1-1-2004

Indian Auto Supply Chain at the Cross-roads

Karthik Balakrishnan
New York University

Ananth Iyer
Purdue University

Sridhar Seshadri
New York University

Anshul Sheopuri
New York University

Indian Auto Supply Chain at the cross-roads

Karthik Balakrishnan*, Ananth Iyer**, Sridhar Seshadri*, Anshul Sheopuri*

*Stern School of Business, New York University, 8-73, KMC, 44 W. 4th St., New York, NY 10012

**Krannert School of Management, Purdue University, West Lafayette, IN 47907, aiyer@mgmt.purdue.edu

** Corresponding author

Abstract

We focus on the auto industry supply chains in India. The Indian auto industry is small in size, compared to the world markets ($ 6.73 billion compared to a world market of $ 737 billion) but has experienced a growth rate of 20-25 % the past few years. Over 13 Indian companies have won the Deming prize and quality has improved significantly. We focus on empirical data in this industry and explain the seemingly counterintuitive trends such as falling margins, no distinct financial advantage for the Deming firms and, in some cases, declining total factor productivity. We then compare the Indian auto industry to the industry in China, which provides an interesting contrast. We conclude with some insights regarding the future of the Indian auto industry – which is an industry at the crossroads.

1. Introduction

We study the evolution of the auto-ancillary supply chain in India using a combination of firm product specific data measures, firm level performance, industry performance, global best practice data and country comparisons with China. Our goal is to assess the current state of the industry and identify both the potential and the management realities associated with developing globally competitive auto supply chains in India.

We use empirical data and anecdotal information to offer our best guess answers to the following questions: Will the future of the Indian automobile industry be that of a globally competitive car producer that can offer quality at a competitive price point? Will the industry mainly compete at the component level, focusing on design intensive and process intensive engineered products? Will the domestic car market provide sufficient incentives for foreign suppliers and OEMs? How are these trends influenced by infrastructure investments in India, the impact of China, and world commodity price levels? How will the Indian government policies affect the development of these supply chains?

A quick summary of our analysis suggests some intriguing and initially counter intuitive results: (1) The quality movement and the associated adoption of lean manufacturing techniques have been extremely successful in the Indian industry. Table 2.1 shows that currently, there are (as of September 2004) 13 Indian companies that have won the Deming prize. However, our analysis shows that none of these firms show any improved financial benefits over the rest of the industry (consisting of non Deming award winning companies in India in that industry). Given this data, how do we interpret the impact of such quality improvement initiatives? (2) Any understanding of the auto components industry has to focus on component type such as transmissions, engines, braking components etc. An analysis of the price pressure by segment shows that for many segments, margins have decreased in recent years. In addition, a total factor productivity analysis by segment shows decreasing productivity across the precise period that volumes have risen. How do we reconcile these findings? (3) Any focus on firm level growth has to consider firm size as we understand industry evolution. Analysis by firm size (large versus small segments), and by product segment, reveals that newer firms that have the benefit of size have shown the most improvement in recent years. Also, an export oriented strategy shows limited benefits in general. (4) Finally, despite higher raw material costs, higher energy costs and poorer infrastructure in India, multinational OEMs that have entered the Indian market have managed to produce cars that have high local content and are sold at competitive retail prices. In many cases, the delivered retail price of a car in India is 50 % of the price in China. In addition, the Indian car companies operate at lower profit margins. Does this suggest that the Indian car industry is more economically viable than that of China? Is the car volume mix in India more reflective of the steady state than the mix in China?

1.1 The Indian Automobile Industry – A quick data survey[1]

The Indian automotive components industry's annual turnover (for FY 2003) was US$ 6.73 billion. When compared to the global automotive components industry of US $737 billion, the Indian industry dwarfs in size. But, at a compounded growth rate of 20-25 %, the growth in India's auto components exports is much faster than that of the domestic market (10-14%). Many consider this growth in exports as just the tip of the iceberg similar to that witnessed by the information technology industry in the early 1990's. The auto ancillary industry caters to three broad categories of the market:

1) Original equipment manufacturers (OEM) or vehicle manufacturers, that comprises of 25% total demand
2) Replacement market, that comprises 65% of the total demand
3) Export Market, that comprises primarily of international Tier I suppliers and constitutes 10% of total demand

The auto ancillary industry can be further divided into six main segments:

1) Engine Parts - Engine assembly, fall into 3 broad categories: core engine parts; fuel delivery system; and others. This also includes products such as Pistons, Piston Rings, Engine Valves, Carburetors, and Diesel-based Fuel Delivery Systems. This by far is the most critical component and requires high involvement from the supplier.
2) Electrical Parts - The main products in this category include starter motors, generators, spark plugs and distributors.
3) Drive Transmission & Steering Parts- Gears, wheels, steering systems, axles and clutches are the important components in this category.
4) Suspension & Braking Parts – These include Brakes, Leaf Springs, Shock Absorbers
5) Equipment – This includes headlights, Dashboard Instruments
6) Others - Sheet metal components and plastic molded parts are two of the major components in this category.

The charts below, Figures 1.1.1-1.1.3, show the growth of sales, exports, and profits for these segments over the period 1998-2003. The different segments show similar trends, however, there are differences in the cost structure as well as the productivity improvements amongst these segments. The major factors influencing growth and profitability in these segments are listed below. Detailed cost and productivity analysis of the segments is presented later in this section.

