Chapter 1

The Indian Automotive Industry: Enhancing Innovation Capability with External and Internal Resources

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CHAPTER 1

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India's automobile market is one of the fastest growing auto markets in the world. It is one of those manufacturing industries which have grown significantly since the liberalization of India's economy which began in a haphazard fashion way back in the 1980s. The industry is also known for many innovations. The paper undertakes a detailed survey of the differential performance of domestic and MNCs within the industry with respect to innovations. It then analyses the sources of these innovations in terms of internal and external sources. The resulting analysis shows that while the domestic firms have relied on internal sources, the MNCs have relied far more heavily on external sources. The study also contains case studies of seven of the leading domestic firms.

1. Introduction

India's automotive industry is one of the successful cases of India's economic liberalization strategy set into motion since 1991. The industry which was dominated by a few domestic manufacturers was hardly known for any innovations before 1991, but is now one of the fastest growing manufacturing industries not just in India but globally as well. In 2010, India has emerged as the second fastest growing car market in the world next only to China. Sales of two wheelers crossed 10 million units during the year, a first, with all major two-wheeler manufacturers registering high double digit growth. India in 2010 is the largest tractor manufacturer, second largest two-wheeler manufacturer, fifth largest commercial vehicle manufacturer and the eleventh largest car manufacturer in the world.

There are many instances of innovations in the industry, the Tata's Nano car being one of the celebrated examples of these innovation efforts. All told, it is an industry that is truly successful in introducing a range of new products not just in the domestic market but in the international market as well.

In the context, the purpose of this study is to understand the internal and external sources of information on innovation to the firms within this industry some of which are domestic while others are affiliates of well-known automotive MNCs.

The study is structured into two parts. The first part maps out the insights that may be drawn from the case studies provided in the second part. The second part discusses seven case studies based on eight domestic firms in the Indian automotive industry. The first part, in turn is, structured into four sections. Section 2.1 outlines some basic facts about the industry in terms of the number of and size distribution of firms, the geographic distribution, phases in its historical evolution and recent trends in production and exports of vehicles from India. This is followed by Section 2.2, where we analyze the recent trends in innovative efforts in the industry. Section 2.3 decomposes the sources of information on innovation to internal and external sources. Finally Section 2.4 and concluding section marshals the poly conclusions emanating from the study.

2. PART I: The Macro Picture

2.1. Development and Structure of the Industry

The auto industry consists of two separate industries: (i) The automobile industry; and (ii) The auto components or parts industry. The automobile industry in turn has three sub sectors: (a) two-wheelers; (b) three-wheelers; and (c) four-wheelers (passenger vehicles and commercial vehicles).

Researchers have found it convenient to map out the history of the Indian auto industry from 1947 until now into three phases. See Table 1 for a summary of the three phases:

Table 1: Three phases in the evolution of India's Automotive Industry

Phases	Main features
Phase 1: 1947-1983	• Closed market • Growth of market limited by domestic supply • Very few innovations, outdated model, fuel inefficient • Number of firms: 5
Phase 2: 1983-1993	• Joint Venture between Government of India and Suzuki to form Maruti Udyog • Number of firms: 6
Phase 3: 1993-	• Industry delicensed in 1993 • Major MNC Original Equipment Manufacturers (OEMS) commenced assembly in India • Implementation of the Value Added Tax (VAT) • Imports allowed from April 2001 • Number of firms: >35

Source: India Brand Equity Fund (2010).

2.1.1. Trends in Production

Production of automobile (in numbers) has doubled itself (Table 2) during the period under consideration. Although the rates of growth of output had plummeted, due essentially to the financial crisis, in 2008-09, it has picked up in all categories the very following year and indications are that this high growth rate will be maintained during 2010-11 as well.

There are two important findings. First, is that two wheelers account for the lion's share of production (in numbers) followed by passenger vehicles (cars). So the driving force behind the spectacular growth of the industry is the output of two-wheelers (motor

cycles and scooters) and cars. Second, is that, over time, India has become a base for exports of automobiles. Again most of the exports are accounted for by cars. In fact India has become a base for the manufacture of compact cars.

