level factors on performance

The deployment of rigorous TQM efforts through the establishment of Quality Control Circles (QCCs), Cross Functional Teams (CFTs), and Supervisory Improvement Teams (SITs) is known to contribute to a firm's operational improvement significantly. These teams actively embark upon the TQM journey to improve product quality, delivery time, customer satisfaction, safety and human resources through top management leadership and with the help of scientific methods, Quality Assurance Systems, TQM Frameworks, use of TQM Concepts and Values etc. These quality and operational improvement efforts in turn are expected to improve the financial and market performance of the implementing firm.

Awards in general work as a signaling mechanism in the markets. Award winning firms are likely to attract more customers, which results in higher sales. When multinational firms first enter a new market, they look to identify competent local suppliers that can meet their quality and delivery requirements. Although most OEMs have elaborate vendor selection programs involving multiple stages of screening, the initial screening primarily happens based on the publicly available information sources such as popularity of vendors in the local markets, quality certification etc. The quality and other awards obtained by the suppliers play a significant role in influencing the customers in the initial screening. They could also become a critical selection criterion in the later stages, if that is the only differentiating factor between various shortlisted candidates. In our study, we try to capture the extent to which, quality and other type of awards play a role in attracting customers and hence result in higher sales, after controlling for other firm level factors such as group, tier, exports and technology and financial joint ventures

Hypothesis 4

Award winning firms are likely to enjoy higher sales volume than their non-award winning counterparts in the Indian auto component industry.

Impact of Tier, Group and Technology Joint ventures on firm performance

In the automotive industry, the tier-1 firms typically do more value addition compared to other tiers. In the more recent times, the tier-1 firms are also donning the role of system integrators, as the OEMs are trying to reduce their manufacturing and assembly content and rationalize on the number of suppliers they have to manage. This in addition is increasing the value addition the tier-1s are making to the entire supply chain and hence increases their profitability. The tier-1s also enjoy closer relationship with the OEMs, as

they are expected to take part in the product and process development activities during the new product development stages. Therefore, they are in a better position to garner a bigger share of the value chain compared to other tiers. The business group based companies have higher financial resources compared to individually owned companies, and also enjoy the network externalities such as introduction to a new customers and access to resources from other group based companies etc. The micro level business group networks use control pyramids which allow the leveraging of a small quantity of family wealth to control huge assets (Morck and Yeung, 2004). In addition to this, these firms have access to the group's highly talented managerial resources and low cost financial resources (Khanna & Palepu, 2000). These firms also wield substantial power through long term political connections nurtured and fostered over long period of time (Morck and Yeung, 2004) allowing them to influence regulatory and policy changes which provide them with a competitive advantage over the non-group companies. The empirical research on group based companies in India has therefore found that group based companies in general outperform the individual firms (Khanna and Palepu, 2000; Khanna and Rivkin, 2001). We expect this holds true in the case of Indian auto component industry as well.

Technology licensing and joint ventures are a quick and relatively cost-effective way to upgrade a firm's 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). 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. 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. However, 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. Also, even if 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 (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. This coupled with the fact that cost of technology licensing could become prohibitively expensive would ultimately make this choice a losing proposition for firms, if they have not taken various other factors into account. Based on all the above arguments we posit the following hypothesis:

Hypothesis 5

Firm profitability in the Indian auto component industry is determined by the group, tier and the joint venture arrangements with multinational companies.

4 Data and methodology

4.1 Data Description

In the first round, information is collected through various structured in-depth interviews with Executive Purchasing Managers from OEMs, Tier 1 and Tier 2 companies in the three primary clusters of the Indian Automotive Industry (North, South and West). We interviewed the executives from the purchasing divisions with an overall professional experience of at least 20-25 years. The companies focused on are in the organized sector which comprises mainly of large and medium scale component firms and a few small scale firms. To supplement the results of the interviews and to add quantitative perspectives to the research questions, additional data was gathered through a comprehensive questionnaire survey in the second round. The interviews in the first round were used to prepare and test the questionnaire in the second round.