[1] The data for this section has been collected from CMIE Prowess and ICRA 2004

Figure 1.1.1: Indian Auto Ancilliary Industry Profits

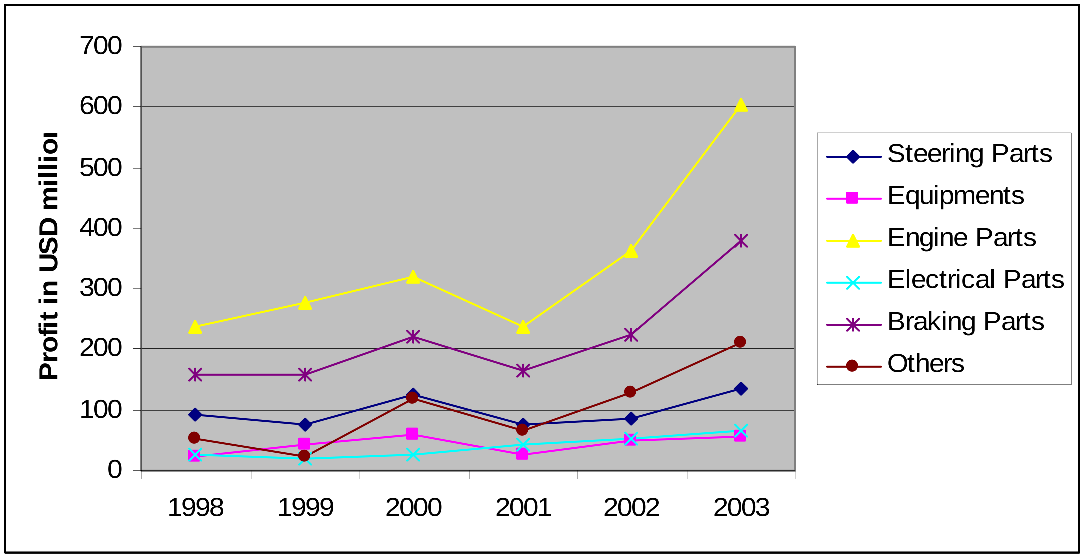


Figure 1.1.2: Indian Auto Ancilliary Industry Sales

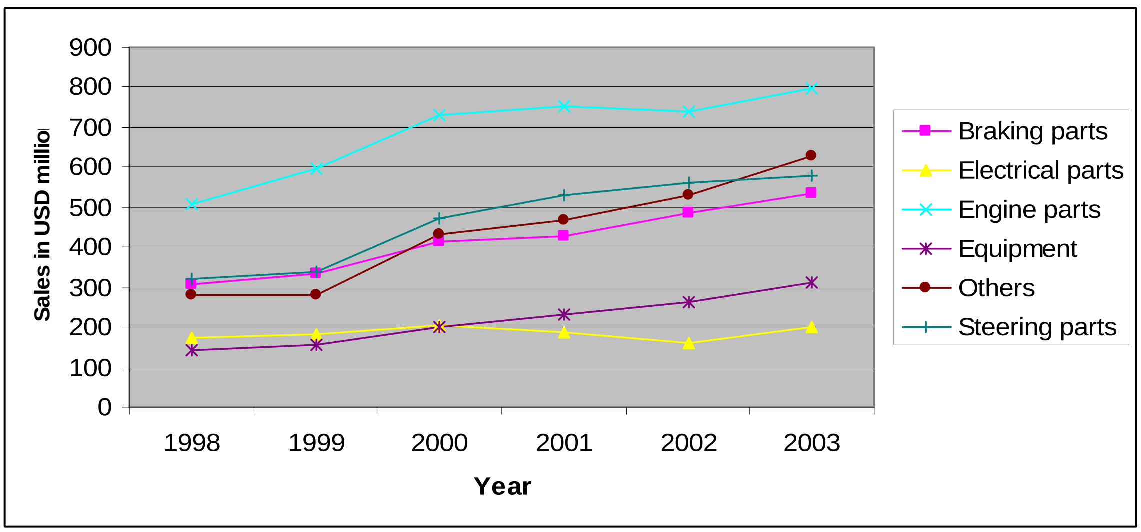
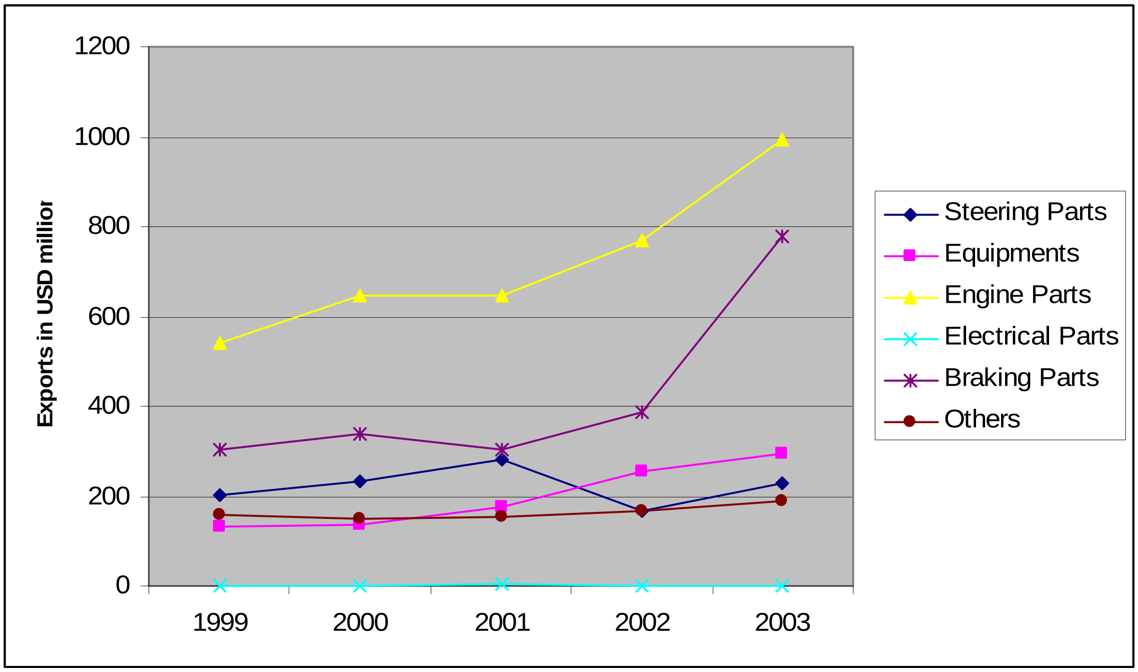


Figure 1.1.3: : Indian Auto Ancilliary Industry Exports



The Engine Parts segment is technology and capital intensive and is likely to be dominated by the existing major firms in the short to medium term. Engine technology is expected to move towards superior design (for optimal fuel consumption and lesser emission), thus access to such technologies will be limited to existing major firms. On the other hand, this is the most labor intensive segment (see Figure 1.1.4) and holds promise for growth of exports.

Starter and generator manufacturers form a major part of the electrical parts segment. The products are directly attached to the engine, which in turn is assembled mostly by the vehicle manufacturer, given the engine's criticality in vehicle performance. Besides the increasing popularity of electronic ignition systems, the increasing electronic content per vehicle has provided growth opportunities for companies in this segment. Many multinational companies are strengthening their position here, because of the opportunity to introduce new technology.

Among drive transmission and steering parts, the steering systems are among the critical components of a four-wheeler. The capital and technology intensive nature of the segment acts as an entry barrier for companies in the unorganized segment. As power steering systems reduce driving effort considerably, these are being increasingly preferred by OEMs, which in turn is prompting manufacturers to shift their product mix towards such steering systems. Access to technology and localization of production for power steering components are factors that impact the ability of local companies to withstand increasing competition and cost pressures from OEMs.

The demand for gearboxes is primarily linked to the demand for passenger cars. The gearbox segment is currently witnessing a tierization of the supply base. Since gear boxes require high precision engineering, and the establishment of a manufacturing unit calls for significant capital investments, quite a few companies in the passenger car segment rely on imports of knock down assemblies of gearboxes. The clutch segment the OEM market is expected to be dominated by a few players, with technology, and ability to supply complete assemblies, being critically important.

Axles are critical components of a vehicle, the capability to design and offer products to meet exact engine specifications is a key success factor. Also, high capital requirements and technical know-how may act as an entry barrier in this segment, thus leading to the likely concentration of market among a few players. Although some of the OEMs source complete assemblies, a large number of them still source individual components, like housings, shafts and differentials, from various vendors. However, over time, it is expected that OEMs will source complete axle assemblies from one or two vendors rather than individual components like housing, shafts and differentials from various vendors.

The brake system has a high replacement value and is not very technology intensive. As a result, the companies in this segment continue to maintain a diversified customer base in both the replacement and OEM segments (apart from exports). In addition, in this segment, there is the threat of further tierization as the present Tier I suppliers (brake assembly suppliers) could be relegated to the Tier 2 position. Currently, brake assembly suppliers supply and deal with the vehicle manufacturers directly. However, in the emerging structure, companies like Delphi have started outsourcing brake assemblies from Tier I suppliers, integrating them with front-end suspension parts, and then supplying whole units directly to OEMs.

In the equipment segment, the head light segment is perhaps the only one that is not directly related to automotive technology. Interestingly, leading companies in this segment have initiated innovative measures to improve their responsiveness to OEM customers. In addition, the existing market leaders are expanding and upgrading their facilities to meet the needs of the new car manufacturers. The head light segment also has considerable export potential. Currently, exports account for about a fifth of the total demand for head lights. For the replacement market, companies are likely to focus on distribution network, brand image, product portfolio and pricing policy. It is clear that the prominent threats are of tierization and technological obsolescence. These reflect the rapid increase in demand for more sophisticated cars within India.

Cost Structure

The cost structure in the auto ancillary sector is shown below. It is clear that any analysis of the cost should focus on material cost, labor cost and other manufacturing costs.

Table 1.1.1: Cost Structure in the auto ancillary sector

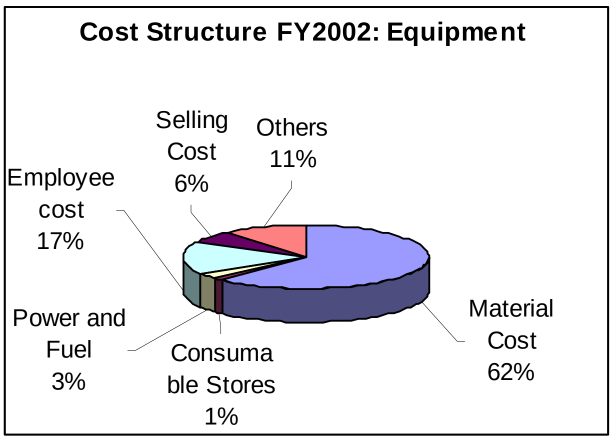
Cost Item	%
Material Costs	51.3
Power & Fuel	3.8
Employee Costs	12.5
Other Mfg Expenses	6.9

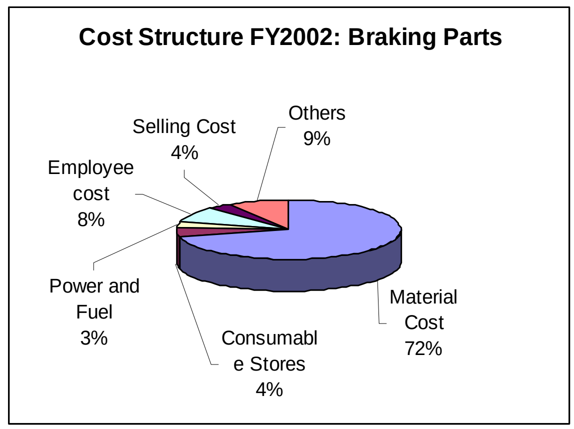
Selling expenses	3.3
Interest & Finance Costs	3.6
Depreciation	6.4
Tax	2
OPBDIT Margins	15.3
NPM Margins	4.2

