Indian Auto Component Supply Chain at the Crossroads

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Abstract

We trace the evolution of the auto component supply chain in India (following the opening of the Indian economy in 1990) using a combination of data on firm and sectoral performance, customer satisfaction surveys and interviews with experts. During the last decade, the industry has made remarkable progress on multiple fronts. This is particularly true with regard to quality - ten firms in this industry have won the coveted Deming award during the last six years. We first observe that, surprisingly, the financial performance of the Deming firms show no clear-cut differences from the rest of the industry. We then analyze the productivity growth at the firm level across two five-year intervals using a total factor productivity model. Our results suggest that productivity has improved much more in the second period, which is the interval in which most of the firms won the Deming award. We then analyze the impact on profitability and suggest that new firms were able to grow faster in the growing business environment. To“externally” validate our findings, we compare the auto sector in India with that in China. . Despite a ten-year disadvantage in start-up and costs that are beyond the control of the firm, the auto sector in India seems to be competitive with China on all firm specific factors. In summary, we suggest that firms in this sector have taken the first step by becoming competitive on the cost and quality dimensions. We suggest that they are now at a crossroads, and have to make several choices in order to leverage these quality gains into a profitable global supply chain strategy.

1. Introduction

We study the evolution of the auto component supply chain in India since the opening of the economy in 1990 using a combination of data on firm and sectoral performance, customer satisfaction surveys and interviews with experts. We relate these changes to competitive forces and operational decisions made by firms. We also discuss future trajectories for firms in this industry.

Our findings are that:

(1) The quality movement and the adoption of lean manufacturing techniques have been extremely successful in this sector. As of September 2004, ten Indian auto companies had won the Deming prize - a spectacular achievement, considering the number of firms and the short duration in which they have turned themselves from pedestrian to world-class-quality-award status. We find that on the metric of financial performance, there are no clear-cut differences between any of these firms and other firms that operate in the same business within the industry. Our analysis suggests that this is not due to a lack of significant improvement by the award winners but a lack of significant differences between the award winners and others. The award winners and the other firms appear to be clustered together along quality and delivery metrics.

(2) We analyze whether the quality improvements have translated into productivity gains by studying total factor productivity gains over 1994-1998 and 1998-2003. Our results suggest that productivity has improved much more in the second period, which is the interval in which most of the firms won the Deming award. Further, we find that there is significant variation in productivity gains across segments.

(3) We perform a financial analysis of the sector to trace whether the quality and productivity gains have translated into an increase in profitability. Despite the price pressure from OEMs, and consistent with our findings about quality and productivity, the profitability of the entire sector has improved. Further, a study of firm-level profit performance with respect to firm size and by product segment reveals that newer firms were able to grow faster; but an export oriented strategy shows limited benefits in general. Also, segments of the industry that had higher increase in productivity show no drop in financial performance despite price pressures. The improvement in profitability of the sector is a remarkable confirmation that operational decisions that began with a

concerted effort to improve quality helped almost every firm to improve on multiple dimensions.

(4) In order to examine whether the above-mentioned changes have made these firms more competitive in world markets, and to "externally" validate our findings, we compare the auto sector in India with that in China. Data availability permits only a limited analysis. Despite higher costs (raw material, energy, etc) in India, multinational OEMs operating in the Indian market produce cars that have high local content and are sold at competitive retail prices[1]. Further, though the Indian car companies operate at lower profit margins, their return on capital employed is higher. In the last section, we discuss how we can interpret our findings and the implications for future strategic directions of these firms.

We describe our findings in three parts: We first trace the response by firms in this sector to market and economic forces (Section 2). This is followed by an in-depth analysis of the supply chain with regard to cost, quality, productivity and profitability (Sections 3, 4, 5, 6). Then, we evaluate the performance of the sector in the context of increasing its market share in the global auto supply chain by comparing with China (Section 7). We also present alternative strategies currently pursued by individual players in the chain, and comment upon these strategies (Section 8).

2 The Indian Automobile Industry[2]

In this section, we trace the growth in the Indian auto-component sector and describe the market, cost structure and export performance. The Indian auto-component industry's annual turnover (for FY 2003) was US $6.73 billion. This is miniscule compared to the global automotive components industry turnover of US $737 billion. However, at a compounded annual growth rate of 20-25 %, the growth in India's auto-component exports is significantly higher than that of the domestic market in India (10-14%) and markets elsewhere.

A very visible outcome of the transformation of the auto-component sector is the rapid growth in cars exported from India. Indian auto OEMs exported 13.1% of their production in 2003-04; up from 3.9% in 2000-01 (Table 2.1). The significant growth of exports from India signals that the auto sector is rapidly becoming globally competitive,

[1] In many cases, the delivered retail price of a car in India is 50% of the price in China
[2] The data for this section has been collected from CMIE Prowess and ICRA 2004

particularly in the small car segment (Morgan Stanley Equity Research (2004)). This is examined in later sections.

Table 2.1: Indian Car Exports (number of units)

	1/00-1/01[3]	4/02-1/03[3]	4/03-1/04[3]
Ford India	0	22,751	19,236
Hyundai Motor	5,759	7,038	32,775
Maruti Udyog	15,025	24,560	39,132
Tata Motors	463	1,539	7,468
Total	22,913	56,982	98,663
Exports as a percentage of sales	3.9	7.4	13.1

Source: ACMA (2004).

The auto-component industry that helped to enable this transformation caters to three markets: (1) Original equipment manufacturers (OEM) or vehicle manufacturers, who comprise 25% of the total demand. (2) The replacement market that forms 65% of the total demand. (3) Export market that comprises primarily exports to international Tier I suppliers and constitutes 10% of the total demand. The auto-component industry can also be sub-divided into six segments: (1) Engine Parts. (2) Electrical Parts. (3) Drive Transmission & Steering Parts. (4) Suspension & Braking Parts. (5) Equipment. (6) Others. Table 2.2 shows the cumulative annual growth rate of sales, profits and exports by segment over the period 1998-2003. The growth has been similar in all the segments but for sales in the electrical parts segment.

Table 2.2: Segment-wise growth in Sales, Profits and Exports over the period 1998-2003

Segments	**Sales**	**Profits**	**Exports**
Braking parts	9.59%	15.56%	17.03%
Electrical parts	2.77%	16.30%	9.35%
Engine parts	7.71%	16.80%	10.72%
Equipment	14.13%	16.83%	14.73%
Others	14.45%	25.93%	3.06%
Steering parts	10.43%	6.60%	1.88%

Source: CMIE Prowess

[3] The time intervals are inconsistent due to reporting changes and lack of availability of alternate data.

The six business segments share many common features such as a common management and customers, as well as a similar cost structure. The auto-component sector is dominated by family businesses, such as the Anand group, the Rane group and the TVS group. Each group owns a cluster of companies that supply different kinds of parts to OEMs. The cost structure is also not very different amongst the segments (see Table 2.3) except for the high share of labor in the engine parts segment. We have focused on the time period from 1998-2003 because that is the period for which we had the detailed data required for this section. It is evident from Table 2.4 that any analysis of cost should focus on material cost, employee cost and other manufacturing costs that account for 70.4% of the total operating income. However, there are some differences with regard to technology. The engine parts segment is a very critical segment. Suppliers in this segment work in close collaboration the OEMs. It is also the most *labor-intensive* segment and, consequently, holds potential for growth in exports due to the abundance of technical talent in India.