2.1.2. Trends in Exports

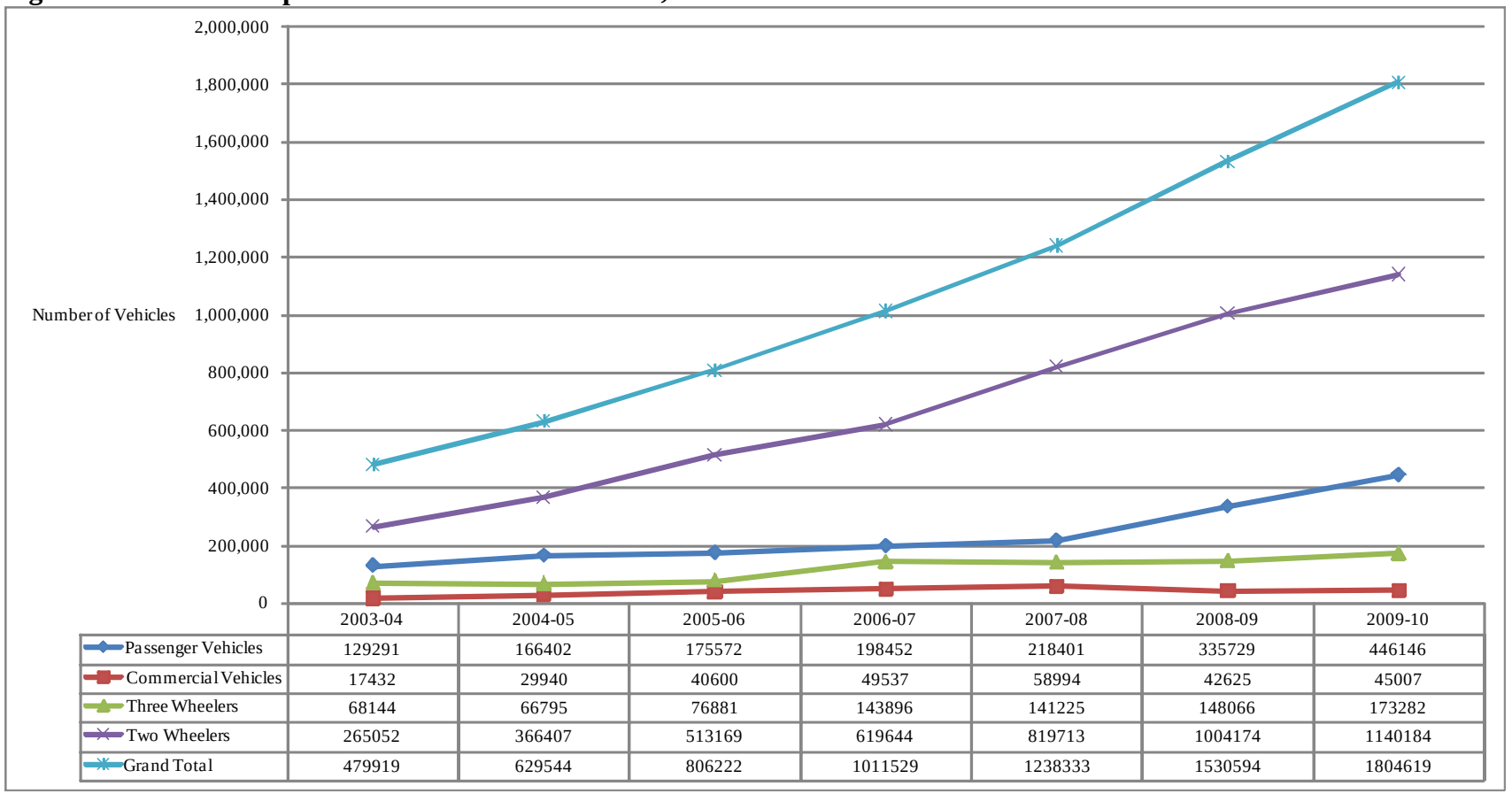
Exports too have registered some appreciable increases (Figure 1). Overall about 11 per cent of the total out is exported although the export intensity varies across the various categories ranging from as high as 24 per cent in the case of three-wheelers to as low as 9 per cent in the case of commercial vehicles. Much of the exports, in quantitative terms, is accounted for by cars and motorcycles reflecting their proportinate share in domestic production. What is interesting is that India has now become base for the manufacture and exports of compact cars.

Table 2: Trends in Production of India's Automobile Industry (in numbers)

	Passenger Vehicles	Growth Rate (%)	Commercial Vehicles	Growth Rate (%)	Three Wheelers	Growth Rate (%)	Two Wheelers	Growth Rate (%)	Grand Total	Growth Rate (%)
2003-04	989,560		275,040		356,223		5,622,741		7,243,564	
2004-05	1209,876	22.26	353,703	28.60	374,445	5.12	6,529,829	16.13	8,467,853	16.90
2005-06	1309,300	8.22	391,083	10.57	434,423	16.02	7,608,697	16.52	9,743,503	15.06
2006-07	1545,223	18.02	519,982	32.96	556,126	28.01	8,466,666	11.28	11,087,997	13.80
2007-08	1777,583	15.04	549,006	5.58	500,660	-9.97	8,026,681	-5.20	10,853,930	-2.11
2008-09	1838,593	3.43	416,870	-24.07	497,020	-0.73	8,419,792	4.90	11,172,275	2.93
2009-10	2351,240	27.88	566,608	35.92	619,093	24.56	10,512,889	24.86	14,049,830	25.76

Source: Compiled from the website of Society of Indian Automobile Manufacturers (http://www.siamindia.com/).

Figure 1: Trends in Exports of Automotive from India, 2004-2010



	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Passenger Vehicles	129291	166402	175572	198452	218401	335729	446146
Commercial Vehicles	17432	29940	40600	49537	58994	42625	45007
Three Wheelers	68144	66795	76881	143896	141225	148066	173282
Two Wheelers	265052	366407	513169	619644	819713	1004174	1140184
Grand Total	479919	629544	806222	1011529	1238333	1530594	1804619

Source: Society of Indian Automobile Manufacturers (http://www.siamindia.com/).

2.1.3. Structure of the Industry

Here we focus only on the vehicle producing sector. This consists of two sets of firms, domestic and affiliates of a large number of MNCs. Although the industry was largely domestic for a long time, MNCs entry to the industry started with the joint venture Maruti Suzuki's plans to build small compact cars. Gradually over time, a number of MNCs have established their manufacturing activities in the country. Maruti itself has diluted its domestic equity held by the union government in favour of a larger shareholding by its parent firm. Over time and especially since 1991, there has been entry to the industry by a large number of MNCs. MNCs are focusing much more on passenger cars and motorcycles, while the domestic firms have their presence across the entire spectrum of vehicles. In terms of total sales the industry is roughly divided between the two the segments although on an average over the last decade or so, the domestic firms have a slightly higher share (Table 3), as the two large commercial vehicle firms are in the domestic sector.

Table 3: Sales and Exports of Automobiles: Domestic Vs MNCs (Rs in Crores)

Year	Exports of Goods (Rs Crores)		Sales (Rs Crores)		Exports of Goods to Sales (%)		Ratio of Domestic to MNC	
	Domestic	MNC	Domestic	MNC	Domestic	MNC	Exports	Sales
2000	1,077.46	2,433.72	22,298.37	19,519.52	4.83	12.47	0.44	1.14
2001	1,197.82	2,501.76	21,883.20	20,993.81	5.47	11.92	0.48	1.04
2002	1,001.55	2,157.87	22,122.72	19,789.59	4.53	10.90	0.46	1.12
2003	1,001.57	3,229.19	26,227.74	21,440.01	3.82	15.06	0.31	1.22
2004	1,699.89	2,428.32	34,330.25	30,308.19	4.95	8.01	0.70	1.13
2005	2,535.77	3,512.20	40,455.42	39,256.10	6.27	8.95	0.72	1.03
2006	3,483.47	3,726.40	47,276.37	44,637.80	7.37	8.35	0.93	1.06
2007	4,540.04	4,192.76	61,429.95	53,514.79	7.39	7.83	1.08	1.15
2008	7,426.48	4,891.48	75,810.47	55,992.37	9.80	8.74	1.52	1.35
2009	7,593.78	27,610.06	70,464.44	63,379.07	10.78	43.56	0.28	1.11
2010	7,389.76	17,246.04	89,928.63	55,402.27	8.22	31.13	0.43	1.62
Average					**6.67**	**15.17**	**0.67**	**1.18**

Source: Compiled from Centre for Monitoring Indian Economy (CMIE) *Prowess Dataset*.