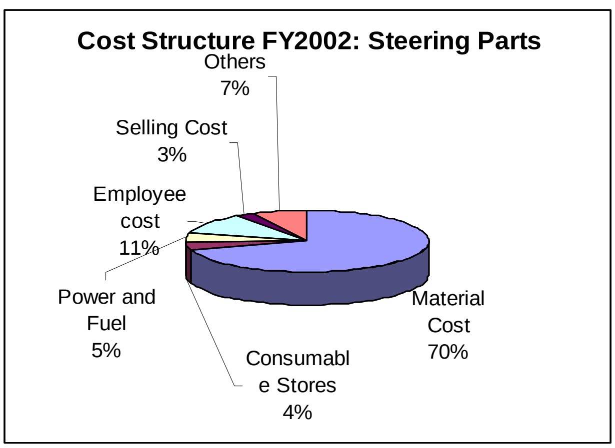
As % of Operating Income; Source: ACMA

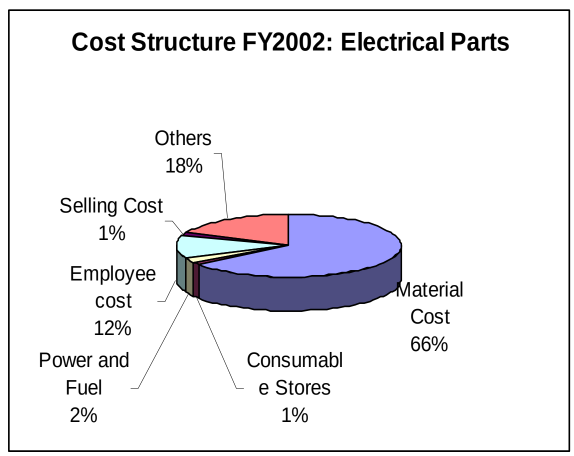
The segment-wise cost break up is shown below:

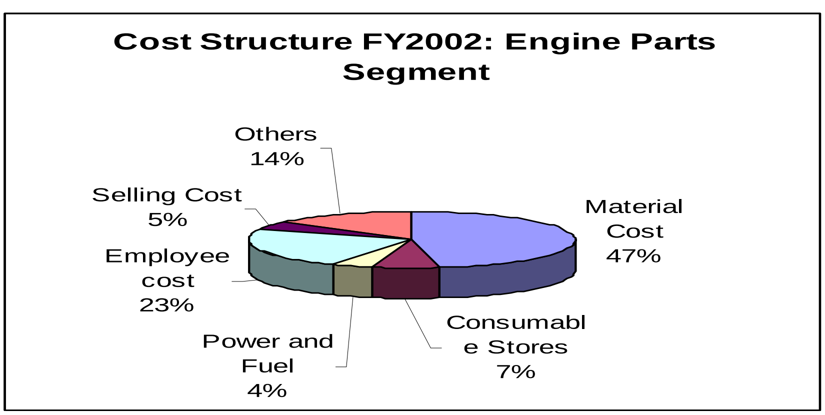
Figure 1.1.4: Segmentwise Cost Structure in the auto ancillary sector











It is evident from the Figure 1.1.4 that for the engine parts segment, the employee costs as a fraction of total cost are higher than for other segments, indicating the complexity of the activity. This plays an important role in explaining the total factor productivity trends, described later.

Exports

India exported 15% of its production of cars (120,000 units in 2004), as shown in the Table 1.1.2 below. The surge of exports of cars from India suggest that the auto industry in gaining in global competitiveness, at least in the small car segment:

Table 1.1.2: Indian Car Exports (number of units)

	2000-01	4/02-1/03	04/03-1/04
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
% of total	3.9	7.4	13.1

1.2 Paper Outline

This paper analyzes how the supply chain has evolved in maturity and sophistication, discusses measurable indices of this success, and capabilities that drive these shifts. The analysis comprises the following three parts: We first trace the response to market and economic forces. This is followed by an in-depth analysis of the chain on the dimensions of cost, quality, productivity and firm structure. Then, we evaluate the performance of the sector in the context of increasing its market share in the global auto supply chain. We present alternative strategies currently pursued by individual players in the chain, and comment upon the rewards and pitfalls of these strategies.

There are a number of papers that have used empirical approaches to understand industry supply chains. Randall and Ulrich (2001) study product variety and supply chain structure in the US bicycle industry. Terweisch and Loch (1999) measure the effectiveness of overlapping development activities by studying development projects in global electronics industries. Raman, DeHoratius and Ton (2001) discuss the impact of execution in retail operations. Rajagopalan and Malhotra (2001) study if US manufacturing inventories have really decreased. Corbett (2003) and Corbett et al (2002) study the impact of ISO certification on firms and supply chains. Gaur, Fisher and Raman (2004) study inventory turnover in retail stores. Our goal is to contribute to this literature by providing an empirical study of the Indian auto supply chains.

In the next four sections, we analyze the Indian Supply Chain on metrics such as quality, profitability and productivity. The goal of the analysis is to pull together company specific performance data in order to understand industry trends. We first examine the impact of recent successes among auto component firms that have won the Deming prize (awarded by JUSE – the Japan Union of Science and Engineers). We then focus on price pressures by industry segment. Finally, we use a total factor productivity analysis to understand productivity changes in the industry.

2 Quality

Firms in the auto sector have made significant advances in quality over the last 10 years. This is evidenced from the fact that 13 Deming awards have been won by Indian firms (refer Table 2.1). This is the largest number of firms from any country outside Japan that have won this award.

Table 2.1 Deming Award winners list (1998-2004)

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
SRF Limited, Industrial Synthetics Business	2004
Lucas-TVS Limited	2004
Indo Gulf Fertilisers Limited	2004
QUALITY CONTROL AWARD FOR OPERATIONS BUSINESS UNITS	
Hi-Tech Carbon GMPD (India)	2002
Birla Cellousic, Kharach-A Unit of Grasim Industries Ltd. (India)	2003
JAPAN QUALITY MEDAL	
Sundaram-Clayton Ltd., Brakes Division (India)	2002

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

According to conventional understanding, this rapid change should have resulted in better bottom line performance. For example, Hendricks and Singhal (1997) and Hendricks and Singhal (2001) document the performance of firms with effective Total Quality Management (TQM) programs. In Hendricks and Singhal (2001), they follow an event-study approach to indicate that an effective implementation of TQM principles and philosophies leads to significant wealth creation.

We now focus on the Indian auto component firms that have won the Deming prize (we call this the sample firm) and contrast their financial performance with that of a control group (of Indian firms). We use all companies in the particular segment as the control group. We divide performance metrics into two sets: one set that accounts for the past performance of the firm and the other that reflects the future prospects. Return on capital employed, cost of production, asset turnover and inventory turns form 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, need not be normalized. Inventory turns is defined as the ratio of revenue or cost of goods sold and average inventory held during the year. Asset turnover is defined as the ratio of sales to assets. Improvements in these metrics are the possible benefits of a quality program.

For measuring firm performance, we compute the average year-on-year change for the control group for each metric and subtract this from the year-on-year change of the sample firm. A positive value in each year will indicate that the firm has outperformed the control group every year. The changes have been plotted as charts in *Appendix 1*. It can be observed that the values fluctuate on both sides of zero indicating that the firms have not outperformed the control group. In order to check if these fluctuations are purely random we perform Run Tests (Stevenson 1996). 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, we cannot dismiss the hypothesis that the changes are purely random[2].

What does the analysis suggest? We see that none of the Deming companies have outperformed the control group significantly and consistently with respect to the past performance. In addition, we calculate the correlation between the profit to earnings ratio (P/E) of the firm and that of the control group (Table 2.2). We observe that the firm performance seems to be strongly correlated with the industry segment performance. This suggests that the quality successes have not translated into significantly different performance than the rest of the industry.

Table 2.2: P/E: Correlations with control group

Sundaram Clayton	0.953
Rane	0.996
Sona Koyo	0.696

Discussions with senior quality managers in auto component companies reveal that one of the very first conditions that MNC OEMs set out for Indian auto component companies in the late nineties was the need to conform to internationally recognized standards within three years. According to ACMA, at present, there are 337 Indian companies (not all in the auto sector) in the organized sector who have obtained ISO 9000 certification; 93 companies with QS 9000 certification and 25 companies with TS 16949 certification. A number of companies are also simultaneously embarking on a Six Sigma program in order to reduce defects and delays in their processes, drastically. All these initiatives have resulted in a perceptible increase in quality levels of auto component industry as a whole. Customer Satisfaction Tracking Surveys[3] conducted during FY2002, FY2004 for 68 companies form the basis of the below data on Quality

[2] For brevity, the results of the run test are not provided in this paper.
[3] Conducted by Ramnath Management Consultants, Chennai, India.

Metrics. The study also reveals that, as a result of Quality Initiatives that the industry majors have undertaken since the late 1990s, the Quality Metrics have improved significantly over the last few years for the industry as a whole (Refer Table 2.3).

Table 2.3: Quality Performance of the auto-component industry

2001	2003
Process conformance through Quality Certifications	Process Improvements through Quality Initiatives like TQM, TPM, Six Sigma
Customer (OE) Line Rejections 1000 plus ppm	Customer (OE) Line Rejections 100 – 400 ppm
Rework 3 – 5%	Rework < 1%
First pass yield < 80%	First pass yield 95 to 97%
OEE 70 to 80%	OEE 90 to 95%
Warranty > 95%	Warranty 500 – 2000 ppm

Source: Customer Satisfaction Tracking Surveys

Delivery parameters are linked to Supply Chain (SC) metrics of an organization. It was, again, the entry of the MNCs that heralded a paradigm shift in the way supply chain was thought of and implemented in India (Refer Table 2.4). Today, all the automobile OEMs demand (JIT) supplies and daily milk runs and the use of third party logistics (3PL) for component supplies have now become commonplace. The result is that OEMs no longer maintain large stocks of components / raw materials but instead leave it to their suppliers to ensure that there is a smooth flow of parts in the logistics pipeline.