We have interviewed about 10 companies in our first round during the questionnaire preparations stage and approached about 100 companies with questionnaire surveys thereafter. Out of these 100 companies, we have managed to collect data from 77 companies. We then supplemented this perceptional data with objective financial data from public databases to test the hypotheses posited above. However, the financial data required to carry out the empirical analysis was available for only 47 companies. Therefore, we report different sample sizes for different parameters, depending upon the number of companies that have provided that specific information and the availability of financial data from secondary sources. The questionnaire covered broad topics such as competitive strategy, operations strategy, and quality management strategy followed by the firms. The detailed questions were aimed at assessing various production planning methodologies, production technologies and quality certifications and other process improvement initiatives adopted by the firms. We used the Likert scale ranking of 1 to 5

to measure the various levels of adoption of the selected variables by the sample firms. Table 6 below for example, gives the average ratings on competitive strategies followed by the sample firms. As one may note, the highest rating is given to 'quality leadership' followed by 'technology leadership' and 'time to market leadership'. This is in line with the general perceptions portrayed by the industry experts and analysts that the focus in the Indian automotive industry is on quality and technology compared to other developing countries such as China, who are mainly focusing on high volume production and cost competitiveness.

Table 6: Average ratings of competitive strategies followed by the Indian auto component firms

S.No	Variable	Average Weight(1-5)
1	Cost Leadership	4.28
2	Quality Leadership	4.65
3	Time to Market Leadership	4.36
4	Technology Leadership	4.40
5	Brand Leadership	4.26

Note on scores: The rating is from 1-5 where **1** is for *'not important at all'* and **5** is for *'extremely important'*

Sample Size (N) = 77

The individual ratings on quality related initiatives such as quality certifications adopted by each individual company are provided in Table 7. As one may note, the total number of quality certifications for a sample of 77 companies is 197, which means, companies have gone for multiple quality certifications. The interviews with the industry experts reveal that, most firms began quality certification with ISO 9000 in the early 90's and then kept upgrading to latest certifications as and when they were introduced. Also, depending upon who their customers are, each exporting supplier went in for industry specific and sometimes country specific certification[2].

[2] For example, the most recent trend is towards VDA 6 certification, which is preferred by German OEMs and German Tier-1 suppliers such as Bosch and Continental.

Table 7: Summary statistics on Quality and environmental certifications

Certificate Type	Number of certificates	Percentage %
ISO 9001	59	76.62
TS 16949	56	72.73
ISO 14001	39	50.65
QS 9000	23	29.87
Other	20	25.97
Total	197	

Note: Sample Size (N) = 77

The summary statistics on awards received by the sample firms are reported in Table 8. The sample firms were asked to name the awards received from their customers and any external agencies. As one may note, the list is dominated by 'quality' related awards with 26 out of 77 companies receiving some type of quality award; followed by 'best supplier' awards, with 18 companies out of 77 adjudged as best suppliers by their customers and 10 companies winning award for timely delivery. This list also includes awards such as 'Deming Application Prize' and 'Rajiv Gandhi Quality award' etc. under the 'quality awards' category and awards for innovativeness, technology, productivity and timely delivery under the respective categories. The 'best supplier' category comprises of awards for overall performance, good finishing and timely support. There are also 7 companies that have received awards for cost competitiveness, safety, marketing and export intensity, which have been clubbed under 'others' category.

Table 8: Summary statistics on Quality and other Awards

Award	No. of firms receiving the award	Total no. of awards	Awards %
Innovativeness	6	7	6.54
Quality	26	46	43
Technology	5	8	7.48
Productivity	5	6	5.61
Timely delivery	10	15	14.01
Best supplier	18	18	16.82
Others	7	7	6.54
Total	77	107	

Note: Sample Size (N) = 77

Note: Some sample firms received awards under multiple categories. Therefore the total of 77 awards under the second column does not mean that all 77 sample firms have received some award or the other. The third column in Table 8 gives the total number of awards under each category, received multiple times. For example, while each of the 26 sample firms out of 77 received at least one quality award, these 26 put together have received a total of 46 quality awards.

Table 9 reports level of adoption of various advanced design and manufacturing practices and production planning systems, facilitated by the Information Technology (IT), such as Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), Material Resource Planning (MRP) and Enterprise Resource Planning (ERP) etc. as well as Japanese philosophy based Just In Time (JIT), Lean and Agile Manufacturing. As one may note, CAD has been adopted by most number of sample firms, followed by PPC, ERP and CAM.