But on the export front, the foreign firms have not only a higher level but also higher export intensity as well (on an average two times). This shows that the MNCs are actually using India as a base for their exports.

2.2. Innovations in the Automotive Industry

There have been many instances of new product development in the Indian automotive industry. To name a few:

- The development of the Nano, the innovative US$2,250 car, has showcased India's ability to innovate and design;
- Reva, India's first electric car, is also an example in this case;
- Companies like M&M and the Hero Group are planning to develop electric vehicles;
- In the commercial vehicles space, Tata Daewoo, a subsidiary of Tata Motors, has recently developed an LPG-based MCV (4.5 ton), the Novus, which conforms to Euro V emission norm;
- Ashok Leyland has developed India's first six-cylinder CNG engine for buses, which uses the multipoint fuel injection system and conforms to Euro IV emission standards ; and
- Two-wheeler manufacturers Bajaj Auto, Hero Honda and Mahindra are in discussions with Energtek, a provider of absorbed natural gas products, for technology that will enable two-wheelers to run on natural gas instead of gasoline.

The auto industry is one of the largest R&D spenders within India's industrial establishment closely following the leader in this sphere, namely the pharmaceutical industry (Table 4).

Table 4: Relative share of India's Automotive Industry in Total Private Sector in-house R&D Expenditures (Rs in Crores)

	In-House R&D Expenditure	Rate of Growth (%)	R&D Intensity	Total Private Sector Industry	Auto Industry as a Share of Private Sector Industry
1998-99	420.62		0.87	2,177	19.32
1999-00	431.37	2.56	0.73	2,178	19.80
2000-01	451.96	4.77	0.77	2,411	18.74
2001-02	528.61	16.96	0.81	2,787	18.96
2002-03	434.27	-17.85	0.77	2,785	15.60
2003-04	546.50	25.84	0.80	3,643	15.00
2004-05	862.80	57.88	0.99	5,076	17.00
2005-06	1,047.20	21.37	1.07	6,268	16.71

Note: Rs 1 crore = Rs 10 million.
Source: Department of Science and Technology (2009).

Although the industry consists of domestic and MNCs, most of the new product development has come from the domestic companies. In order to examine this further, we analysed the two major costs of developing new technologies: in-house R&D expenditures and cost of purchasing technology from abroad. The source of data for this exercise is the Centre for Monitoring Indian Economy (CMIE) *Prowess Dataset.*

Two indicators are developed: (i) R&D to sales ratio signifying the research intensity of the sector (Table 5); (ii) Ratio of R&D expenditure to cost of purchasing technology from abroad signifying relate importance of domestic technology generating efforts (Table 6). These ratios are presented separately for domestic and MNCs.

Table 5: Research Intensity: Domestic vs. Foreign Firms
(Values are in Rs Crores)

Year	R&D Expense (Rs Crores)		Sales (Rs Crores)		R&D to Sales (%)		Ratio of Domestic to MNC	
	Domestic	MNC	Domestic	MNC	Domestic	MNC	R&D	Sales
2000	146.83	164.56	22,298.37	19,519.52	0.66	0.84	0.89	1.14
2001	159.31	77.45	21,883.20	20,993.81	0.73	0.37	2.06	1.04
2002	292.18	62.84	22,122.72	19,789.59	1.32	0.32	4.65	1.12
2003	364.79	51.47	26,227.74	21,440.01	1.39	0.24	7.09	1.22
2004	439.92	102.96	34,330.25	30,308.19	1.28	0.34	4.27	1.13
2005	751.54	123.24	40,455.42	39,256.10	1.86	0.31	6.10	1.03
2006	900.35	106.00	47,276.37	44,637.80	1.90	0.24	8.49	1.06
2007	1,301.71	103.39	61,429.95	53,514.79	2.12	0.19	12.59	1.15
2008	1,939.72	120.60	75,810.47	55,992.37	2.56	0.22	16.08	1.35
2009	2,663.34	154.60	70,464.44	63,379.07	3.78	0.24	17.23	1.11
2010	2,401.38	210.87	89,928.63	55,402.27	2.67	0.38	11.39	1.62
Average					**1.84**	**0.34**	**8.26**	**1.18**

Source: Compiled from the *Prowess Database*.

Although the R&D expenditures for both the sets of firms have increased, it is the domestic firms that have registered faster growth rates in the absolute levels of intramural R&D investments, but also in its intensity. In contrast the R&D intensity of MNCs has hardly shown an increase but just inter-year fluctuations.

Consequently the main source of technology to the foreign firms is the technical knowhow that they import from their respective parent firms and as such their ratio of in-house R&D to technology purchase from abroad (referred to as the average propensity to adapt) is significantly less than unity in all the years and is also significantly less than that for domestic firms (Table 6).

Table 6: Average Propensity to Adapt: Foreign vs. Domestic Firms

Year	R&D Expenses (Rs Crores)		Forex Spending Royalty/Technical Know-How (Rs Crores)		Average Propensity to Adapt, R&D to Tech Know-How (%)	
	Domestic	MNC	Domestic	MNC	Domestic	MNC
2000	146.83	164.56	53.95	164.7	2.72	1.00
2001	159.31	77.45	51.66	208.11	3.08	0.37
2002	292.18	62.84	63.25	224.68	4.62	0.28
2003	364.79	51.47	51.26	330.29	7.12	0.16
2004	439.92	102.96	44.69	377.08	9.84	0.27
2005	751.54	123.24	114.34	657.86	6.57	0.19
2006	900.35	106	111.77	879.73	8.06	0.12
2007	1301.71	103.39	227.03	1134.65	5.73	0.09
2008	1939.72	120.6	247.89	1258.95	7.82	0.10
2009	2663.34	154.6	313.61	1554.52	8.49	0.10
2010	2401.38	210.87	278.75	1488.66	8.61	0.14
Average					**6.61**	**0.26**

Source: Compiled from the *Prowess Database*.