Table 2.4: Delivery Performance of the auto-component industry

2001	2003
Functionally oriented delivery mechanisms	Integrated Supply chain Systems
OEMs maintained raw material & components inventory at their end	Stocks maintained by suppliers to service OEMs Just In Time (JIT) systems
Component suppliers used "push" systems - minimum batch quantity	Component suppliers use Kanban, Bin Systems - "pull" system
Key Delivery Metrics: OTD - OEMs: 70 to 80% JIT Adherence: 80 - 90% Milk Van Residence Time: 60 mins	Key Delivery Metrics: OTD - OEMs: 90 to 100% JIT Adherence: > 95% Milk Van Residence Time: 30-45 mins

Source: Customer Satisfaction Tracking Surveys

How do we interpret this data? We suggest that the net effect of the TQM successes is that quality, in the Indian auto parts industry, is now considered a hygiene factor and that effective quality programs have changed the industry frontier. Thus, while the Deming firms improved, the data above shows that the industry overall also improved significantly. In addition, in the late 90's, there was a severe downturn in the Indian economy with a large amount of slack capacity. Quality related improvements were thus passed on to buyers in the form of lower prices, leaving margins unchanged. We believe that this was *not* necessarily bad. We suggest that these changes that improved quality without raising prices permitted foreign OEMs to enter the Indian market, create cars with high local content and be price competitive. Table 2.5 below shows the local content of several foreign car manufacturers in India. It also enabled OEMs such as Hyundai to successfully produce cars in India for export markets within five years of entering the Indian market. While our conclusions require rigorous testing, our interpretations have been confirmed by interviews with Indian industry insiders who echo our conclusions.

Table 2.5: Local Content in foreign cars

Car Brand	India Local Content %	Volume - Cars Sold in 03-04	Exports 03-04
Ford Endeavour	20%	1110 (From Dec 03)	24,000
Ford Ikon	90%	20,881	
GM Travera	85%	Launched only in May 04	0
Honda Accord	30%	2,109	131
Honda City	34%	18,384	
Hyndai Elentra	40%	Launched only in April 04	42,115
Hyndai Santro	90%	1,00,017	
Mahindra Scorpio	almost 100%	23,976	Not Available
Maruti 800, Alto and Wagon R	90%	4,72,122	50,247
Tata Indica	100%	80,205	8,895
Toyota Corolla	50%	9,547	Not Available
Skoda Octavia	40%	5,950	Not Available

3. Profitability

We next focus on the profitability of the firms by product segment. We focus 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.

Table 3.1:Segment-wise Profitability measures

Steering Parts						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	7.46%	6.72%	7.97%	5.72%	4.72%	5.82%
Net Profit Margin	3.87%	2.73%	4.20%	1.74%	1.12%	2.26%
Asset Turnover	2.71	2.64	3.07	3.17	3.31	3.16

Equipments						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	6.11%	6.79%	6.63%	3.98%	7.33%	4.03%
Net Profit Margin	-0.08%	5.06%	5.00%	0.54%	3.55%	0.55%
Asset Turnover	2.29	2.36	2.47	2.12	2.45	2.75
Engine Parts						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	7.60%	7.91%	9.20%	7.53%	7.20%	11.72%
Net Profit Margin	6.39%	6.68%	7.30%	5.90%	5.54%	7.89%
Asset Turnover	3.82	4.10	4.79	4.87	5.44	6.35
Electrical Parts						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	10.35%	8.57%	8.76%	11.76%	11.08%	11.50%
Net Profit Margin	6.93%	5.22%	6.24%	7.45%	9.08%	9.01%
Asset Turnover	4.67	5.24	5.49	5.62	5.57	6.62
Braking Parts						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	9.37%	8.22%	9.92%	7.92%	9.16%	10.74%
Net Profit Margin	5.71%	5.40%	6.34%	4.45%	6.38%	7.10%
Asset Turnover	2.72	2.51	2.57	2.62	2.98	2.98
Others						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Net Operating Margin	1.56%	-1.12%	3.90%	1.80%	4.82%	4.86%
Net Profit Margin	-2.99%	-5.04%	-0.87%	-3.92%	-0.25%	0.86%
Asset Turnover	3.66	3.01	3.47	3.81	3.93	3.46

Source: Calculated from CMIE Prowess Data

The first conclusion is that Electrical parts and Suspension & Braking Parts are the only segments for which profitability measures show improvement during 2002-2003 (Table 3.1). A further understanding of segment-wise profitability is obtained by analyzing which segments are under price pressure. The weighted price of a product in each segment is calculated (with the weights being the sales ratios). This is compared over time taking into account inflation effects. The annual compounded inflation rate is determined as approximately 5% over 1998-2002. Significant price pressure is observed in Engine Parts and Drive Transmissions and Steering Parts. The results show that prices have not kept up with the inflation trends, thus resulting in real price reductions, except for the Electrical Parts segment. (Table 3.2).

Table 3.2: 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

To understand the segment wise profitability better, we performed a regression analysis of 68 firms over five years (1998-2003). Specifically, we studied empirically how the performance of a firm depends on the following factors: 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 key performance indicators of a firm: growth (G), operating margin (O) and return on net worth (R) were regressed separately against age of firm, exports as a percentage of sales, net sales, overheads using:

$$Y = \alpha_1 + \alpha_2 (Age) + \alpha_3 (Export\%) + \alpha_4 (Sales) + \alpha_5 (Overheads) + \varepsilon$$

An OLS regression was used; the results of which are shown in Table 3.3. The age of the firm (A) was measured by the number of years since incorporation; export orientation (E) by the percentage of sales as exports, size by annual sales (S) and overheads (OH) as the difference between PBDIT and Operating Profit as a percentage of sales. The data from 68 firms over five years in the sector was used in this analysis.

Table 3.3: Analysis of Financial Performance

	Industry			Size-based segmentation						Product-segment wise categories								
	All Firms			Small Firms			Big Firms			Steering Parts			Engine Parts			Braking Parts		
	R	G	O	R	G	O	R	G	O	R	G	O	R	G	O	R	G	O
A		-			--	-	-	-			-							
E					-				+		--							
S			++		+	++					+				++			
OH		--			--	-											--	

Source: Calculated from CMIE Prowess Data

Notes: R, G and O denote the return on net worth, growth and operating margin of the firm, whereas A, E, S, OH are the age of the firm, exports as a percentage of sales, revenues and overheads respectively.

Significance at the 10% level is denoted by the symbol + or -, and at the 5% level by the symbol ++ or --. The direction of the effect (positive + or negative -) determines the symbol used.

A summary of the results is given in Table 3.3. The detailed analysis is available in Appendix A2. When the analysis was done at an industry level, we found that new firms with lower overheads had high growth rates. To obtain a deeper understanding of the results, a similar regression was performed by classifying firms based on size and also product segment. We find that the small firms that are newer, larger and have lower overheads witness high growth rates and are more profitable. We also find that amongst large firms, new firms have better return on assets than old firms, i.e., traditional large companies perform poorly. They also show higher growth. An interesting insight obtained by segment-wise analysis is that firms in the steering parts segment with high export focus grow poorly. This is consistent with a similar result for small firms. This may be because firms with an export focus that operating in segments that lack a critical scale cannot leverage their volumes to get export orders easily.

4 Total Factor Productivity Analysis

Productivity—the amount of output per unit of input—is a basic yardstick of a firm's efficiency of operations. Total factor productivity, captures the contribution to output of everything except labor and capital: innovation, managerial skill, organization, and randomness. In this section, we study the growth in TFP in the auto-ancillary sector.

4.1 Methodology:

The concept of TFP growth dates back to the work of Tinbergen (1942), Abramotivz (1956), Solow (1957), Farrell (1957) and Griliches and Jorgenson (1966) among many others. Hulten (2000) provides an excellent short biography on the Total Factor Productivity. TFP growth measurement techniques can be broadly categorized into two approaches: frontier and non-frontier. The frontier and the non-frontier categorization is of methodological importance since the frontier approach identifies the role of technical efficiency in overall firm performance while the non-frontier approach assumes that firms are technically efficient. There is considerable debate on which approach is more appropriate for TFP growth measurement (see Mahadevan 2003). We follow a non-frontier approach. This approach uses the standard growth accounting framework that separates the growth of real output into an input component and a productivity component. In our further work, we plan to use the frontier approach to validate our results.

The first step towards estimating the TFP is to estimate the production function. We assume a Cobb-Douglas functional form for the production function that remains the same over the period of study given by:

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

where, Y refers to the output, L is the labor inputs and K is the capital input. The index "i" refers to a firm and "t" refers to the year. If $\beta + \alpha = 1$, it would imply constant returns to scale, < 1 would imply decreasing returns to scale and >1 would imply an increasing returns to scale. 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 small letters for the logarithms, the equation then becomes:

$$\mathbf{Y_{it} = A_{it} + \alpha L_{it} + \beta K_{it}}$$

This equation can be characterized by OLS regressions.