Table 2.3: Segment-wise cost structure in the auto-component Sector

	Equipment Parts	Braking Parts	Steering Parts	Electrical Parts	Engine Parts
Raw Material Cost	62%	72%	70%	66%	47%
Power and Fuel Cost	3%	3%	5%	2%	4%
Employee Cost	17%	8%	11%	12%	23%
Consumable Stores	1%	4%	4%	1%	7%
Selling Cost	6%	4%	3%	1%	5%
Others	11%	9%	7%	18%	14%

Source: Morgan Stanley report (2004)

Table 2.4: Cost structure in the auto-component sector[4]

Cost Item	**%**
Material Cost	51.3
Power and Fuel Cost	3.8
Employee Cost	12.5
Other Manufacturing Expenses	6.9
Selling expenses	3.3
Interest & Finance Costs	3.6
Depreciation	6.4
Tax	2.0

[4] Unlike Table 2.3, the costs here are as a percentage of operating income.

Operating Profit Margins	15.3
Net Profit Margins	4.2

Costs a*s a % of Operating Income; Source: ACMA (2004)*

3. Financial Performance of Deming Award Winners

Firms in this sector made significant advances in quality since 1990. This would not have been as visible but for the ten Deming awards that were given to firms in this sector during 1998-2004 (see Table 3.1). This is the largest number of firms from any country across all industries outside Japan to win this award.

Table 3.1 Deming Award winners list (1998-2004)

Award	**Firm**	**Year**
Deming Application Prize	Sundaram-Clayton Limited, Brakes Division (India)	1998
	Sundaram Brake Linings Ltd. (India)	2001
	TVS Motor Company Ltd. (India)	2002
	Brakes India Ltd., Foundry Division (India)	2003
	Mahindra and Mahindra Ltd., Farm Equipment Sector (India)	2003
	Rane Brake Linings Ltd. (India)	2003
	Sona Koyo Steering Systems Ltd. (India)	2003
	Lucas-TVS Limited	2004
Quality Control Award for Operations Business Units	Hi-Tech Carbon GMPD (India)	2002
Japan Quality Medal	Sundaram-Clayton Ltd., Brakes Division (India)	2002

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

We began our study to understand the performance of Deming award winning firms relative to the rest of the industry. We expected to find that the rapid improvement in quality resulted in better financial performance, following Hendricks and Singhal (1997) work that documents the performance of firms with effective Total Quality Management (TQM) programs to show that firms that have won quality awards outperform the control firms on operating income-based measures.

We compare the financial performance of firms that have won the Deming prize (we call these the sample firms) with that of a control group. We use financial data from the Center for Monitoring the Indian Economy (CMIE). The data is reported for 168 firms but there is missing data for 27 firms. Therefore, we use data for 141 firms. We use all the non-Deming companies in the particular segment of the auto sector of the award-winning company as the control group.

We use two sets of performance metrics: one set that accounts for the past performance of the firm and another that reflects future prospects. Return on capital employed, cost of production, asset turnover and inventory turns comprise the first set, and the price-to-earnings ratio forms the second set. To remove size effects, cost of production is taken as a percentage of sales. The other metrics are ratios and, hence, are not normalized. Inventory turns is defined as the ratio of revenue to the average inventory held during the year. Asset turnover is defined as the ratio of sales to assets.

To measure a firm's relative performance, we compute the average year-on-year change for the control group between 1998 and 2004 for each metric and subtract this from the year-on-year change of the sample firm. The mean of these fluctuations is presented in Table 3.2. A test that the mean of these differences is different from zero shows no significant results.

Table 3.2 Test of means of differences

Variable	Mean	t Value
Changes in Return On Capital Employed	-0.27375	-0.29
Change in Inventory turns	0.2575	1.26
Change in Cost of Production	0.0005	0.1
Change in Asset Turnover	-0.035	-0.48

We also do a t-test of the difference between the price to earnings ratio (P/E) of the sample firms and that of the control group to see if it is significantly different from zero. The t-test presents a value of 0.4696 and we are unable to rule out the hypothesis that the performance difference is not significant. In addition, we also test to rule out the possibility that there were any trends or cycles over time in this data. We perform run tests (Stevenson 2005) to check whether the observed patterns are random. These tests are routinely applied to determine if there are any patterns or trends in the plotted points in control charts to see if the variations are random. We perform two types of run tests, above and below the median run test and the up and down run test on the values for each parameter for every firm. Using the z-statistics for these tests, we reject the hypothesis that the changes are non-random[5]. We

[5] For brevity, the results of the run test are not provided in this paper.

thus conclude, to our surprise, that the Deming companies have not outperformed the other firms in their segment of the industry.

It may be argued that Deming companies may have been excellent performers to begin with and therefore do not show much improvement. However, the t-test comparing the initial performance of these companies with the rest of the firms produces inconclusive results: The t-test on the Return on Capital Employed in 1998 shows that the difference in means between the two groups is not significant. Further, out of the three test that turn out to be significant, the Deming firms perform better in inventory turns and cost of production but worse in asset turnover. (see Table 3.3).

Table 3.3: Comparison of Raw Performance of Deming and Other Firms

Variable	Deming Companies	Others	t-value
Return On Capital Employed	18.67	22.07	-0.87
Inventory turns	12.33	7.56	4.49
Cost of Production	0.67	0.79	-2.77
Asset Turnover	2.11	3.33	-2.45

There are two possible explanations for the lack of any difference in performance of the Deming winners: Either the Deming firms could not capitalize on their improvement in quality, or a majority of firms in this sector also improved in quality, thus preventing differentiation on quality. We suggest that it was the latter. The next section examines the quality improvements across the industry.

4. Sector-Wide Quality Performance

In this section, we present data which shows that many firms in this industry made quality improvements and that these improvements resulted in considerable and measurable impact on customer satisfaction in the auto industry. Our findings are based on data on quality certification and customer satisfaction surveys.

The auto-component manufacturers association, ACMA, represents over 479 companies, whose production forms a majority of the total auto-component output in the organized sector. ACMA reports that the industry has been making rapid strides towards achieving world-class quality systems. As of 2003, 417 companies in ACMA membership obtained ISO 9000 certification, 242 companies QS 9000, 101 companies ISO 14001, 176 companies TS 16949, and 22 obtained ISO 18001. Thus, a majority of the firms in the organized auto- component sector have obtained quality certification. Next, we turn to customer satisfaction tracking surveys[6] conducted for FY2002 and FY2004 that are summarized in Table 4.1. These surveys were conducted as part of an engagement on behalf of two foreign OEMs whose plants are located in India. The surveyed firms may thus be considered representative of suppliers to large OEM's. These surveys show clear trends of improvement on a variety of metrics that are important to customers. We find that all these initiatives appear to have resulted in a perceptible increase in quality levels of the auto-component industry as a whole. We therefore conclude that quality has improved "across the board" in this sector, i.e., companies that have won the Deming award are not the only firms with "superior" quality.