2.3. Source of Innovation: Internal vs. External Factors

In other words, while domestic firms have relied much more on internal sources of technology the MNCs have relied more on external sources. We now proceed to elaborate on these internal and external sources.

2.3.1. Internal-In-House R&D Efforts

In Tables 4 and 5, it is already seen that the firms and especially the domestic firms have invested rather robustly in in-house R&D. These investments have been increasing over time. India's auto policy announced in 2002had a number of fiscal incentives for domestic R&D. The main provisions of this policy dealing with R&D in the auto industry are summarized in the following Box.

Box 1: Incentives for R&D as Proposed in the Auto Policy of 2002

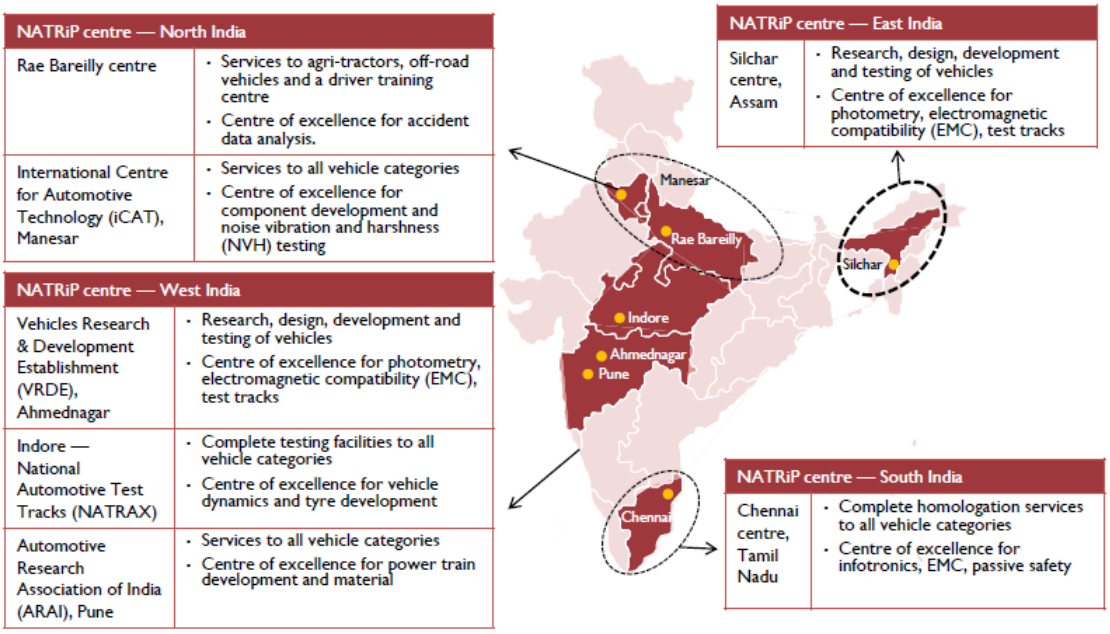
- The Government shall promote Research & Development in automotive industry by strengthening the efforts of industry in this direction by providing suitable fiscal and financial incentives.
- The current policy allows Weighted Tax Deduction under I.T. Act, 1961 for sponsored research and in-house R&D expenditure. This will be improved further for research and development activities of vehicle and component manufacturers from the current level of 125%.
- In addition, vehicle manufacturers will also be considered for a rebate on the applicable excise duty for every 1% of the gross turnover of the company expended during the year on Research and Development carried either in-house under a distinct dedicated entity, faculty or division within the company assessed as competent and qualified for the purpose or in any other R&D institution in the country. This would include R&D leading to adoption of low emission technologies and energy saving devices.
- Government will encourage setting up of independent auto design firms by providing them tax breaks, concessional duty on plant/equipment imports and granting automatic approval.
- Allocations to automotive cess fund created for R&D of automotive industry shall be increased and the scope of activities covered under it enlarged.

Source: Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises (http://dhi.nic.in/autopolicy.htm, accessed January 27, 2011).

This policy was further elaborated in the *Indian Auto Mission Plan (AMP).* AMP (2006-16) is a ten year vision document launched by Government of India in January, 2007 with the vision to make India emerge as a destination of choice in the world for design and manufacture of automobiles and auto components with output reaching a level of US$145 billion and providing additional employment to 25 million people by 2016. The most critical intervention of the government thus far in the automotive sector has come in the form of an ambitious project on setting up world-class

automotive testing and R&D infrastructure in the country in the form of *National Automotive Testing and R&D Infrastructure Project (NATRIP*). NATRIP[1] envisages setting up of world-class automotive testing and homologation facilities in India with a total investment of Rs 17 billion by 2011. The principal facilities will come up in the three automotive hubs of the country, in the south, the north and the west (Figure 2).

Figure 2: Geographic Distribution of the NATRIP Centers within the Country



Source: India Brand Equity Fund (2010), p. 48.

The project aims at (i) creating critically needed automotive testing infrastructure to enable the Government in ushering in global vehicular safety, emission and performance standards, (ii) deepening manufacturing in India, promoting larger value addition leading to significant enhancement of employment potential and facilitating convergence of India's strengths in IT and electronics with automotive engineering,

[1] The source of information on the NATRIP project is based on Department of Heavy Industry (2010).

(iii) enhancing India's considerably low global outreach in this sector by debottlenecking exports; and (iv) removing the crippling absence of basic product testing, validation and development infrastructure for automotive industry.

The project envisages setting up of the following facilities: (i) A full-fledged testing and homologation centre within the northern hub of automotive industry at Manesar, Haryana; (ii) A full-fledged testing and homologation centre within the southern hub of automotive industry a location near Chennai, Tamil Nadu; and (iii) Up-gradation of existing testing and homologation facilities at Automotive Research Association of India (ARAI), Pune and at Vehicle Research and Development Establishment (VRDE), Ahmednagar, Maharashtra.