Firms that have a large positive productivity shock may respond by using more inputs. This is refered to as the simultaneity problem in the productivity measurement literature. Many alternatives to OLS have been proposed to deal with this problem (see Olley and Pakes 1996 and Levinsohn and Petrin 2003). We use the Olley and Pakes (1996) approach, which takes into account the simultaneity, selectivity and attrition biases, to estimate the co-efficients of labor and capital. This method involves a semi-parametric estimation. Having estimated the production function consistently at the level of industries, we can construct plant- and time-specific productivity realisations by simply deducting the predicted values for logY from its true realization.

4.2 Data:

Our primary source of data is the Prowess database provided by the Centre for Monitoring Indian Economy. For estimation of the production function, the following variables we need the value of output, labor and capital inputs.(check this sentence). 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 measure is gross output. There has been considerable discussion on which is the most appropriate measure. Here we use the former i.e. value-added output. We recognize the fact that TFP growth based on the value-added measure is greater than that based on the gross output measure due to the upward bias created by the omission of intermediate goods and services. In fact, this bias makes our forth-coming results stronger.

The other inputs such as labor, capital and investments have been collected in real Indian Rupees. All the values are brought to real terms with 1993 as the base year through appropriate CPI and WPI deflators. We use the WPI for motor vehicle parts to deflate the values of output and the WPI for Manufacturing Industry to deflate the values of capital and investment.

4.3 Results and analysis:

The co-efficients of the production function based on our regression estimate is presented in Table 4.1 below:

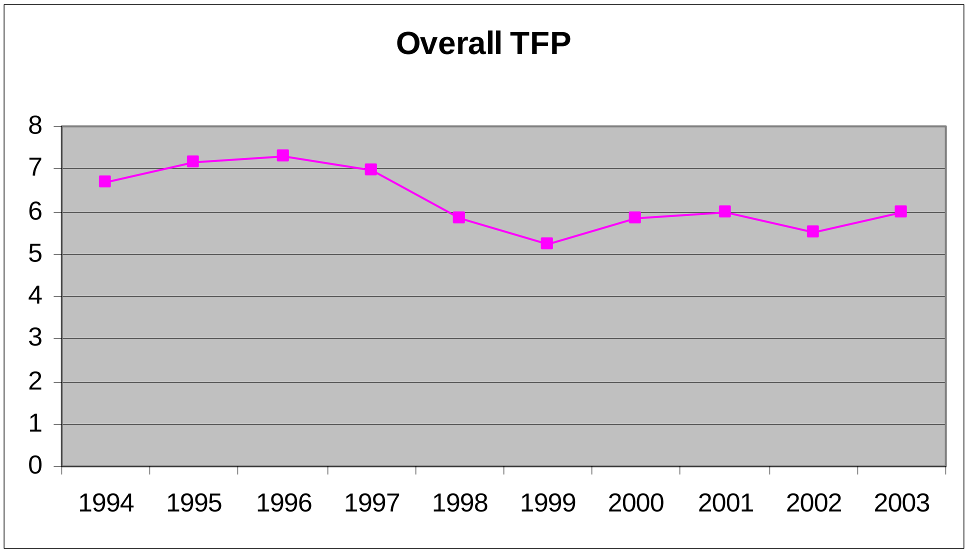
Table 4.1: Estimates of the co-efficients of the production function

Estimate	Value	t-stat
Co-efficient of labor, α	0.54	27.29
Co-efficient of capital, β	0.44	7.62

The values of the co-efficients concur with those calculated in Mitra et al 1998. It can be observed that the sum of the co-efficients add up almost to one, indicating constant returns to scale.

The calculation of TFP shows the following trend in the auto-ancillary sector as a whole:

Figure 4.1: TFP for the auto-ancilliary industry



A closer look at the segment-wise movements in the last 5 years is as below:

Figure 4.2: Segment-wise TFP for the auto-ancillary industry

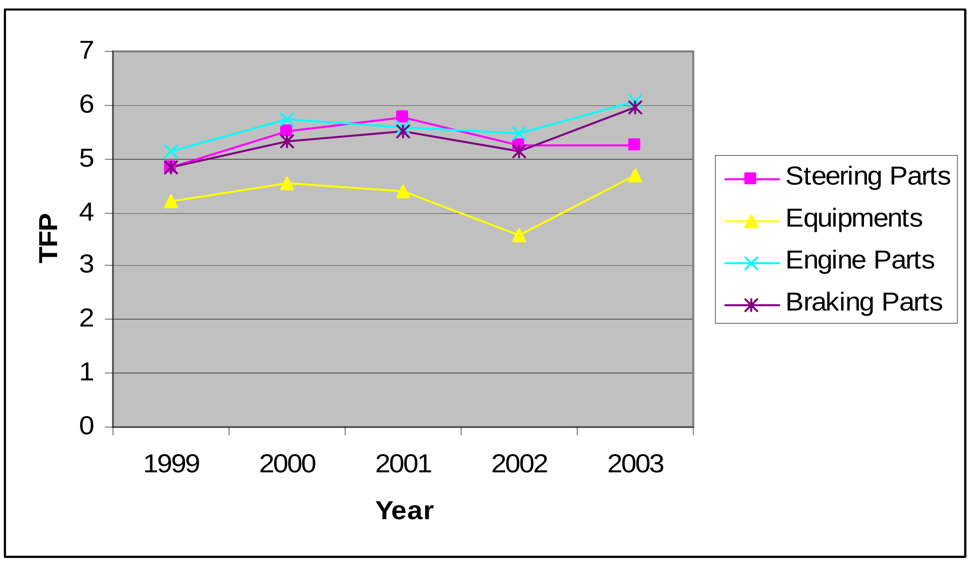


Table 4.2: TFP Growth between 1999-2003

Steering Part	8.50%
Equipments	10.98%
Engine Parts	17.99%
Braking Parts	22.70%

It can be observed that the TFP for the engine and braking parts has shown an upward trend that is almost double that of other segments (Table 4.2).

4.4 Explanation of Results:

The results for overall sector TFP show a decline during 1998-2003 compared to earlier years. However, a segment-wise analysis shows some increasing trends, particularly for engine parts and braking parts. An examination of the cost composition for engine parts (in section 1.1) shows that the labor cost for engine parts is higher than in other segments. The data given in Appendix 2 also shows that engine parts segment is growing faster. All of these factors put together suggest an industry in transition, from parts with lower labor content to parts with higher labor content (and possibly higher associated design and engineering content). This increase in share of the engine parts results in higher use of labor giving the false impression that the factor productivity is declining. However, these conclusions need further substantiation.

The productivity measurements are highly sensitive to methodological factors (Hulten and Srinivasan 2000 and Mahadevan 2002). Further, there have been considerable changes in the product-mix and in the level of complexity of the products that are now being manufactured. Further research is required in these areas.

5. India Vs China

China's economy is 2.4 times the size of India. Moreover, in terms of Purchasing Power parity also, China with \$5.9 trillion is far ahead of India at \$2.9 trillion (2002 estimate., CIA world Factbook). Strong foreign direct investment (FDI) flows in China (\$38 bn in 2000) compared with India (\$5.2 bn in 2000) have catapulted China to an enviable position. The sectoral compositions are also different, with the manufacturing sector in 2002 making up just 15% of India's GDP, compared to 35% for China. Finally, China and India's relative success in attracting FDI represents the sharpest contrast of all between the two countries. According to the official data, China received \$52.7 billion last year; India got just 4% of that amount, \$2.3 billion. Despite these differences, real GDP growth rate projections are similar for the two countries in the next decade and higher relative to Brazil and Russia. Beyond the dissimilarities listed above and the overall similarity due to a fast growing market, there are differences in the manufacturing sectors especially as they pertain to the auto component industry. Some of these are discussed below.

5.1 Size

China is the bigger market (2.5 times bigger). However, the variety of cars might offset the size advantage. Maruti, Hyundai and Tata together account for 85% of the market share in India, whereas the share of the top three sedan makers in China is 46% (VW, GM, Honda, Source: Morgan Stanley report). The Indian auto ancillary industry also enjoys relatively more stable product mix.

5.2 Exports

India exports 15% of its production of cars (120,000 units in 2004) compared to virually none for China. It is interesting to see the surge in exports of cars from India, attesting to its competitiveness in the small car segment (Section 2). However, Chinese cars are larger and therefore have more components in common with world market. China exports more auto components. It exported $0.3 billion worth of engines, $3.25 billion worth of auto parts and bodies and $1.35 billion worth of tires. India's auto-ancillary exports, on the other hand, are only $800 million.

It is somewhat contradictory that, in the auto ancillary industry, China's product advantage stems from the commonality with parts used in rest of the world. Whereas its process advantage comes from cost advantages in lower duties, good infrastructure and lower logistics cost, and more productive labor and stable wage rates (see below). As mentioned in many interviews, "when it comes to large scale production without stringent quality control, China is virtually unbeatable." In contrast, India has product advantage in making a low cost car. Its process capabilities are related to design and development skills and a solid IT base. Using the process capability, India might have an advantage in lower-volume, technology intensive products.

5.3 Cost structure

The costs for an Indian firm are significantly higher (Table 5.1). The primary cost differential, 15-17%, between the two countries is due to country-specific costs, such as taxes, duties and government policy. Firm specific costs, such as labor, engineering and logistics are marginally, 1-3%, higher in India. Thus, though China has advantage due to scale of operations, it is not significant. Some of the major cost factors are discussed below.