This still does not answer the question as to why firms chose to take the route of dramatically improving "quality first". A possible rationale for the route pursued by these firms is given by Ferdows and DeMeyer (1990). They suggest that that in order to build lasting manufacturing capability, management attention should begin with enhancing quality, followed by dependability, cost efficiency and flexibility. Likewise, Deming argued that quality gains precede cost and productivity gains[7]. One might argue that it is not essential to improve quality, win awards, etc. to be able to operate effectively in an economy that is just opening up. We will discuss this in the concluding section. We first analyze the success of the "quality first" strategy as predicted by theory in the next three sections.

Table 4.1: Quality Performance of the auto-component industry

2001	**2003**
Process conformance through Quality Certifications	Process Improvements through Quality Initiatives like Total Quality Management, Total Productive Maintenance, Six Sigma
Customer Line Rejections 1000 plus ppm	Customer Line Rejections 100 – 400 ppm
Rework 3 – 5%	Rework < 1%
First pass yield < 80%[8]	First pass yield 95 to 97%
OEE 70 to 80%[9]	OEE 90 to 95%

[6] Conducted by Ramnath Management Consultants, Chennai, India.
[7] The Deming Management Method
[8] First Pass Yield – another quality parameter which refers to the proportion of components which pass through various processes with accepted quality levels without any rework or rejections.
[9] Operational Equipment Effectiveness (OEE) – this parameter refers to the equipment effectiveness measured by the actual production divided by the ideal production from the total available time on the

Warranty 50,000 ppm	Warranty 500 – 2000 ppm

Source: Customer Satisfaction Tracking Surveys

5. Analysis of Productivity

The implication of Ferdows and DeMeyer (1990)'s observations for the Indian auto component industry is that we would expect to see quality improvement translated into significant productivity gains for a majority of firms in this sector. Two recent studies on the Indian auto-component sector have found improvements in the productivity of the sector over the period of study. Sivadasan (2003) finds that the mean productivity growth is approximately 3% over their study period from 1987 to 1995. Das and Rao (2005) finds that the simple average of productivity of the sector was 1.09% between the period 1992 and 1999. Neither study reports a segment-wise analysis. Also, our sample of firms is different from the samples of Sivadasan (2003) and Das et al (2005). While Das and Rao (2005) use firm-level panel data obtained from the Reserve Bank of India for the period 1976-77 to 1989-99, Sivadasan(2003) uses industry unit-level (not firm level) data from the Annual Survey of Industries sponsored by the Government of India over the period 1986-87 to 1994-95. We use data from Prowess database provided by the Centre for Monitoring Indian Economy (CMIE). This data is obtained from the financial statements issued by the companies and, hence, is different from self-reported measures or unit-level measures. Further, this data allows us to understand segment-wise performance. Thus, in order to relate quality improvements and profitability of segments to productivity gains, we independently estimate the productivity of the firms in our sample.

5.1 Methodology

The first step towards estimating productivity is to estimate the production function of the firms. We follow the commonly used (Berndt (1991)) Cobb-Douglas functional form for the production function that remains the same over the period of study given by:

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta},$$

same equipment, OEE accounts for all losses in production system where, Y refers to the output, L to the labor inputs and K to the capital input. The index "i" refers to a firm and "t" refers to the year. A_{it} measures the total factor productivity (TFP) because it increases all factors' marginal product simultaneously.

Transforming the above production function into logs allows linear estimation. Using lower case letters for logarithms, the equation becomes:

$$y_{it} = a_{it} + \alpha^* l_{it} + \beta^* k_{it}$$

Following an approach similar to Das and Rao (2005), we model a_{it} as $\gamma_{it} + \gamma_t + \gamma_i$ where $\gamma_t + \gamma_i$ refers to the fixed effects for time and firm. To capture the fixed effects, we allow the intercept to vary with time and firm as shown below:

$$y_{it} = \gamma_{it} + \gamma_t + \gamma_i + \alpha * l_{it} + \beta * k_{it}$$

This equation is modeled as an ordinary least squares (OLS) regression where we run a regression to estimate α and β. In this study we do not allow α and β to vary over time. One reason for this choice is that due to the short time-period of the study, we do not expect a large change in these coefficients. Once we obtain α and β, we algebraically obtain A_{it} and growth in A_{it} over time.

5.2 Data

Our primary source of data is the Prowess database provided by the Centre for Monitoring Indian Economy (CMIE). Our sample covers 35 firms in the auto-component sector over a period of 10 years spanning 4 sectors – Steering, Equipment, Engine Parts and Braking.[10] For the estimation of the production function, we need the values of output, as well as labor and capital inputs. There are two types of output measures that can be used to calculate TFP growth: One is value-added output, which is the gross output corrected for purchases of intermediate inputs, and the other is gross output. As suggested by Mahadevan (2003), the value-added output is preferred when firms have different product-mix or the comparison is across different industries that use different amounts of intermediate goods and

[10] The CMIE database covers 168 firms. However, there were only 50 firms with the complete time-series of data necessary for the productivity calculations for the period of our study. Out of these 50, 2 belong to the 'electrical' segment and 13 belong to the 'others' segment. Since there were insufficient observations we had to drop 'electrical' segment and to maintain consistency with our other sections we had to drop the 'others' segment. However, our results in this section hold even when we consider all the six segments.

services. Therefore, as the firms are drawn from different segments within the sector and the comparison is made across these segments, we use the value-added approach.

The values of inputs such as labor and capital have been collected in real Indian Rupees. All the values are brought to real terms with 1994 as the base year through use of appropriate Consumer Price Index (CPI) and Wholesale Price Index (WPI) deflators. We use the CPI for motor vehicle parts to deflate the values of output and the WPI for the manufacturing sector to deflate the values of capital and labor.

5.3 Results and analysis

The coefficients of the production function based on our regression estimate are presented in Table 5.1 below.

Table 5.1: Estimates of the coefficients of the production function

Estimate	Value	Std error
Co-efficient of labor, α	0.79*	(0.033)
Co-efficient of capital, β	0.17*	(0.031)

** denotes significant at 5% level*

It can be observed that the sum of the coefficients is close to one, indicating constant returns to scale (see Table 5.1). The values of the coefficients are similar to those reported in Mitra *et al* (1998).[11] The average year-on-year TFP growth starting 1994 for the overall industry and the different segments is provided in Table 5.2. Panel A of Table 5.2 shows the simple average of the year-on-year growth rates of firms in the different segments. Panel B of Table 5.2 shows the weighted average of the year-on-year growth rates of firms in the different segments weighted by the value-added at the beginning year. Panel C shows the simple average of productivity growth in the different segments in 1994-1998 and 1999-2003 and Panel D shows the weighted average, weighted by the value-added, at the beginning year.