Table 9: Adoption of various advanced manufacturing practices

S.No	Process	Average Weight(1-5)
1	Computer Integrated Manufacturing (CIM)	3.82
2	Computer Aided Design (CAD)	4.42
3	Computer Aided Process Planning (CAP)	3.88
4	Computer Aided Manufacturing (CAM)	3.97
5	Computer-aided Quality Assurance (CAQ)	3.86
6	Production Planning and Control (PPC)	4.10
7	Material Resource Planning (MRP)	3.96
8	Enterprise Resource Planning (ERP)	4.06
9	Cellular Production (CP)	3.49
10	Just In Time (JIT)	3.88
11	Lean Manufacturing (LM)	3.57
12	Agile Manufacturing (AM)	2.87

Note on scores: 1 = never heard about it; 2 = don't intend to implement; 3 = not yet begun
4 = standard/common implementation; 5 = highly advanced implementation

Note: Sample Size (N) = 77

We also collected data on various process and quality management tools adopted by the Indian auto component firms for shop floor management on a day to day basis. The ratings of the level of adoption of these tools are reported in Table 10. As one may note from the table, Production Part Approval Process (PPAP) and Employee Suggestion Scheme (ESS) seem to be the most popular tools, followed by FMEA, APQP and Kaizen. PPAP is a requirement by many customers, especially from Europe, and hence adoption seems to have been mandated by the customers, while ESS, FMEA and Kaizen seem to have been influenced by the Japanese manufacturing philosophies.

Table 10: Adoption of various process related and quality management tools

S.No	Method	Average Weight(1-5)
1	Kanban	3.34
2	Statistical Process Control (SPC)	3.96
3	Kaizen	4.07
4	Poka Yoke	3.69
5	Advanced Product and Quality Planning (APQP)	4.11
6	6 Sigma	3.91
7	Total Productive Maintenance (TPM)	4.08
8	Path analysis	3.79
9	Quality Circles	3.97
10	Quality Function Deployment (QFD)	3.82
11	Failure Modes, Effects Analysis (FMEA)	4.13
12	Employee Suggestion Scheme	4.18
13	Multi-skilling	3.88
14	Production Part Approval Process (PPAP)	4.18
15	8-D Report	3.39

Note on scores: 1 = never heard about it; 2 = don't intend to implement; 3 = not yet begun
4 = standard/common implementation; 5 = highly advanced implementation

Note: Sample Size (N) = 77

The financial performance data for this sample of companies was collected from an India specific database, *Prowess*, maintained by the Center for Monitoring Indian Economy (CMIE) (available at http://www.cmie.com). Prowess contains detailed information on all listed companies and public limited companies in India and has time series information of variable lengths on over 9,300 firms. One of the main limitations of the Prowess database is its focus on publicly traded and listed companies; hence the set of privately owned companies as well as unregistered firms are not a part of the empirical analysis which uses financial data.

4.2 Methodology

We use the logistic regression to test the first three hypotheses posited in the above section and multiple regression to test the fourth and fifth hypotheses. The objective of logistic regression is to find the best fitting model to describe the relationship between the dichotomous characteristic of interest (dependent variable = response or outcome variable) and a set of independent (predictor or explanatory) variables. Rather than choosing parameters that minimize the sum of squared errors (like in ordinary regression),

estimation in logistic regression chooses parameters that maximize the likelihood of observing the sample values. Logistic regression generates the coefficients (and its standard errors and significance levels) of an independent variables to predict a logit transformation of the probability of winning an award.

$$\log(p) = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + ... + b_k X_k$$

Where 'p' is the probability of winning an award

$$\log(p) = \ln\left[\frac{p}{1-p}\right]$$

In the current context logistic regression is applied to predict winning an award by a firm given a set of predictors. Here the dependent variable is binary or dichotomous, i.e. it only contains data coded as 1 (winning an award) or 0 (not winning an award). Three types of explanatory variables are considered, first type are continuous variables (Sales, Research & Development Expenses and Exports), second type is discrete variable (Age of company) and the third is dichotomous variable (Group, Tier1). Sample size is 47. Fisher's scoring method which is iterative optimization technique is used to estimate regression parameters.

$$\log(p) = b_0 + b_1 * Size + b_2 * R\&D + b_3 * Exports + b_4 * Age + b_5 * Group + b_6 * Tier$$

(1)

where $b_0, b_1 \ldots b_6$ are regression coefficients.