Table 5.1: Segment wise cost differences

	Engine and Engine Parts	Transmission and steering	Suspension and braking	Electrical parts	Equipment	Others
Cost for an Indian Company	100	100	100	100	100	100
:less	vis-à-vis China	vis-à-vis China	vis-à-vis China	vis-à-vis China	vis-à-vis China	vis-à-vis China
Higher excise duty and sales tax	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Cascading impact of taxes	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
Higher cost of Power and Fuel	0.9%	1.3%	1.1%	0.6%	0.5%	1.2%
Higher Cost of Logistics	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Higher Labour Cost (including all benefits)	1.2%	0.8%	0.6%	0.7%	0.6%	0.5%
Higher Cost of Funds	0.0%	1.3%	0.6%	-0.2%	0.4%	1.1%
Higher Rate of Insurance	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Higher Rate of Import Duty on Raw Materials	6.0%	8.5%	8.5%	8.9%	9.7%	8.9%
Cost of "No Exit Policy"	4.1%	2.6%	2.0%	2.4%	1.9%	1.6%
Engineering Costs	-0.7%	-0.5%	-0.5%	-0.5%	-0.4%	-0.5%
Higher rate of income tax	0.7%	0.3%	0.6%	0.3%	0.4%	0.3%
Cost of Delay in Government Clearance	0.3%	0.5%	0.5%	0.3%	0.4%	0.6%

Cascading impact of taxes on depreciation	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Total	**18.4%**	**20.6%**	**19.3%**	**18.4%**	**19.1%**	**19.4%**

Source:ICRA, 2004

5.4 Labor

Even though the overall labor productivity in India is lower than that in China, the labor productivity for registered firms in India is higher than that of large firms in China. An ICRA report (ICRA, 2004) places China's automakers with a slightly higher productivity (1:1.2) that might be offset by current salary level differences. Thus, for automakers in India these costs are similar to the costs in China.

5.5 Efficiency

Contrary to the conventional perception, India performed better than China in raising productivity until the mid-1990s. However, China has experienced a higher degree of openness and therefore a faster rate of catching-up with the world's best practice. Few direct studies have compared India and China on the efficiency front. Liu, Liu, Wei (2001), however, perform an interesting analysis of the efficiency trends in the two countries. They estimate a stochastic frontier based on accounting data and measure efficiency as a distance from the efficient frontier. Their analysis shows that though, prior to 1992, India had a significant advantage in efficiency, the same is not being witnessed in the period after 1992. They conclude that the efficiency levels are nearly the same in both countries now.

5.6 Cost of capital

It turns out that perhaps the most serious handicap faced by Indian manufacturing has been the relatively higher cost of capital. Between 1997 and 2000 real interest rates on the average five-year loan fell from 7.8 to 4.9 percent, whereas in India they actually rose from 6.4 to 7.8 per cent (due to a decline in the domestic inflation rate). Since 2000, however, the trend has reversed thanks to several cuts in the administered interest rates in India. For the first time, real interest rates in India are lower than in China. The effects of this are dramatic: Every 10 per cent fall in interest rates leads on average to a 30 per cent increase in profits before tax for larger Indian corporations. (Source: Raja Loll**,** Managing Director, Warburg Pinks.)

5.7 Cost of Raw materials

China automobile maker's costs used to be higher due to higher import content of steel. China's economy kept its rapid growth in recent years propelled by investment. The rapid growth of investment in capital assets provided wide market spaces for the growth of the steel industry. Starting 2004, the government has put policies in place to slow this growth. The construction of local steel projects will be severely controlled. National

Development and Reform Commission pronounced that, in principle, it would no longer ratify new steel joint ventures, independent iron mills and steel mills.[4]

The pressure of indigenization continues to be felt by the auto component industry in India. The government made it mandatory for any foreign manufacturer entering India to achieve 50% local content within three years and 70% by five years (verification needed). By the same token, the local auto component manufacturers attest that if they do not keep up with the cost-quality requirements the foreign entrants will switch to someone else. Our interviews suggest that the material cost advantage in the auto component sector between the two countries might not be significant. In fact, steel producer Tata Steel and axle maker Bharat Forge appear to have significant cost advantages.

5.8 Power and Infrastructure

Power cost is lower in China by 30-40%. Power cuts are frequent in India. The Indian government might attempt to reform the power sector. According to an ICRA report, the transit time to the US is 2-3 weeks for China while 6-12 weeks for India. Part of the advantage might be due to better facility location in China. India's auto component plants were located due to historic reasons at different places. It is not clear whether increased scale of operations will lead to improvements in the logistics facilities in India. The national highway project called the Golden Quadrilateral linking major cities might help relieve the congestion.

5.9 India Tariffs

ICRA estimates tariffs as contributing 9.6% more 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 with about 13-14% out of the 18-19% difference in costs coming from duties and taxes. Tariffs should not be a major factor to compare costs if export oriented production is compared. On the other hand, domestic consumption will be taxed heavily if the past trends continue.

5.10 The Supply chain

The degree of development of the supply chain can be gauged by examining the extent to which carmakers choose to buy in components, rather than manufacture in-house.

Table 5.2. Group-wise percentage of localized production in India and China

Category of component	Examples	% of in-house production in India	% of in-house production in China
Group 1 (normally made in-house)	Cylinder Head and Cylinder Block.	50	89
Group 2 (Often outsourced)	Engine mounting, crankshaft	55	49

[4] Source: CEI annual industrial reports (Steel Industry)

Group 3 (Normally outsourced)	Pistons, Braking systems	83	90

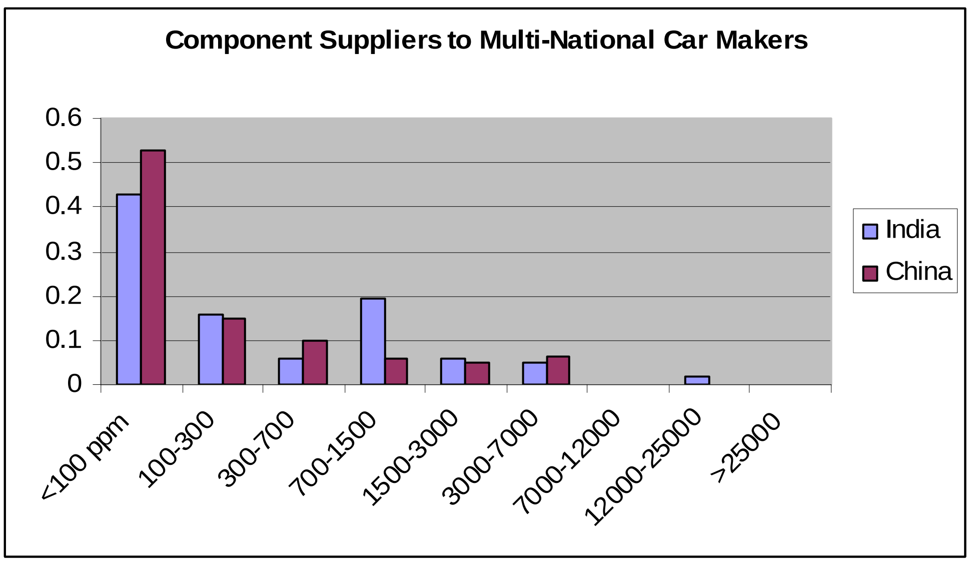
Source: Sutton, 2004

Sutton's study summarized in Table 5.2 suggests that carmakers in both countries show a similar pattern of outsourcing except in case of group 1 components where the Indian supply chain seems to be more mature.

5.11 Supplier Quality

International best practices for carmakers in US, Japan and Europe currently aim to bring the large majority of suppliers under 100 ppm. The distribution of defects observed (Figure 5.3) confirm the view that first-tier suppliers to newly arrived carmakers in India and China are already operating close to world-class standards. The 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.

Table 5.3: Distribution of defect rates in India and China



Source: Sutton, 2004

An ICRA report (ICRA, 2004), further, substantiates Suttons view that with regard to quality there are not significant differences between India and China. Our initial interviews with managers and Ramnath Consulting Ltd. reveals that China might be slightly ahead in some areas and more importantly, both countries are behind world standards.

5.12 Management

The profitability of firms in the auto component sectors in the two countries seems to be similar. Given the profit squeeze by OEMs on component manufacturers in India, their performance is very creditable. Indian auto firms seem to use their capital better (ICRA , 2004). Auto component firms have higher inventory turns and greater return on capital employed. Moreover, despite a lower margin in production Indian firms have similar net profit margins. This seems to indicate their superior managerial skills at using capital. It also reflects the relative strengths of the banking sector, emphasis on accountability to share holders, and adoption of transparent reporting practices. It might also reflect the different product mix and thus the different emphasis in the supply chains in the two countries.

5.13 Overall competitiveness

Some common myths regarding China are that its growth stems entirely from investment, not improvements in productivity; that manufacturing is driven primarily by exports; that low Chinese prices are the result of flawed accounting; that exports are priced more or less at cost; and that Chinese products are shoddy. According to a report commissioned by the Confederation of Indian Industry, these notions are baseless. The report attributes the differences in the cost between Indian and Chinese manufacture products to

1. Higher sales and excise taxes
2. Cost of capital
3. Higher import duties (a trade weighted average of 24% in India compared to 13% in China).