Table 5.2: Productivity growth

Panel A: Simple Average

Year	Steering	Equipments	Engine Parts	Braking	Overall
1994-1995	10.95%	15.60%	6.29%	7.96%	9.73%
1995-1996	3.36%	-1.84%	0.82%	0.75%	1.37%
1996-1997	-3.83%	-10.93%	-3.38%	0.99%	-3.63%
1997-1998	-10.76%	-16.54%	-14.95%	-10.46%	-12.60%
1998-1999	5.24%	2.65%	9.07%	0.13%	4.69%
1999-2000	9.19%	5.52%	6.40%	10.42%	8.23%
2000-2001	-0.17%	-6.25%	-7.60%	-4.27%	-3.89%
2001-2002	-2.93%	-13.07%	0.85%	-1.58%	-3.10%
2002-2003	5.14%	37.68%	16.48%	23.22%	16.84%
1994-2003	11.44%	-3.64%	11.27%	24.35%	12.19%

Panel B: Weighted Average (weighted by value-added)

Year	Steering	Equipments	Engine Parts	Braking	Overall
1994-1995	0.21%	0.23%	0.37%	0.45%	0.31%
1995-1996	0.09%	-0.02%	0.09%	0.11%	0.08%
1996-1997	-0.11%	-0.23%	-0.14%	0.10%	-0.09%
1997-1998	-0.24%	-0.37%	-0.22%	-0.25%	-0.26%
1998-1999	0.04%	0.03%	0.59%	-0.16%	0.13%
1999-2000	0.24%	0.20%	0.34%	0.38%	0.29%
2000-2001	0.00%	-0.05%	-0.55%	-0.13%	-0.18%
2001-2002	-0.07%	-0.35%	0.04%	-0.01%	-0.07%
2002-2003	0.15%	0.71%	1.41%	0.93%	0.73%
1994-2003	0.27%	-0.22%	1.67%	1.29%	0.79%

Panel C: Simple Average over two periods 1994-98 & 1998-2003

Years	Steering	Equipments	Engine Parts	Braking	Overall
1994-1998	-0.67%	-18.07%	-13.02%	-1.80%	-6.59%
1998-2003	15.85%	16.94%	25.20%	26.43%	20.83%

Panel D: Weighted average for two periods 1994-98 & 1998-2003

Years	Steering	Equipments	Engine Parts	Braking	Overall
1994-1998	-0.08%	-0.39%	-0.02%	0.44%	0.01%
1998-2003	0.40%	0.32%	1.66%	0.94%	0.83%

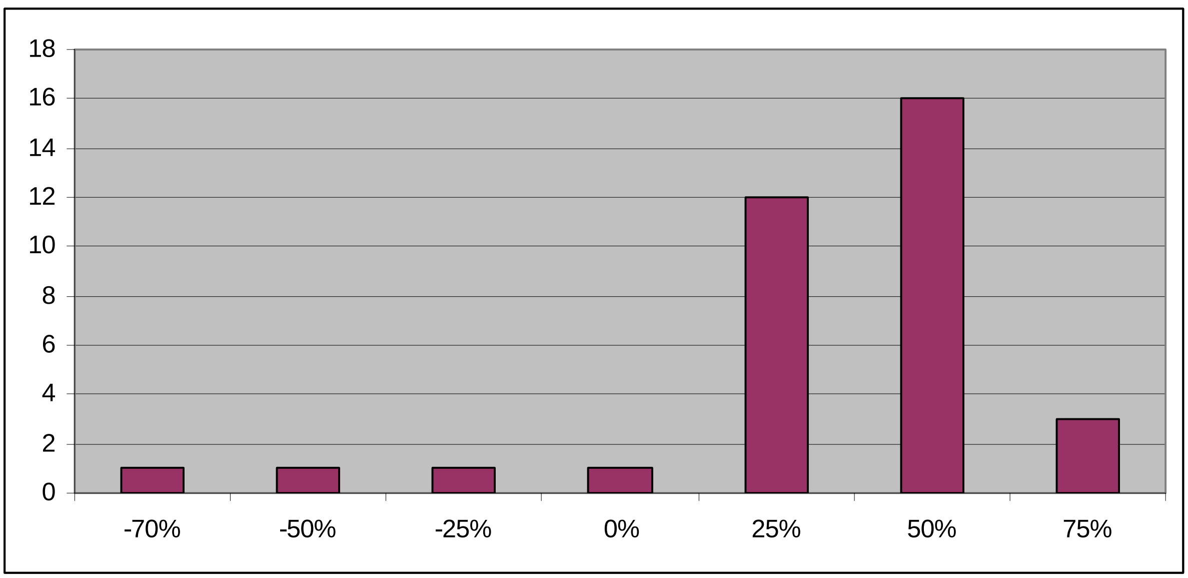
In order to summarize these results, we divide the time interval into two five-year periods 1994-1998 and 1998-2003. The logic for this split was twofold. First, most of the

[11] Mitra *et al* (1998) find the coefficient on capital to be 0.26 and the coefficient on labor to be 0.66.

firms that received the Deming prize, obtained it in the second period. Second, research by Hendricks and Singhal (1997) suggests that the observed improvements in performance did not appear before the award periods but appeared during the period of the award and post award periods. We also performed the entire analysis with 1995-1998 and 1998-2003, as well as, 1994-1998 and 1999-2003 as the two periods to check the robustness of the results and arrived at similar conclusions. The basic suggestion from Table 5.2 is that there was a difference in productivity growth between the first and second periods. We performed firm-level analysis to verify this at the company level.

We first identified the change in productivity growth by individual firms and checked whether the difference in TFP growth across the two periods was significantly different from zero. The Figure 5.3 below shows the difference in productivity growth across the two periods across the 35 firms in the sample.

Figure 5.3: Difference in TFP Growth



We did a t-test to check whether the difference in the mean productivity growth for the two periods is different from zero. The mean difference is 21.6 % with an associated t-statistic of 4.41 suggesting that we can reject the hypothesis that the difference in TFP growth is zero. The fact that the productivity has shown a positive growth in the second period is consistent with the findings in Sivadasan (2003) and Das and Rao (2005). The differences in numbers presented in the studies can be attributed to the difference in datasets used as well as methodological differences.

We then examined whether there was a difference in value added at the firm level across the two periods. Our results (see t-stat below) suggest that there is no significant difference in value added across the two periods.

	Growth in value added in 1994-1998	Growth in value added in 1999-2003
Mean	60.97%	47.12%
Hypothesized Mean Difference	0	
t Stat	1.37	

Finally, we calculated the correlation between firm level TFP growth and value added and found no significant correlation between these values.