We next use multiple linear regression to test hypotheses four and five which hypothesize the influence of awards and various firm specific variables like business group affiliation, position in supply chain, export intensity, technological and financial alliances with foreign companies on sales performance and profitability of the firm. The 'average net sales over a period of 5 years' is used to represent the sales performance of the firm in the fourth hypothesis and 'Profit After Tax (PAT) as a % of sales' and 'Profit Before Depreciation, Interest, Tax and Amortization (PBDITA) as a % of sales' averaged over a period of 5 years is used to represent the profitability of the firm in the fifth hypothesis. Please note that equations (2) and (3) below are used to test hypotheses 4 and 5 respectively.

$$Sales = \beta_0 + \beta_1 * Group + \beta_2 * Tier + \beta_3 * Exports + \beta_4 * Tech\&FinJV + \beta_5 * Award$$

(2)

$$\text{Profit} = \beta_0 + \beta_1 * Group + \beta_2 * TierDummy + \beta_3 * Exports + \beta_4 * Tech \,\&\, FinJV \quad (3)$$

4.3 Results and Discussion

The results of logistic regression, which tries to estimate the influence of various firm level factors on winning an award, are reported in Table 11. As one may note, the only variable which seems to have significant (at 10% level) influence on winning the 'best supplier award' seems to be the 'age of the firm'. The results suggest that, the older the firm, the higher the probability of winning the best supplier award. Perhaps, the established systems and processes and the access to customers and markets for a longer period of time are helping the older firms to understand the customer requirements better and hence provide the excellent service that is winning them the awards. The quality awards on the other hand seem to have been won by the tier-1 companies, as the only variable that is significant (at 5% level) in this case turns out to be the tier variable. This is not surprising, as most of the qualitative studies also show that the tier-1 firms in the Indian auto component industry have initiated rigorous quality initiatives since the liberalization in the early 90's, many of which resulted in worldwide recognized quality awards such as Deming Application Prize. Also, the fact that, some of these quality initiatives, such as TQM, require continuous adherence to serious process improvement practices on a long term basis yielding tangible financial returns only in the long run, which is quite difficult for the lower tier suppliers due to lack of financial resources. Also, stable demand and close working relationship with the customers certainly help in adopting best practices in quality and process improvement initiatives. Finally, we tested the likelihood of winning an award (irrespective of whether it is a quality award or a best supplier award), and the last two columns in Table 11 present the corresponding results. According to these results, it seems both 'age of the firm' and 'tier' play an important role in determining whether a firm is capable of winning an award or not. Again, considering the above two results and the corresponding discussion, this is not surprising and only bolsters the individual results.

Table 11: Effect of R&D, Exports and Tier on winning an award

Logistic Regression Results						
	Best Supplier Award		Quality Award		Award	
Parameter	Estimate	P - Value	Estimate	P - Value	Estimate	P - Value
Intercept	-3.9732	0.0165	-4.013	0.023	-3.644	0.019
SALES	0.00376	0.1156	-0.001	0.657	0.0009	0.69
R&D*	-0.1826	0.4636	-0.053	0.806	-0.088	0.7
EXPORTS*	0.0222	0.2474	0.0003	0.976	0.016	0.367
AGE	0.0703	0.0813	0.057	0.147	0.077	0.057
GROUP	-1.0122	0.2841	0.044	0.956	0.567	0.48
TIER*	1.1866	0.2442	2.83	0.025	1.706	0.062

Sample size (N) = 47

We next look at how an award and various firm level factors such as the tier, group, export intensity, technology and financial joint ventures influence the sales turnover of firms in the Indian auto component industry. As one may note from Table 12, awards per say, irrespective of which type of award, do not have any influence on the sales turnover of a firm. However, other firm level variables like tier and group are very significant (at <1% level) and are positively associated with the sales. Similarly, the technology and financial joint ventures also seem to be significantly (at 5% level) influencing the sales. These results shed some interesting insights into the determination of sales in the Indian auto component industry. The firms belonging to the business groups and tier-1 are enjoying higher sales compared to their non-business group and tier-2 counter parts. Also, the technological and financial joint venture partnerships with multinational organizations are helping Indian firms garner higher sales contracts.

Table 12: Determinants of performance (turnover) in the Indian auto component industry

Dependent Variable →	Average Sales during 2003-2005							
Independent Variables ↓	Without Award		Quality		Best Supplier		Award	
	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|
Intercept	2.55636	<.0001	2.56237	<.0001	2.47397	<.0001	2.50218	<.0001
Tier	1.45988	0.0014	1.48193	0.0023	1.37556	0.0026	1.39511	0.0031
Group	0.99811	0.0060	0.99658	0.0067	1.02029	0.0049	0.97047	0.0084
Average Exports	0.00595	0.1456	0.00589	0.1569	0.00446	0.2881	0.00561	0.1767
Tech-Fin JV	0.75296	0.0428	0.75464	0.0450	0.74022	0.0450	0.75160	0.0449
Award			-0.05519	0.8798	0.46069	0.2082	0.21920	0.5464
R-Square	0.5210		0.5212		0.5393		0.5253	
Adj R-Sq	0.4753		0.4629		0.4832		0.4674	

Note: Sample size (N) = 47 & we use ln(average sales) as the response variable, since ln transformation was found to be a good candidate model for achieving the most homogeneous variances as well as results in a liner fit.