Source: CII-Mc Kinsey study

5.14 Government policy

Under India's (2002 policy) there are no minimum investment norms. In contrast, China's (2004 policy) requires 100 per cent foreign direct investment (FDI) in the automobile and component sectors under the automatic route. 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 summary, 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, engineering and logistics are marginally higher in India. This is clearly illustrated in the table shown below. Thus, though a scale effect is visible, it is not significant.

Table 5.4: Country-specific and firm-specific cost differential between India and China

	Engine and engine parts	Transmission and Steering	Suspension and Breaking	Electrical Parts	Equipment	Others
Taxes, Duties and 'No exit policy' cost	15.9%	16.5%	16.6%	16.7%	17.1%	15.9%
Other costs	2.5%	5.1%	2.7%	1.7%	2%	3.5%

Source: ICRA, 2004

7 Discussion and Conclusions

The empirical analysis of the impact of quality improvements suggests that the Indian industry has been forced to change its production frontier through the adoption of quality improvement programs and lead manufacturing techniques. While the auto components industry has not seen improved margins, it has set the stage for entry of OEMs into the Indian market, who, through their use of the quality components available locally, have managed to create cars with high local content at competitive domestic prices. The auto industry has also seen an export of cars from India (15 % of the total market). These trends seem to be linked, providing an interesting crossroads for the industry i.e., focus on domestic growth of the car market, focus on exports or both. The availability of consumer financing in India has pushed the growth of the local market. There are also fundamental differences in the growth of car segments with India being a small car market and China being a large car market. The auto supply chains, however, are not yet tierized and consolidated. Total factor productivity trends for the industry show a decline, suggesting a change in the product mix towards higher labor content, i.e., higher design content and engineering content products.

Some of the conclusions from our study are that the evolution of the Indian auto-ancilliary sector has been driven by changes in the domestic market particularly by the agenda set by the OEMs. OEMs have responded to price and heightened competition by undertaking initiatives to protect their main brands. This has led to unparalleled competence in manufacture of low cost low volume cars for mass consumption. However, as new products with advanced technologies were introduced to the market the existing players have seen a decline in volume as well as profitability. Thus, despite quality and productivity improvements and despite developing capability to modify and manage processes the efforts made in the sector have not resulted in corresponding increase in profitability. This period of change can be viewed as one of transition wherein firms have tried to reinvent themselves without massive influx of new capital or technology. What they have to show for this is a capability to develop, improve and manage processes. Firms are now changing directions from a pursuit of cost reduction and quality improvement to more diverse strategies. Those that are tightly integrated with OEMs are continuing the TQM approach and also looking across the border to China for sourcing components. Firms that are less tightly tied to OEMs but that have access to technology are trying to increase exports by capitalizing in their low volume, high variety, low cost manufacturing capability. Mean while, the global tier 1 suppliers are seeing the developments as an opportunity to tap into the talent pool and set up manufacturing hubs. In summary, the Indian auto ancillary supply chain presents a fascinating case study of firms at crossroads, that have to select whether to pursue business as it is, develop a global supply network, grow their demand globally or develop more complex products and design capabilities.

Acknowledgements: We would like to thank Mr. K. Subramaniam of MACONS (India) for helping us collect field data. We also acknowledge the assistance of Ramnath Management Consultants (Chennai) in collecting industry information.

References:

Abramovitz, M. 1956. Resource and output trends in the US since 1870. *American Economic Review*, 46(2), 5-23.

Arup Mitra, Aristomène Varoudakis and Marie-Ange Véganzonès. 1998. State infrastructure and productive performance in Indian manufacturing *Working paper* No. 139 OECD Development centre.

CEINet (2004)"Features and Problems of China's Auto Industry after WTO Entry."

C.J. Corbett, "Global Diffusion of ISO 9000 Certification Through Supply Chains." Manuscript. UCLA, December 2003.

C.J. Corbett, M.J. Montes, D.A. Kirsch and M.J. Alvarez-Gil ,"Does ISO Certification Pay?". *ISO Management Systems*. Special Report: 31-40. July-August 2002.

Farrell, M.J. 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society,*120, 253-281.

Gaur, V., Marshall L. Fisher, Ananth Raman. 2004. "An Econometric Analysis of Inventory Turnover Performance in Retail Services." Forthcoming in *Management Science*

Griliches, Z. and Jorgenson, J. 1966. Sources of measured productivity change: capital input. *American Economic Review*, 56(2), 50-61.

Hendricks, K. B., V. R. Singhal. 1997. Does Implementing an Effective TQM Program Actually Improve Operating Performance: Empirical Evidence From Firms That Have Won Quality Awards. *Management Science*, **43**, 1258-1274.

Hendricks, K. B., V. R. Singhal. 2001. The Long-run Stock Price Performance of Firms with Effective TQM Programs as Proxied by Quality Award Winners. *Management Science*, **47**, 359-368.

Hulten, C. and Srinivasan, S. 1999. Indian manufacturing industry: Elephant or tiger? Evidence on the Asian miracle, *NBER Working Paper*.

Hulten. 2000. Total Factor Productivity: A Short Biography, *NBER Working paper*.

ICRA Industry Watch Series, The Indian Automotive Components Industry, March 2004

Levinsohn, J. and Petrin, A. 2003. Estimating Production Functions Using Inputs to Control for Unobservables, *Review of Economic Studies*,70, pp.317-341.

Liu, G , Liu, X , Wei ,Y. 2001 "Openness and Efficiency of India and China Relative to the World Economy: A Comparative Study"

Mahadevan, R. 2002. Is there a real TFP measure for Malaysia's manufacturing sector? *ASEAN Economic Bulletin*,19(2) (Forthcoming).

Mahadevan,R. 2003. New Currents in Productivity Analysis: Where To Now? *Asian Productivity Organization*

Olley, S. and Pakes, A. 1996. The Dynamics Of Productivity In The Telecommunications Equipment Industry, *Econometrica* 64, pp.1263-1297.

Rajagopalan, S., A. Malhotra. 2001. Have U.S. Manufacturing Inventories Really Decreased? An Empirical Study. *Manufacturing & Service Operations Management*, **3**, 14-24.

Raman, A., N. DeHoratius and Z. Ton. 2001. Execution: The Missing Link in Retail Operations. *California Management Review* **43** 136 - 152.

Solow, R. 1957. Technical change and the aggregate production function. *Review of Economics and Statistics*,39(3),312-320

Stevenson, W. J. *Production/Operations Management.* 5th ed. Burr Ridge, IL: Richard D. Irwin, 1996.

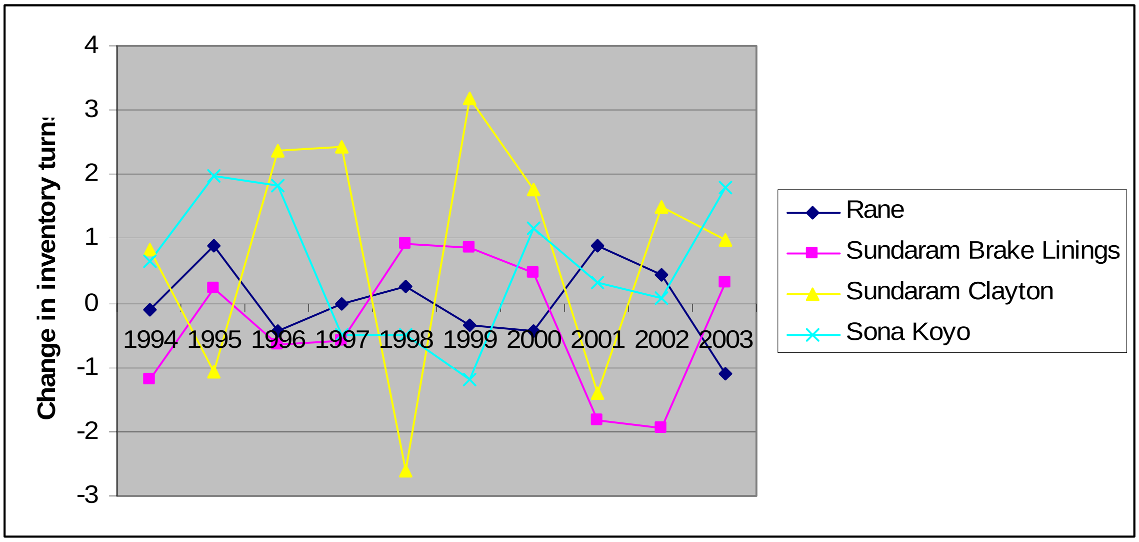
Sutton, J., “The Auto-Component Supply Chain in China and India: a benchmarking study”, January 2004