We offer the following explanations of these results. In the first period, firms focused on meeting the growth in demand by relaxing various constraints. This growth was not associated with significant productivity increase, possibly because of the emphasis on exploiting the opportunities presented by the liberalization measures. However, in the second period, there seems to have been a greater emphasis on TQM related initiatives which resulted in productivity improvements. There was continued growth in value added during this period. We surmise that quality and productivity improvement became important in the second-period due to the entry of foreign OEMs and their suppliers into the Indian market. This resulted in an industry-wide adoption of TQM initiatives. Anecdotal evidence from discussions with industry personnel suggests that since the late nineties, it has become fairly common for consulting firms to offer TQM related advice, as well as process level consulting for this sector. This facilitated the adoption of TQM practices not just to manage shop-floor level processes but almost all processes within the firm. These observations, combined with the industry wide quality improvement data presented in the earlier sections, suggest that the industry as a whole is now globally quality and cost competitive.

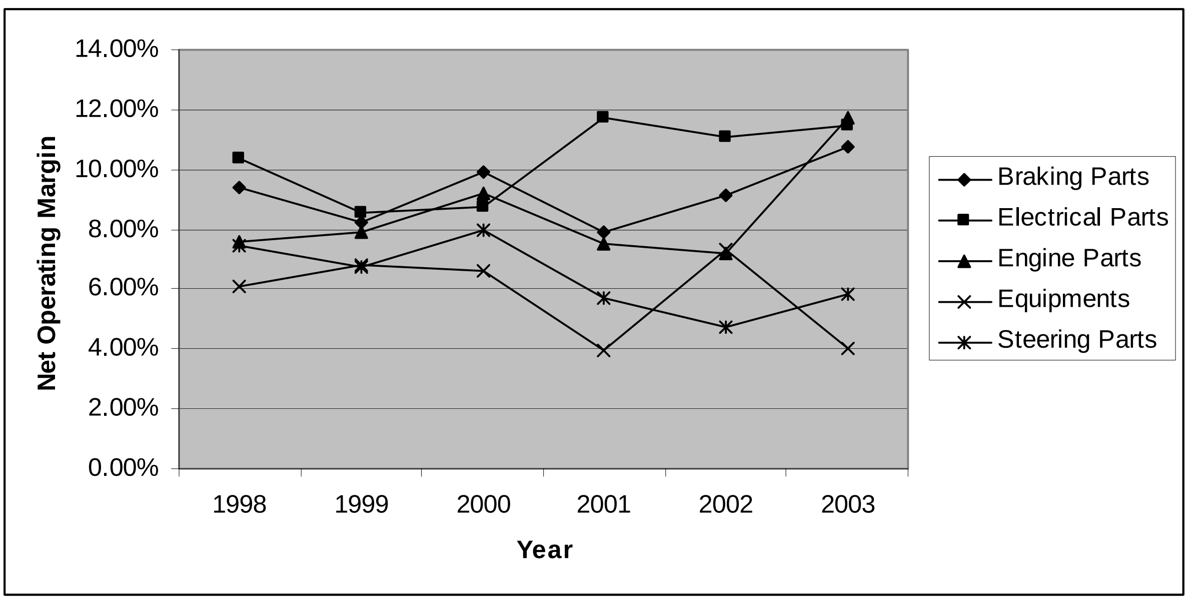
However, as we discussed in the earlier section, the award-winning firms do not show a significant profitability improvement as against benchmark firms. In the next section we will examine whether the firms in the *sector* benefited from adoption of TQM.

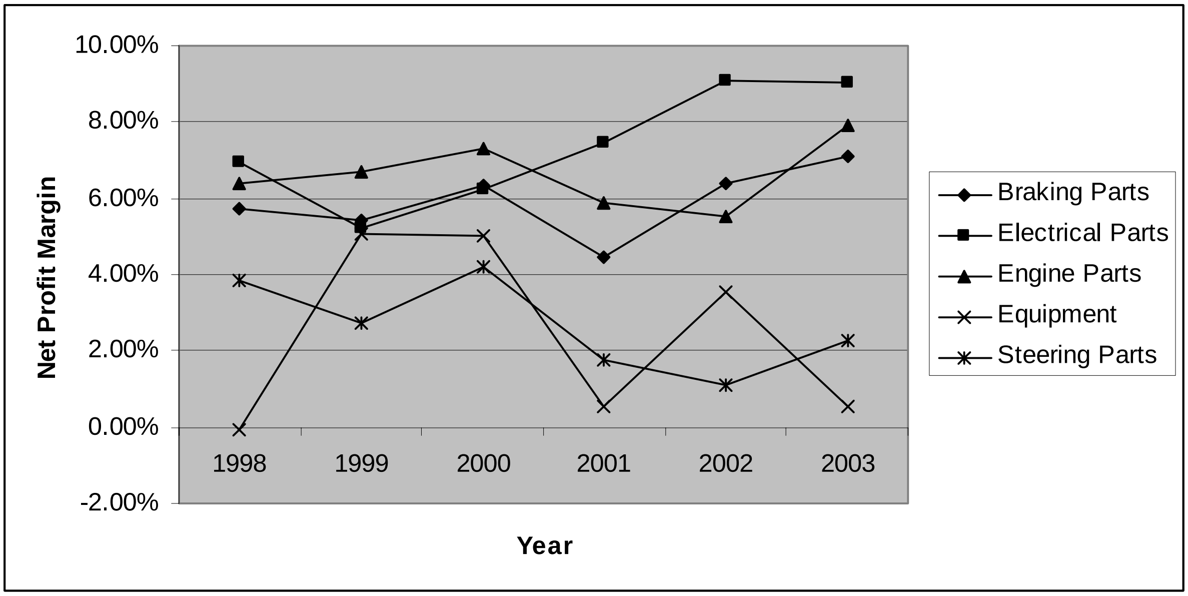
6. Profitability

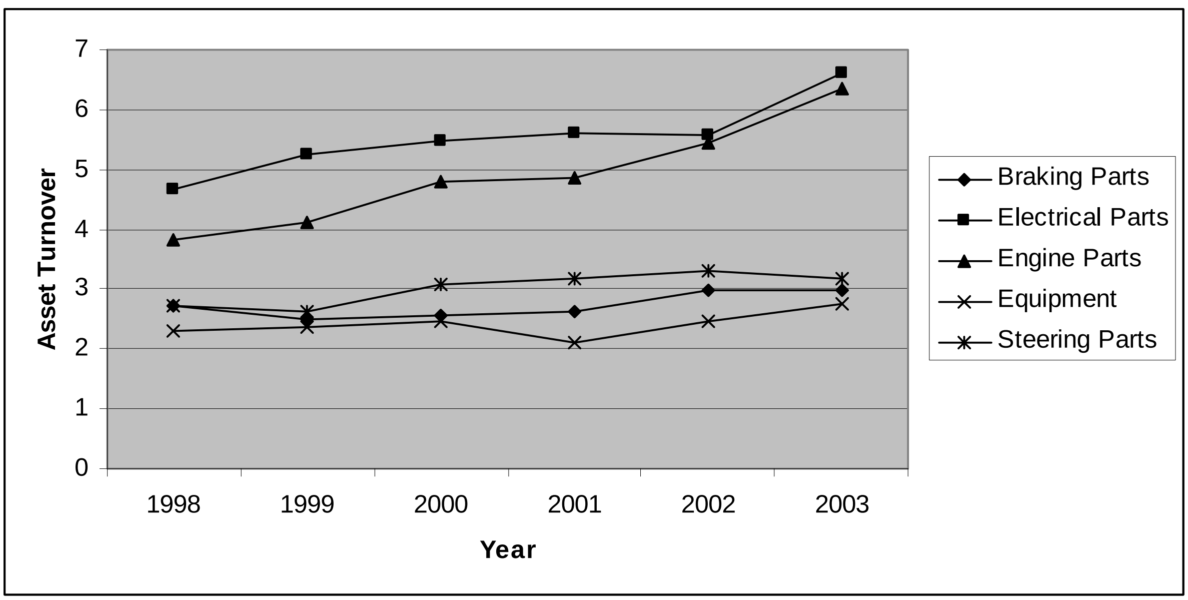
In this section, we examine the impact of productivity gains on profitability. We first focus on profitability by product segment. We also study if specific firm characteristics affected the nature and extent of gains. We present data in Figure 6.1 on the net operating margin (the ratio of operating profit to sales), net profit margin (the ratio of profit after tax to sales) and asset turnover for each product segment. The sample comprises 43 firms from the Center for Monitoring Indian Economy (CMIE) database. We eliminated all firms in this analysis for which data was missing for any item for any year.