The investment of Rs 17 billion is proposed to be funded jointly by the Government and the industry based on the following manner:

A. Plan Support by the Government: Rs. 16 billion
By way of grant: Rs. 8.17 billion
By way of Cess Funds[2]: Rs. 5.10 billion
By way of loan: Rs. 2.73 billion
B. User Charges to be Paid by Auto Industry: Rs. 1.18 billion
Total Project Cost (A+B): Rs. 17 billion

2.3.2. External Sources

Regarding external sources, I could identify at least five sources. These are: (i) Licensing of technologies; (ii) Joint Ventures; (iii) Spillovers from MNCs; (iv) Merger and acquisition deals; and (v) Certification schemes. Of these five, it is the MNCs that have been relying, relatively speaking, more on licensing of technologies and on joint

[2] Under the R&D Cess Act of 1986, every company importing technology from abroad has to pay to the government a cess to the tune of 5 per cent of the total payments for technology. The funds thus accumulated are returned to the industry in the form of grants for financing indigenous R&D projects.

ventures. The domestic firms, on the contrary, have been using mergers and acquisition as a way of securing state-of-the art technologies. Some of the major acquisitions are listed in Table 7.

Further the completion from MNCs has been an important source of technological improvements for the domestic manufacturers. Finally conformity with various international certification schemes have been an important source of information on innovation for the auto parts firms especially.

Table 7: Major Acquisitions in the Indian Auto Industry

Recent outbound deals primarily driven by acquisition of technological know-how		
Acquirer	**Target Company**	**Rationale**
Amtek Auto	UK-based Triplex Ketlon Group for US$39.9 million	The acquisition will provide Amtek with access to superior technology and expand its precision machining operations (Nov 2007)
Bajaj Auto	Increased its stake to 30% in Austria based KTM Power Sports	The acquisition will give the company access to KTM's technology and distribution network across Europe (Feb 2009)
Mahindra and Mahindra	Italy-based motor cycle design developing company, Engines Engineering, for EUR 8.5 million	The acquisition will provide M&M with access to technological expertise to widen its engineering and design services and an exposure to the international markets (June 2008)
Tata Motors	50.3% stake in Norway-based Miljo Grenland for INR 94 million	The acquisition is in line with the company's strategy of developing convenient, affordable and sustainable mobility solutions through electric and hybrid vehicles (Oct 2008)

Source: Ernst and Young (2010), p. 24.

2.4. Conclusions

The Indian automotive industry has now emerged as one of the most innovative industries in India. There are many instances of new product development not just in the auto industry but also in the auto parts industry. The sales of the industry are almost equally divided between the domestic and foreign firms. Our analysis of the innovative behavior of the industry showed that it is the domestic firms that have been more innovative and the main route they have adopted for improving their respective

innovative activities can be divided into internal and external sources. Of the internal sources, the most important one is investments in R&D. These investments have registered some sharp increases during the period under consideration. Government too has encouraged this by offering a number of fiscal incentives.

3. Part II: Case Studies

3.1. Case Study 1: Ashok Leyland

3.1.1. Brief History

In 1948, Ashok Motors was set up in what was then Madras (now known as Chennai), for the assembly of Austin Cars. The Company's name changed soon with equity participation by British Leyland and Ashok Leyland commenced manufacture of commercial vehicles in 1955. Since then Ashok Leyland has been a major presence in India's commercial vehicle industry with a tradition of technological leadership, achieved through tie-ups with international technology leaders and through systematic investments in-house R&D. Its ownership underwent a major change in 1987 when the overseas holding by Land Rover Leyland International Holdings Limited (LRLIH) was taken over by a joint venture between the Hinduja Group, the Non-Resident Indian transnational group and IVECO. Since July 2006, the Hinduja Group is 100% holder of LRLIH.

In the initial period, access to international technology enabled the firm to set a tradition to be first with a number of innovations whether it is full air brakes, power steering or rear engine busses, the firm was the first one to introduce these in the Indian market. Responding to the operating conditions and practices in the country, the Company made its vehicles well designed often enough over-engineering them.

"Designing durable products that make economic sense to the consumer, using appropriate technology," became the design philosophy of the Company. Hitherto the company has manufactured and sold over 500,000 commercial vehicles. The company has a very high share of the buses owned and operated by State Transport Undertakings.

Ashok Leyland reached a major milestone in 1993 when it became the first in India's automobile history to win the ISO 9002 certification. The more comprehensive ISO 9001 certification came in 1994, QS 9000 in 1998 and ISO 14001 certification for all vehicle manufacturing units in 2002. It has also become the first Indian auto company to receive the latest ISO/TS 16949 Corporate Certification (in July 2006) which is specific to the auto industry.

The product mix of the company includes: Trucks, Busses and Light Commercial Vehicles, Defence and Special Vehicles and Engines.

Table 8: Domestic Production, Sales and Exports (Values are in Rs Cores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	2,691.68	151.18	5.62
Mar-01	2,684.50	163.12	6.08
Mar-02	2,712.00	159.13	5.87
Mar-03	3,140.02	203.42	6.48
Mar-04	3,995.34	294.16	7.36
Mar-05	4,908.03	522.88	10.65
Mar-06	6,200.54	451.31	7.28
Mar-07	8,513.93	629.22	7.39
Mar-08	9,192.27	756.05	8.22
Mar-09	6,826.96	863.08	12.64
Mar-10	8,071.75	604.11	7.48
Average			**7.73**

Source: Compiled from CMIE *Prowess Dataset*.

3.1.2. Sources of Technology to the Firm

The firm has essentially used two sources of external technology. Embodied technology, through the importation of capital goods and disembodied through licensing agreements with a number of MNCs such as those with: Nissan Motor Company; John Deere & Company; Automotive Infotronics; and Ashley Alteams. The relative importance of these two is given below.

Table 9: Embodied vs. Disembodied External Sources of Technology
(Values are in Rs Cores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	6.29	2.53	8.82	2691.68	0.33	2.49
Mar-01	28.12	2.92	31.04	2684.5	1.16	9.63
Mar-02	21.6	1.66	23.26	2712	0.86	13.01
Mar-03	23.5	6.27	29.77	3140.02	0.95	3.75
Mar-04	14.94	4.94	19.88	3995.34	0.50	3.02
Mar-05	42.69	19.47	62.16	4908.03	1.27	2.19
Mar-06	71.87	10.54	82.41	6200.54	1.33	6.82
Mar-07	243.52	27.37	270.89	8513.93	3.18	8.9
Mar-08	136.17	41.14	177.31	9192.27	1.93	3.31
Mar-09	293.82	123.73	417.55	6826.96	6.12	2.37
Mar-10	271.15	44.02	315.17	8071.75	3.90	6.16
Average					**1.96**	**5.60**

Source: Compiled from CMIE *Prowess Dataset*.