The final set of results help us identify the variables that have significant association with the profitability of the firm in the Indian auto component industry. As one may note from Table 13, results for both PAT% and PBDIT%, which are used to represent the average profitability of the firm over a period of 5 years, are similar. The only variable that is positively and significantly (10% and 5% respectively) associated with both the profit variables is 'R&D investments'. The 'technology joint venture' variable is in fact negatively associated with the profit margins at 5% level of significance, which is quite surprising. Since we have not tested for causality, it is difficult to say the direction of influence. The first impression would be that the firms that are investing in R&D are more profitable due to benefits accrued from R&D, whereas firms that are going for technology joint ventures to quickly license the technologies in order to attract higher supply contracts from MNCs are less profitable due to the high cost of licensing. However, it is also possible that firms that are highly profitable are investing more into R&D, while less profitable firms are going in for technology joint

ventures to quickly improve their sales volumes and enter into higher value added segments. In order to identify the causality, a long term study based on time series analysis, preferably with a panel dataset, needs to be carried out.

Table 13: Determinants of performance (Profit margin) in the Indian auto component industry

Dependent Variable →	**Profit after Tax (PAT) as a % of Sales**		**Profit before Depreciation, Interest, Tax and Amortization (PBDIT) as a % of Sales**	
Independent Variable ↓	**Parameter Estimate**	**P - Value**	**Parameter Estimate**	**P – Value**
Intercept	4.83570	0.0011	12.82806	<.0001
Tier	2.15525	0.1679	2.86723	0.2379
Group	-1.53174	0.2196	-2.41106	0.2154
Average Exports	0.01981	0.1735	0.02538	0.2618
Technology JV	**-2.92800**	**0.0369**	**-4.20773**	**0.0535**
R&D	**0.79119**	**0.0645**	**1.44805**	**0.0313**
R-square	0.2033		0.2016	
Adjusted R-square	0.1061		0.1042	

Note: Sample size (N) = 47

5 Conclusions

Since the economic reforms liberalized the industry completely, the Indian auto component firms have been following various strategies to survive and grow in the onslaught of global competition. Some of these strategies involve improving process quality, adoption of advanced manufacturing technologies and joint venture arrangements with global companies for technology licensing and financial resources. There were also some inherent firm level characteristics, such as affiliation with a business group, tier-1 status and relatively longer experience and hence well networked in the industry, have all played a critical role in the success of the firms in some way or the other. The current study endeavors to determine exactly how these firm level characteristics and various process improvement initiatives like the adoption of advanced manufacturing technologies and world-class quality management practices have contributed to the performance of the Indian auto component firms during the five year study period 2003-2008.

The data collection exercise and the empirical analysis have resulted in some very interesting findings. The main competitive strategies followed by the Indian auto component firms seems to be 'quality', 'technology' and 'responsiveness' to the customer requirements. However, quality improvement per say does not seem to give an edge in attracting higher business or profits. This may be attributed to the uniform improvement in quality standards across the board and the entry of multinational customers who are demanding higher quality as a minimum requirement. The Indian consumers have a greater choice of products now and hence the quality requirements of the domestic OEMs have also gone up significantly, making 'quality' as an *order qualifier*, a minimum requirement even to be shortlisted for supply contracts by the customers. Therefore, the differentiating factor seems to be 'technology', which needs either long term R&D efforts or the financial resources to license new technologies. Our empirical results suggest that, only 'technology joint venture agreements' have not had any impact on performance. Firms that have gone in for both financial as well as technology joint ventures have benefitted in terms of garnering higher sales during the study period. However, firms which are tier-1 suppliers and firms that are affiliated to business groups garner higher average sales, which suggest that there are significant advantages a tier-1 company enjoys due to the close relationships and collaboration activities that take place with the OEMs and a business group company enjoys due to various networking externalities of being part of a group. In fact, the profitability of firms that have gone in for technology joint ventures seems to be suffering significantly, while firms with greater R&D intensity are enjoying significantly higher profitability.

The results suggest that given the complex nature of various strategies and their interaction effects, Indian firms need to tread the path to development of new technological competencies carefully. Although technology licensing in the short run may win new contracts and higher sales, sole reliance on technology licensing alone may be harmful in the long run, and hence one needs to invest in internal R&D and try to internalize the technological knowledge and aspire to develop new technologies internally, to survive and grow in the globalized world.

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