Before performing any statistical analysis, we provide data regarding average performance of the industry segments as background information. The dataset used consists of 11 firms from the steering parts segment, 3 from equipments, 8 from engines, 5 from braking parts and 12 from others. The firms in the sample constitute 52.7% of industry sales.

Figure 6.1: Segment-wise Profitability measures







Source: Calculated from CMIE Prowess Data

The graphs presented above suggest that the net operating margin and the net profit margin have shown some improvement during the 1998-2003 period in sectors other than the equipment and steering parts segments. Asset turnover appears to have increased in all sectors. In order to further understand segment-wise profitability, we analyze price pressure by segment. The weighted price of a product in each segment can be computed using the sales ratios as weights. The effect of inflation on the weighted price is shown in Table 6.1. Significant price pressure is observed in the engine parts and the steering parts segments. In fact, output prices have not kept up with inflation, except in the electrical parts segment and suspension and braking parts segment**.** Therefore, the sustained financial performance despite the price pressures that we find should have come due to the increase in productivity.

Table 6.1: Weighted Price variation over time for each product segment

Year	1998-99 Actual price	2001-02 Actual price	Inflation adjusted 1998 –99 price	CAGR in adjusted prices	Share of market (%) in 2001-02
Engine Parts	1.824	1.868	2.11	-4	32
Electrical parts	3.14	4.416	3.636	6.7	17
Drive, Transmission and Steering Parts	15.028	15.59	17.396	-3.6	25
Suspension and Braking Parts	5.6	6.64	6.482	0.8	15
Equipment	3.644	4.156	4.218	-0.4	11

Source: Calculated from CMIE Prowess Data

Note: An inflation rate of 5% was used in these calculations

We also analyze whether specific firm characteristics affected the gains from quality and productivity improvements. The factors we consider are: age, which determines the degree of learning as well as technology; export orientation, i.e., a firms ability to reach out to global markets; size, a measure of a firm's scale; and overheads as a percentage of sales, an indicator of the operational efficiency and marketing aggressiveness. The performance indicators considered are: growth and operating margin. These were regressed separately against age of firm, exports as a percentage of sales, net sales, TFP growth (from Section 5) and overheads using the below model[12]:

$$Y = \alpha_1 + \alpha_2 (Age) + \alpha_3 (Export\%) + \alpha_4 SizeDummy + \alpha_5 (Overheads) + \alpha_6 (Segment) + \alpha_7 (TFPgrowth) + \varepsilon$$

The same sample comprising 43 firms was used for this regression. We performed an Ordinary Least Squares (OLS) regression on the average of the variables over the five years. The age of the firm was measured by the number of years since incorporation; export orientation by exports as a percentage of sales and overheads by the difference between PBDIT and Operating Profit as a percentage of sales. We divided firms into large and small depending on revenue, with the threshold chosen as $40 million so that it divided the firms into roughly equal subsets. We controlled for size and segment using dummy variables. We ran two models: Model 1 where we did not control for size and segment and Model 2 where we did. The reason for having these two models is to understand the significance of differences at segment level and size. The results are available in Appendix 1. We notice that the fit, as measured by the adjusted R-squared, improves considerably when we add the dummies.

The coefficients that are found to be significant (at the 5% level) are discussed below. In model 2, when growth is the dependent variable, the intercept is positive; the dummy variables for the steering part, engine and braking parts segment have a negative coefficient; the age and overheads have a negative co-efficient and TFP growth has a positive coefficient. When the dependent variable is the Operating Margin, the intercept, the dummy variable for electrical parts and the co-efficient on TFP growth is positive while the age again has a negative co-efficient.

We draw the following inferences regarding these effects. There is limited evidence that firm characteristics affected the performance on any of the two dimensions. Specifically, at the industry level, new firms with lower overheads have had higher growth rates on an average. The 'SizeDummy' variable is insignificant for both the performance indicators, which implies that there may be no size effects. These results, taken together, suggest that new firms were able to grow faster in this environment, i.e., it did not make a difference whether they started big or small. We conjecture that this could be due to the introduction of new technology that became available with the opening up of the Indian economy.

7. Comparisons between India and China Industry Performance

The analysis in the previous sections was focused only on Indian firms and does not provide insight into the Indian auto supply chain's competitiveness. We use available data sources to compare the Indian auto industry segments' performance with that of China on parameters such as exports, efficiency, cost of raw material, labor cost, etc. Though many options exist for choosing a suitable country to benchmark against (such as Mexico, South Korea, etc), China was considered appropriate due to the similar size (GDP as well as workforce) and due to the increased attention both economies have been receiving[13]. Moreover, China is a premier destination for manufacturing outsourcing.

China is the bigger market for cars (2.5 times larger than India), but, the fragmented nature of the market in China might offset the size advantage. Maruti, Hyundai and Tata