Table 10: Internal Source of Technology (Values are in RS Cores)

Year	R&D Expense	Sales	Research Intensity	Import Intensity	Average Propensity to Adapt
Mar-00	0	2,691.68		0.33	
Mar-01	23.12	2,684.50	0.86	1.16	7.92
Mar-02	25.27	2,712.00	0.93	0.86	15.22
Mar-03	30.60	3,140.02	0.97	0.95	4.88
Mar-04	48.84	3,995.34	1.22	0.50	9.89
Mar-05	92.38	4,908.03	1.88	1.27	4.74
Mar-06	104.95	6,200.54	1.69	1.33	9.96
Mar-07	156.40	8,513.93	1.84	3.18	5.71
Mar-08	202.32	9,192.27	2.20	1.93	4.92
Mar-09	265.39	6,826.96	3.89	6.12	2.14
Mar-10	234.08	8,071.75	2.90	3.90	5.32
Average			**1.84**	**1.96**	**7.07**

Source: Compiled from CMIE *Prowess Dataset*.

3.2. Case Study 2: Tata Motors

3.2.1. Brief History

Tata Motors Limited is India's largest automobile company, with consolidated revenues of Rs. 92,519 crores (US$20 billion) in 2009-10. It is the leader in commercial vehicles in each segment, and among the top three in passenger vehicles with winning products in the compact, midsize car and utility vehicle segments. The company is the world's fourth largest truck manufacturer, and the world's second largest bus manufacturer.

The company's 24,000 employees are guided by the vision to be "best in the manner in which we operate, best in the products we deliver, and best in our value system and ethics."

Established in 1945, Tata Motors' presence indeed cuts across the length and breadth of India. Over 5.9 million Tata vehicles ply on Indian roads, since the first rolled out in 1954. The company's manufacturing base in India is spread across

Jamshedpur (Jharkhand), Pune (Maharashtra), Lucknow (Uttar Pradesh), Pantnagar (Uttarakhand) and Dharwad (Karnataka). Following a strategic alliance with Fiat in 2005, it has set up an industrial joint venture with Fiat Group Automobiles at Ranjangaon (Maharashtra) to produce both Fiat and Tata cars and Fiat powertrains. The company is establishing a new plant at Sanand (Gujarat). The company's dealership, sales, services and spare parts network comprises over 3,500 touch points; Tata Motors also distributes and markets Fiat branded cars in India.

Tata Motors, the first company from India's engineering sector to be listed in the New York Stock Exchange (September 2004), has also emerged as an international automobile company. Through subsidiaries and associate companies, Tata Motors has operations in the UK, South Korea, Thailand and Spain. Among them is Jaguar Land Rover, a business comprising the two iconic British brands that was acquired in 2008. In 2004, it acquired the Daewoo Commercial Vehicles Company, South Korea's second largest truck maker. The rechristened Tata Daewoo Commercial Vehicles Company has launched several new products in the Korean market, while also exporting these products to several international markets. Today two-thirds of heavy commercial vehicle exports out of South Korea are from Tata Daewoo. In 2005, Tata Motors acquired a 21% stake in Hispano Carrocera, a reputed Spanish bus and coach manufacturer, and subsequently the remaining stake in 2009. Hispano's presence is being expanded in other markets. In 2006, Tata Motors formed a joint venture with the Brazil-based Marcopolo, a global leader in body-building for buses and coaches to manufacture fully-built buses and coaches for India and select international markets. In 2006, Tata Motors entered into joint venture with Thonburi Automotive Assembly Plant Company of Thailand to manufacture and market the company's pickup vehicles

in Thailand. The new plant of Tata Motors (Thailand) has begun production of the Xenon pickup truck, with the Xenon having been launched in Thailand in 2008.

Tata Motors is also expanding its international footprint, established through exports since 1961. The company's commercial and passenger vehicles are already being marketed in several countries in Europe, Africa, the Middle East, South East Asia, South Asia and South America. It has franchisee/joint venture assembly operations in Kenya, Bangladesh, Ukraine, Russia, Senegal and South Africa.

The foundation of the company's growth over the last 50 years is a deep understanding of economic stimuli and customer needs, and the ability to translate them into customer-desired offerings through leading edge R&D. With over 3,000 engineers and scientists, the company's Engineering Research Centre, established in 1966, has enabled pioneering technologies and products. The company today has R&D centres in Pune, Jamshedpur, Lucknow, Dharwad in India, and in South Korea, Spain, and the UK. It was Tata Motors, which developed the first indigenously developed Light Commercial Vehicle, India's first Sports Utility Vehicle and, in 1998, the *Tata Indica*, India's first fully indigenous passenger car. Within two years of launch, Tata Indica became India's largest selling car in its segment. In 2005, Tata Motors created a new segment by launching the *Tata Ace*, India's first indigenously developed mini-truck.

In January 2008, Tata Motors unveiled its People's Car, the *Tata Nano*, which India and the world have been looking forward to. The Tata Nano has been subsequently launched, as planned, in India in March 2009. A development, which signifies a first for the global automobile industry, the Nano brings the comfort and safety of a car within the reach of thousands of families. The standard version has

been priced at Rs.100,000 (excluding VAT and transportation cost). However as the figure shows, the sales of Nano cars after reaching a maximum sales of 9,000 cars in July 2010 has since been plummeting down to just 500 cars or so in November, 2010. Several reasons have been advanced for this lackluster performance of the Nano, lack of proper advertisements being one such factor. See also Box. Of late Tata's have started a serious advertisement campaign to regain lost numbers.