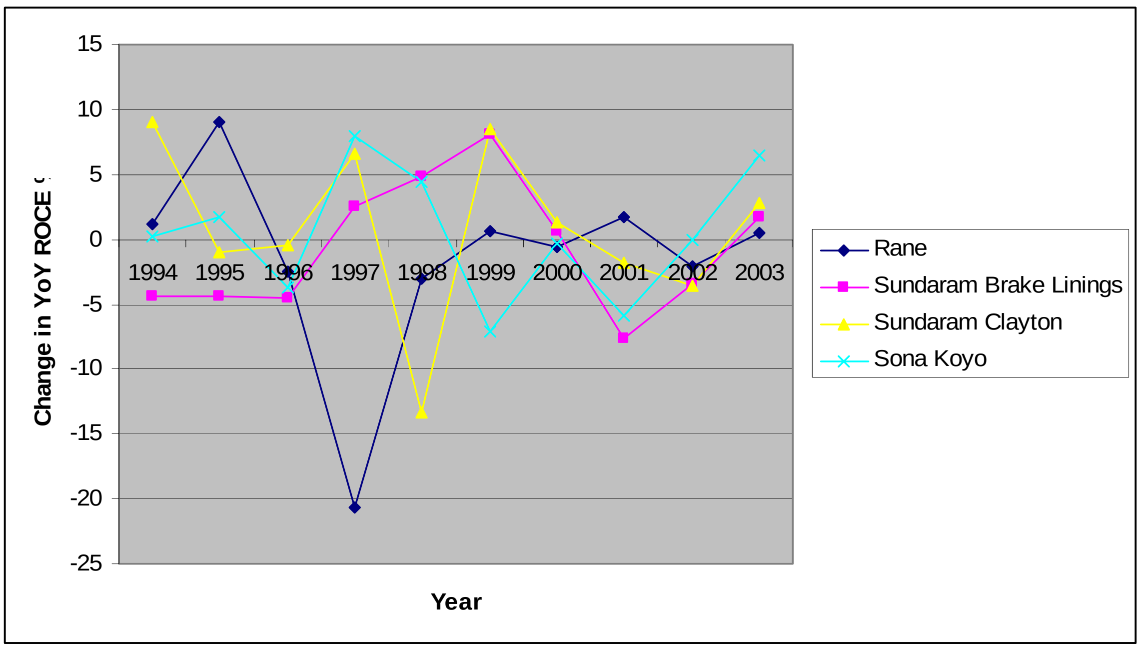
Taylor Randall and Karl Ulrich, "Product Variety, Supply Chain Structure, and Firm Performance: Analysis of the U.S. Bicycle Industry." *Management Science* (2001).

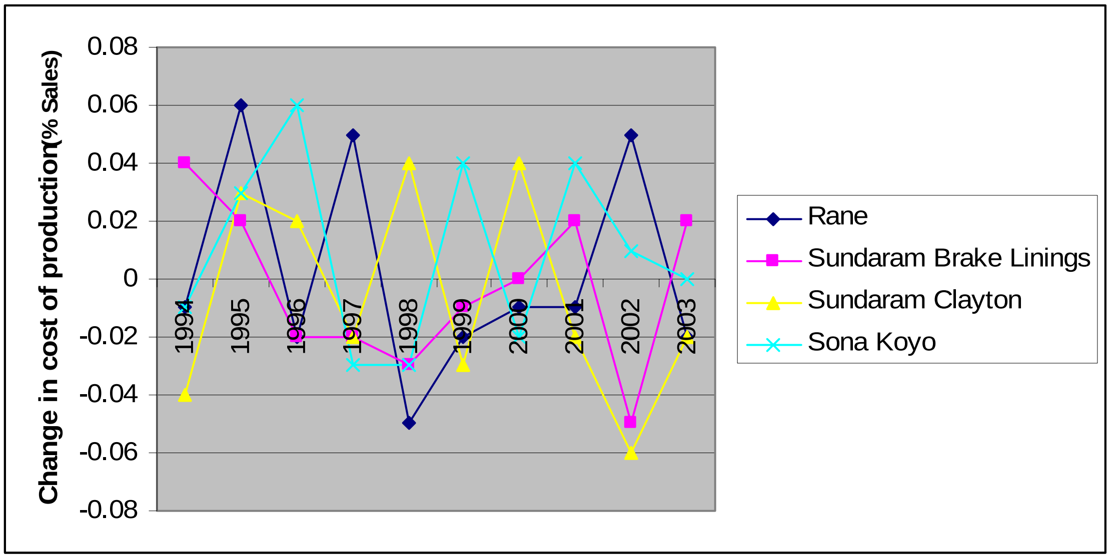
Terwiesch, Christian, Christoph H. Loch, "Measuring the Effectiveness of Overlapping Development Activities", *Management Science,* Vol. 45, Number 4, 1999

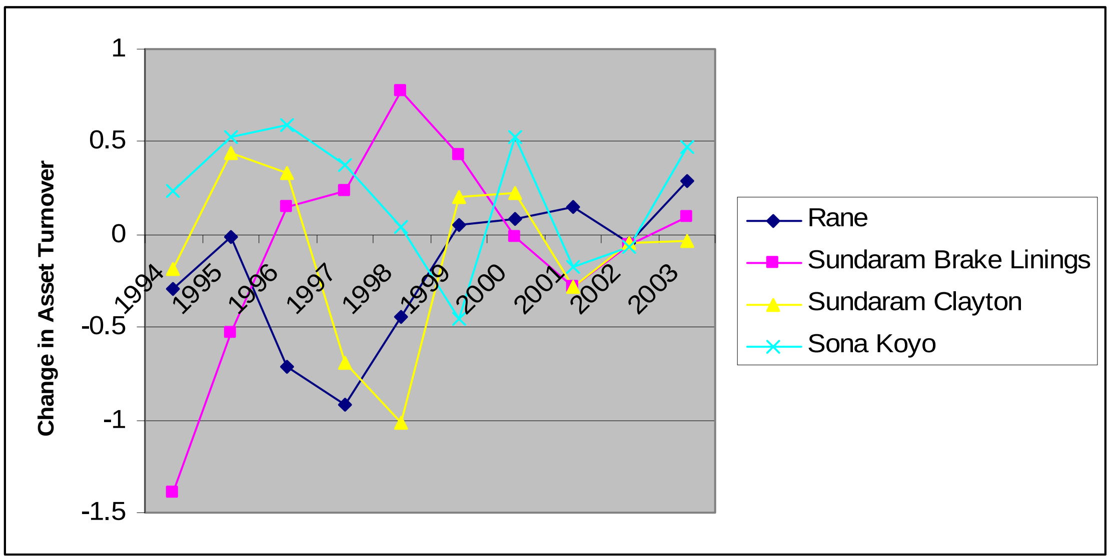
Tinbergen, J. Zur Theorie der Langfristigen Wirtschaftsentwicklung. *Weltwirtsschaftliches Archiv*. 1942; 55(1): 511-549 (translated as On the theory of trend movements. In: Klassen, L.H., Koych, L.M., and Witteveen H.J., eds. Jan Tinbergen Selected Papers. Amsterdam: North Holland; 1959: 82-221.

Appendix 1: Impact of winning the Deming Award on firm's performance









Source: Data from CMIE Prowess

Appendix 2:

Table A2.1: Industry regression analysis

	All Firms		
	Return on net worth	Growth	Operating margins
Intercept	-23.6259	31.5583	-11.144
Age	0.183983	-0.28439*	-0.0886
Export	-124.052	-22.8638	-32.5181
Sales	0.064511	0.008418	0.194575**
Overheads	0.881222	-0.89277**	0.585089

Table A2.2: Firm-size based regression analysis

	Small Firms			Large Firms		
	Return on net worth	Growth	Operating margins	Return on net worth	Growth	Operating margins
Intercept	-30.3	36.5	6.3	21.5	25.2	-45.1
Age	0.27	-0.7**	-0.2*	-0.2*	-0.2*	-0.1
Export	-100.9	-22.3*	-0.8	30.3	-12.4	109.6*
Sales	0.1	0.1*	0.1**	0.01	-0.01	0.2
Overheads	1.0	-0.9**	-0.2*	-0.6	0.4	1.2

Table A2.3: Regression analysis for Steering Parts

	Segment 1: Steering Parts		
	Return on net worth	Growth	Operating margins
Intercept	24.28934	22.37208	7.762972
Age	-0.75376	-0.78008*	-0.04276
Export	-23.1553	-66.9883**	-72.2243
Sales	0.078251	0.097162*	0.002444
Overheads	-0.84585	0.313354	0.680219

Table A2.4: Regression analysis for Engine Parts

	Segment 3: Engine Parts		
	Return on net worth	Growth	Operating margins
Intercept	19.98419	29.33453	47.49059
Age	-0.123	-0.42227	-2.44335
Export	-2.16277	-10.2832	-169.347
Sales	0.009771	0.007072	0.266534**
Overheads	-0.44493	-0.39933	3.884568

Table A2.5: Regression analysis for Braking Parts

	Segment 5: Braking Parts		
	Return on net worth	Growth	Operating margins
Intercept	19.98419	20.75994	29.4103
Age	-0.123	-0.03837	-0.57036
Export	-2.16277	-100.752	67.39955
Sales	0.009771	0.029045	0.010909
Overheads	-0.44493	-1.06812**	-0.35768

**- 5% significance

*- 10% significance