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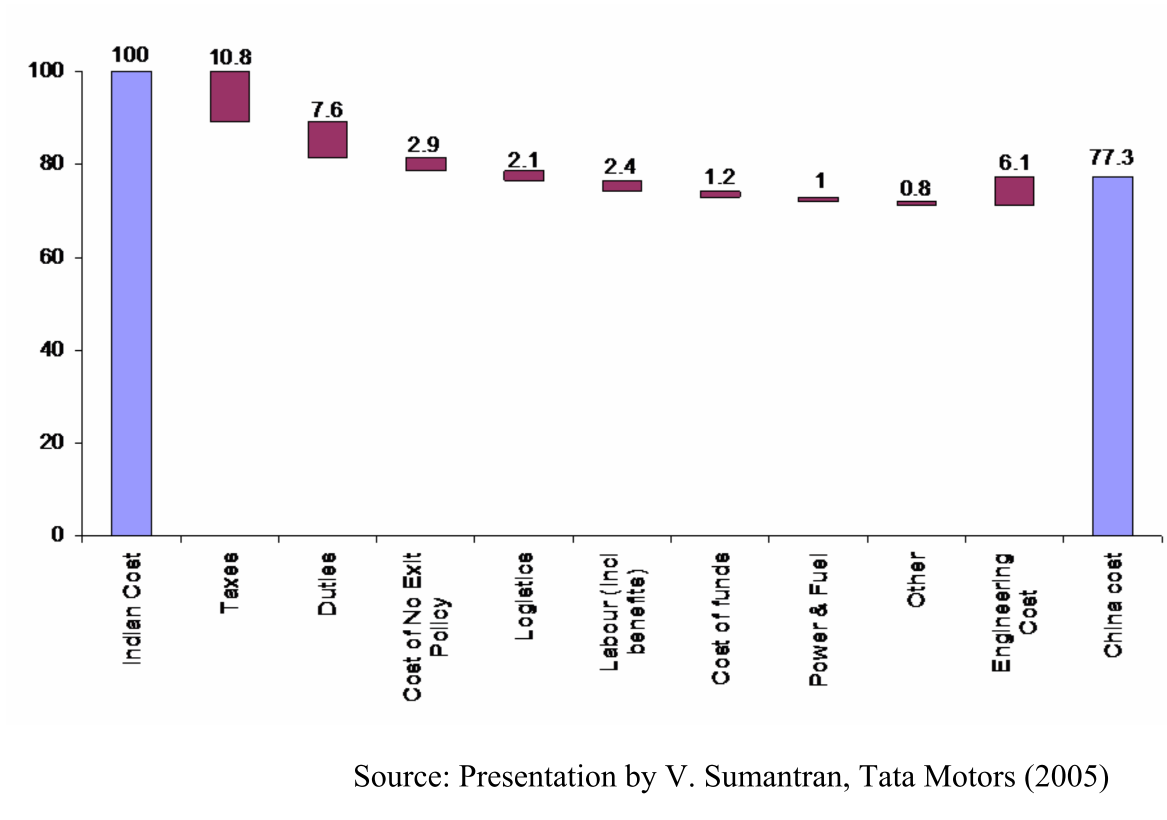
[12] While it may have been interesting to understand the interaction amongst the above variables, alternative specifications including such interaction terms posed significant multicollinearity issues.

together account for 85% of the market share in India, in comparisons to the share of the top three sedan makers in China, which is 46% (VW, GM, and Honda). Further, our analysis in Section 6 showed that size has little effect on the profitability of firms in India. Surprisingly, India exports more cars than China at this stage.

7.1 Cost structure

The total cost for an Indian auto component firm is significantly higher (Table 7.1)[14]. The primary cost differential between the two countries is due to country-specific costs, such as taxes, duties and government policy. Firm specific costs, such as labor and logistics are higher in India, while lower engineering costs provide a cost advantage for Indian manufacturers. Thus, controlling for country-specific costs, and given India's late development of the automotive sector, we conjecture that the cost in India may fall substantially as learning takes place. Some of the major cost factors are discussed below.

Table 7.1: India/China cost differences



Source: Presentation by V. Sumantran, Tata Motors (2005)

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[13] India: Realizing BRICs Potential

[14] Similar figures were reported by ICRA in their final report on the Competitiveness of the Indian Automobile Industry, January 2003, submitted to ACMA. Therefore, there is reason to believe that the presentation goes beyond a domestic auto manufacturer making a case for reduction of taxes and duties.

Cost of capital: One of the handicaps faced by Indian manufacturing has been the relatively high cost of capital. Between 1997 and 2000, real interest rates on the average five-year loan in China fell from 7.8 to 4.9 percent, whereas in India they rose from 6.4 to 7.8 percent (Morgan Stanley report) (due to a decline in the domestic inflation rate). Since 2000, however, the trend has reversed due to several cuts in the administered interest rates in India. For the first time, real interest rates in India are lower than that in China. The effects of this are dramatic: "Every 10 percent fall in interest rates leads, on an average, to a 30 percent increase in profits before tax for larger Indian corporations"[15].

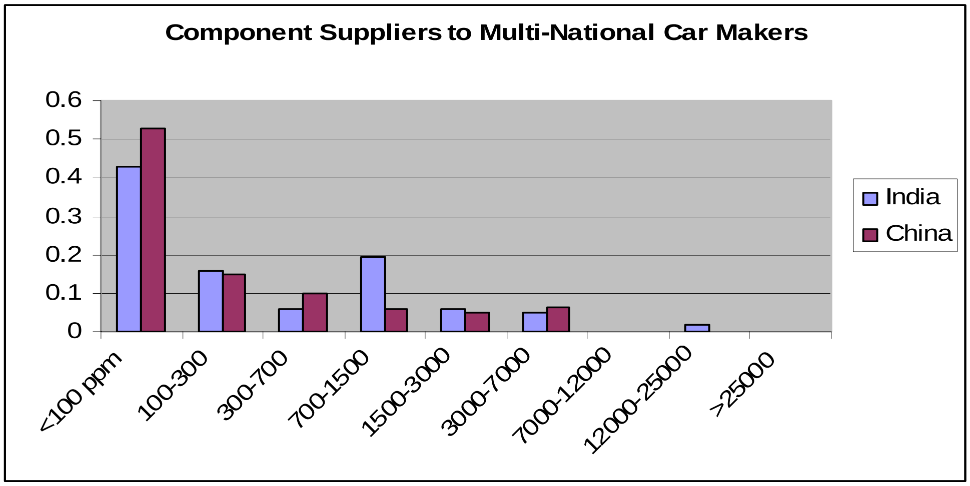
Power and Infrastructure: The cost of power is lower, by 30-40 %, in China. With regard to transportation, according to an ICRA (2004) report, the transit time to the US is 2-3 weeks for China while 6-12 weeks for India. We believe that these shortcomings are due to the lack of quality infrastructure in India. This might take considerable time to improve given the trade-offs faced in budgeting for such improvements.

Tariffs: The ICRA (2004) report estimates that taxes contribute an additional 10.8 % to the cost of cars in India compared to China. The other major cost factor is import duty on raw materials (7.6%). However, both these will be withdrawn for export only units. A similar statement holds for components, for which about 13-14% out of the 18-19% difference in costs arises due to duties and taxes. The Indian government gives duty drawbacks for export-oriented units; therefore, tariffs are not a major factor for fully export-oriented firms. On the other hand, taxation of components for domestic consumption might continue if past trends are an indication.

Supplier Quality: International best practices for carmakers in US, Japan and Europe aim to bring the large majority of their suppliers under 100 ppm. The distribution of defects observed (Figure 7.2) confirm the view that many first-tier suppliers to the newly arrived carmakers in India and China are already operating close to world-class standards. This report was developed based on a survey of nine car manufacturers in China and six in India, a range of general car manufacturers in both countries and on a detailed benchmarking study of six seat producers and six exhaust suppliers in both countries.

[15] Raja Loll, Managing Director, Warburg Pinkus.