Box 2: Plummeting Sales of Nano: Possible Reasons

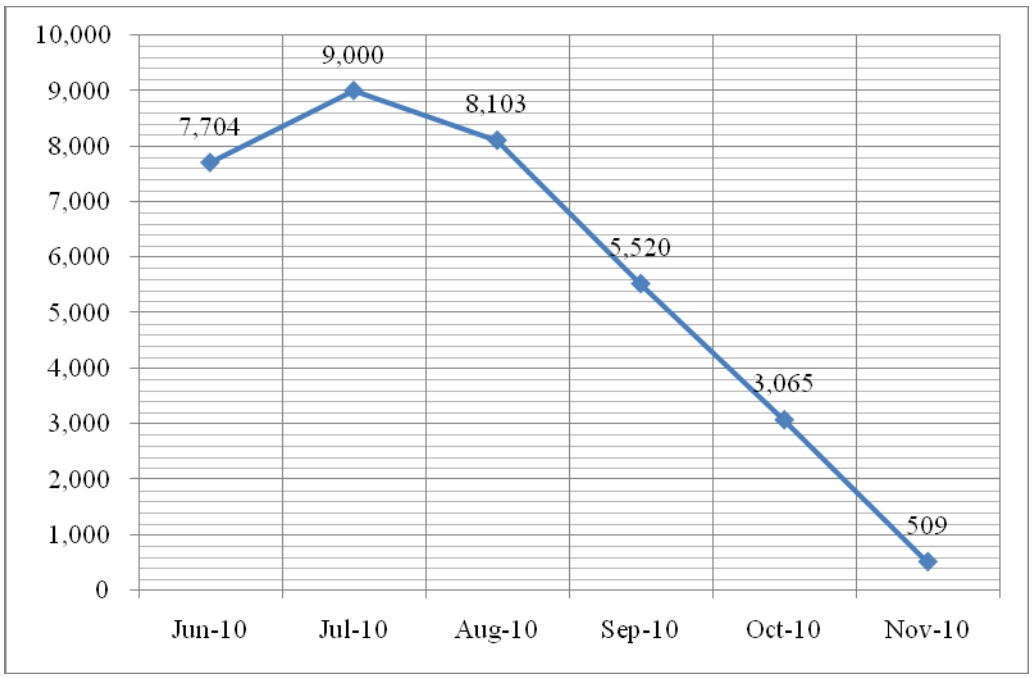
"One reason is that the new car is tricky to find: it is being marketed only in a few parts of India, as Tata struggles to get a new factory up to speed, which in time should churn out 100,000 cars a year. More troubling, dealers report a lack of demand. Some drivers have been put off by price rises: including tax, it is now more like a one-and-a-half-lakh car. Others were deterred by a few early cases of Nanos billowing smoke and flames: Tata is offering to fix this with a free "upgrade." It is also said to be easier to find spares for already ubiquitous Suzukis."

Source: *Economist* (http://www.economist.com/node/17465427?story_id=17465427) (accessed February 14, 2011)

In May 2009, Tata Motors introduced ushered in a new era in the Indian automobile industry, in keeping with its pioneering tradition, by unveiling its new range of world standard trucks called *Prima.* In their power, speed, carrying capacity, operating economy and trims, they will introduce new benchmarks in India and match the best in the world in performance at a lower life-cycle cost. Tata Motors is equally focused on environment-friendly technologies in emissions and alternative fuels. It has developed electric and hybrid vehicles both for personal and public transportation. It has also been implementing several environment-friendly technologies in

manufacturing processes, significantly enhancing resource conservation.

Figure 3: Number of Nano Cars Sold



Source: Press Reports.

Through its subsidiaries, the company is engaged in engineering and automotive solutions, construction equipment manufacturing, automotive vehicle components manufacturing and supply chain activities, machine tools and factory automation solutions, high-precision tooling and plastic and electronic components for automotive and computer applications, and automotive retailing and service operations.

Tata Motors is committed to improving the quality of life of communities by working on four thrust areas – employability, education, health and environment. The activities touch the lives of more than a million citizens. The company's support on education and employability is focused on youth and women. They range from schools to technical education institutes to actual facilitation of income generation. In health, our intervention is in both preventive and curative health care. The goal of

environment protection is achieved through tree plantation, conserving water and creating new water bodies and, last but not the least, by introducing appropriate technologies in our vehicles and operations for constantly enhancing environment care.

The Product Mix of the company includes: Passenger cars, Utility Vehicles, Trucks, Commercial passenger carriers, Defence vehicles.

Table 11: Domestic Production, Sales and Exports (Values are in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	8,616.21	609.03	7.07
Mar-01	7,912.36	722.75	9.13
Mar-02	8,641.81	620.21	7.18
Mar-03	10,607.73	476.43	4.49
Mar-04	15,208.74	1,006.32	6.62
Mar-05	20,217.42	1,452.69	7.19
Mar-06	23,439.41	2,196.69	9.37
Mar-07	31,000.71	2,687.30	8.67
Mar-08	32,434.78	2,754.05	8.49
Mar-09	28,513.28	2,206.43	7.74
Mar-10	NA	1,921.48	
Average			**7.59**

Source: Compiled from CMIE *Prowess Dataset*.

3.2.2. Sources of Technology to the Firm

The firm has essentially used two sources of external technology. Embodied technology, through the importation of capital goods and disembodied through licensing agreements with a number of MNCs such as those with: Jaguar Land Rover; Telco Construction Equipment Co. Ltd. (Telcon); Tata Daewoo Commercial Vehicle Company Ltd (TDCV); Tata Hispano Motors Carrocera S. A.; Tata Motors European Technical Centre plc. (TMETC); Tata Motors (Thailand) Limited (TMTL); Tata Marcopolo Motors Ltd (TMML); Tata Motors(SA) Proprietary Ltd (TMSA); and TML Holdings Pte. Ltd.

Table 12: Embodied vs. Disembodied External Sources of Technology (Values are in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	161.73	9.73	171.46	8,616.21	1.99	16.62
Mar-01	7.91	9.15	17.06	7,912.36	0.22	0.86
Mar-02	25.19	16.68	41.87	8,641.81	0.48	1.51
Mar-03	69.17	29.9	99.07	10,607.73	0.93	2.31
Mar-04	43.22	16.77	59.99	15,208.74	0.39	2.58
Mar-05	226.84	76.89	303.73	20,217.42	1.50	2.95
Mar-06	264.88	91.56	356.44	23,439.41	1.52	2.89
Mar-07	472.76	188.88	661.64	31,000.71	2.13	2.50
Mar-08	1,314.31	172.21	1,486.52	32,434.78	4.58	7.63
Mar-09	861.55	160.6	1,022.15	28,513.28	3.58	5.36
Mar-10	374.16	217.59	591.75			1.72
Average					**1.73**	**4.27**

Source: Compiled from *Prowess Dataset*.