Figure 7.2: Distribution of defect rates in India and China



Source: Sutton (2004)

An ICRA report (2004), further substantiates Sutton's view that with regard to quality, there are no significant differences between India and China. Our interviews with managers and quality tracking surveys suggest that China might be slightly ahead in some areas but, more importantly, both countries are behind world standards, though, as stated earlier, many first-tier suppliers are already operating close to world-class standards.

Government Policy: Under India's (2002) policy there is no minimum investment norm. In contrast, China's (2004) policy requires 100 percent foreign direct investment (FDI) in the automobile and component sectors under the automatic route[16]. The new Chinese auto policy retains control over foreign auto majors and imposes restrictions on imports of foreign-made cars. For instance, there is a restriction on the number of ports that can be used to import vehicles and restrictions on distribution channels for imported and locally made cars. The new agenda is intended to drive consolidation in the fragmented Chinese auto industry. In India, auto OEMs face different pressures. The government made it mandatory for any foreign manufacturer entering India to achieve 50% local content within three years and 70% by five years (ICRA, 2004). Otherwise, both governments seem to have been supportive of this industry.

In summary, the primary cost differential between the two countries is due to country-specific costs, such as duties and taxes. Firm specific costs, such as labor and logistics are

[16] Chinese companies can accept foreign investment under the automatic route without obtaining prior approval from the central bank or the government.

marginally higher in India while lower engineering costs provide a cost advantage. Despite a ten-year disadvantage in start-up and costs that are beyond the control of the firm, the auto sector in India seems to be competitive with China on all firm specific factors. This is consistent with our finding that the entire sector has improved on quality, delivery, productivity and financial performance metrics.

8. Discussion and Conclusions

Our study suggests that the entire Indian auto-component sector has improved on multiple fronts. Most firms have adopted TQM practices, resulting in quality and delivery improvements. Accordingly, there has been an increase in productivity and profitability. Surprisingly, these changes have occurred in a short time and for almost every firm, with greater productivity improvements taking place during the 1998-2003 period. From an operations strategy perspective, we interpret these to suggest that firms have succeeded in taking the first step towards becoming more competitive. This period of change can therefore be viewed as one of transition, wherein firms reinvented themselves without massive influx of new capital or technology (Roth (1996a, 1996b)).

We believe that quality gains preceded the improvements along other dimensions. We arrived at this conjecture based on interviews with executives at several firms. As mentioned before, the firms were taking a rather risky first step by investing in quality when the economy opened up. If they had taken a long time to achieve their goals, foreign component manufacturers could easily have established themselves in India aided by their access to the latest technologies as well as to global markets. However, if quality improved rapidly, then the risk of becoming noncompetitive would be somewhat reduced. This would require, apart from other things, trading-off short-term profits for long-term survival.

We suggest that the strategy paid off due to two main reasons: there was a rapid increase in the demand for cars in India following liberalization of the economy and, as anticipated by theory developed by Ferdows and DeMeyer (1990) and Roth (1996), productivity and profit gains followed quality improvements. The combination provided big dividends not only in terms of better quality and productivity improvement (in later years) but also higher margins applied to larger volume.

There are some intangibles that could have contributed to the evolution of the strategy, two of those mentioned in several interviews are that many firms that invested heavily in this sector were family owned – thus a common strategy could have been adopted, and also the then major Indian car maker, Maruti, might have forced this transition. We are unable to assess the contribution of each of these factors towards the emphasis on TQM.

As stated earlier, this is only the first step towards getting competitive. In 2006, despite having fought off the entry of new firms that possessed the latest technology and had access to global markets with some success, the auto-component supply chain in India finds itself at a crossroad. Firms could now change direction from a pursuit of cost reduction and quality improvement to more diverse strategies, specifically; those that are supply chain oriented.

Firms that are tightly integrated with OEMs could continue the TQM approach but choose to elevate their partnerships through closer collaboration, such as, in product design and process engineering. They could also look across the border to China for sourcing components. In this regard, Sundaram Clayton from India has recently established a unit in China to tap into the manufacturing strengths of that country and JK Tires, the largest tire maker in India, imports tires from China for sale in India.

Firms that are less tightly tied to OEMs but have access to the latest technology could try to increase exports by capitalizing on their low volume, high variety, and low cost manufacturing capability. Bharat Forge in India has successfully pursued this strategy by acquiring firms in Germany and the United States to become the second largest maker of forged products in the world. Several other firms have recently announced their intentions to increase their global footprint through acquisition.

Meanwhile, the global tier 1 suppliers could see the developments as an opportunity to tap into the talent pool and set up manufacturing hubs in India. Delphi and Visteon have set up their units in India. OEMs could follow the example of Hyundai and decide to make India the global hub for the manufacture and exports of small cars. It also remains to be seen whether OEMs will adopt a Greenfield strategy or link up with Indian firms. Toyota has linked up with Kirloskars, India, for manufacturing gearboxes and cars in the state of Karnataka, whereas, Hyundai has brought its suppliers into India in advance of its entry into the market.

We thus believe that the Indian auto component supply chain presents a fascinating case study of firms at crossroads that may have to face intense competition from global

OEMs and suppliers. In response, they have to decide whether to pursue business as it is but emphasize even greater collaboration in the supply chain, grow their demand in global markets independently, join a global supply network, or develop more complex products and design capabilities to further differentiate themselves. The decisions will depend on:

a) How soon will the supply chain quality, delivery, and productivity reach world-class standards? This will, of course, depend on how steep the learning curve is and how government policies will play out with regard to technology transfer and local content.

b) What will be the globally competitive product mix and quantity that will be manufactured in India, to satisfy demands in Asia and elsewhere?

c) Finally, will the size of the domestic market evolve to the extent that it is attractive to auto manufacturers to purchase or make parts and/or cars in India in large quantities?

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Appendix 1: Regression Results (standard errors are presented in parentheses)

	Growth		Operating Margins	
	Model 1	Model 2	Model 1	Model 2
Intercept	30.98* (5.5195)	38.961* (5.282)	0.088* (0.029)	0.098* (0.032)
Steering	-	-17.954* (4.977)	-	0.008 (0.030)
Electrical	-	-7.118 (10.455)	-	0.129* (0.064)
Engine	-	-25.376* (6.338)	-	0.029 (0.039)
Equipment	-	-12.876 (8.216)	-	-0.066 (0.050)
Braking	-	-17.032* (6.357)	-	0.021 (0.039)
Existence (Age)	-0.371* (0.139)	-0.310* (0.132)	-0.001 (0.000)	-0.002* (0.001)
Size Dummy	-	3.283 (4.936)	-	0.0196 (0.030)
Avg exports %	19.3 (22.83)	19.352 (22.764)	0.092 (0.121)	0.116 (0.140)
Overheads%Sales	-24.68 (17.45)	-31.856* (15.815)	-0.037 (0.093)	-0.029 (0.097)
TFP Growth	85.040* (39.655)	90.161* (33.516)	0.408 (0.210)	0.458* (0.206)
Adjusted R Square	22.82%	46.52%	12.25%	17.61%

Note: * significant at 5% level.