Table 13: Internal Source of Technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average Propensity to Adapt
Mar-00	106.73	8,616.21	1.24	10.97
Mar-01	90.45	7,912.36	1.14	9.89
Mar-02	92.37	8,641.81	1.07	5.54
Mar-03	143	10,607.73	1.35	4.78
Mar-04	151.88	15,208.74	1.00	9.06
Mar-05	393.34	20,217.42	1.95	5.12
Mar-06	476.12	23,439.41	2.03	5.20
Mar-07	796.86	31,000.71	2.57	4.22
Mar-08	1,195.97	32,434.78	3.69	6.94
Mar-09	1,476.61	28,513.28	5.18	9.19
Mar-10	1,170.97			5.38
Average			**2.12**	**6.94**

Source: Compiled from *Prowess Dataset*.

3.3. Case Study 3: Force Motors

3.3.1. Brief History

Late Shri N.K.Firodia, a dedicated Gandhian was the Founder-Managing Director of Force Motors. Having participated in the freedom struggle for India in 1932 and 1942 he was determined to achieve industrial modernization for India. He established, starting in 1950, in collaboration with Vidal & Sohn, Hamburg, Germany the import

and later progressive manufacture in India of the Tempo 3-Wheeler.

On 15th August 1957, the 10th anniversary of Indian independence, Mr. N.K.Firodia signed a collaboration with Vidal & Sohn Tempo Werke GmbH for phased manufacturing of TEMPO 3-wheeler and manufacturing was started in a small plant at Goregaon, Bombay. The initial licensed capacity granted by the government was 1000 vehicles per year and 80 vehicles per month. The production was transferred to Pune by the end of 1964. Ambitious plans for producing Light Commercial Vehicles for the growing industrial economy of India were drawn up. The manufacture of TEMPO VIKING 4-Wheeled Trucks & Vans commenced in November 1964. The licensed capacity was increased to 6000 vehicles per year. The VIKING vehicle subsequently was upgraded with a diesel engine and the MATADOR was born. The production of Matador commenced in 1969. In 1975, the manufacturing capacity of the company was increased to 12,000 vehicles per year, in addition to 6,000 diesel engines for other purposes.

The collaborator company in Germany, in the wave of mergers during the 70s merged eventually with Daimler-Benz. In July 1982, the company in a new collaboration - with the then Daimler Benz - produced the Mercedes Benz OM 616 engine under license for fitting on its line of vehicles.

The TRAX Vehicle, specifically designed for the rough roads of rural India was developed by the Company's R&D department, to cater to the growing mechanization of passenger transport in rural India.

To further modernize its LCV product range, the Company took up the production of the TRAVELLER, under license from Daimler-Benz. A new plant was set up in 1987, on a greenfield site in Central India at Pithampur in Madhya Pradesh. This

modern facility was developed in close co-operation with Daimler-Benz. The plant is equipped with a modern conveyorized body welding and Electrophoretic dip painting shop. The Plant has been expanded to house a new Press Shop in 1997.

The product mix of the company includes: Traveller, Trumph, Trax, Tractor.

Table 14: Domestic Production, Sales and Exports (Values are in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	678.83	8.36	1.23
Mar-01	615.11	4.69	0.76
Mar-02	630.73	4.24	0.67
Mar-03	826.6	12.33	1.49
Mar-04	1,111.73	11.70	1.05
Mar-05	999.96	10.96	1.10
Mar-06	1,087.13	16.12	1.48
Mar-07	1,143.84	28.56	2.50
Mar-08	1,092.70	38.59	3.53
Mar-09	890.72	30.08	3.38
Mar-10	NA	26.96	
Average			**1.72**

Source: Compiled from CMIE *Prowess Dataset*.

3.3.2. Sources of Technology to the Firm

The firm has essentially used two sources of external technology. Embodied technology, through the importation of capital goods and disembodied through licensing agreements with a number of MNCs such as those with leading global automotive names like Daimler, ZF, Ricardo, Bosch and MAN and through these associations developed necessary expertise in house for design / development / manufacture of automobiles, sub - systems, components and aggregates.

Table 15: Embodied vs. Disembodied External Sources of Technology (Values are in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	8.58	0.01	8.59	678.83	1.27	858
Mar-01	0.27	0.01	0.28	615.11	0.05	27
Mar-02	9.76	8.59	18.35	630.73	2.91	1.14
Mar-03	1.16	1.92	3.08	826.60	0.37	0.60
Mar-04	3.84	11.16	15	1,111.73	1.35	0.34
Mar-05	4.14	12.89	17.03	999.96	1.70	0.32
Mar-06	39.91	7.52	47.43	1,087.13	4.36	5.31
Mar-07	26.53	0	26.53	1,143.84	2.32	
Mar-08	3.74	1.61	5.35	1,092.70	0.49	2.32
Mar-09	0.02	0	0.02	890.72	0.00	
Mar-10	0.31	0	0.31	NA		
Average					**1.48**	**111.88**

Source: Compiled from CMIE *Prowess Dataset*.

Table 16: Internal Source of Technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average Propensity to Adapt
Mar-00	6.88	678.83	1.01	688
Mar-01	0	615.11	0.00	0
Mar-02	13.78	630.73	2.18	1.60
Mar-03	18.81	826.60	2.28	9.80
Mar-04	25.77	1,111.73	2.32	2.31
Mar-05	27.97	999.96	2.80	2.17
Mar-06	56.49	1,087.13	5.20	7.51
Mar-07	40.10	1,143.84	3.51	
Mar-08	28.43	1,092.70	2.60	17.66
Mar-09	22.10	890.72	2.48	
Mar-10	30.12	NA		
Average			**2.44**	**91.13**

Source: Compiled from CMIE *Prowess Dataset*.

3.4. Case Study 4: Bajaj Auto

3.4.1. Brief History

The Bajaj is amongst the top 10 business houses in India. Its footprint stretches over a wide range of industries, spanning automobiles (two-wheelers and three-wheelers), home appliances, lighting, iron and steel, insurance, travel and finance.

Bajaj Auto is ranked as the world's fourth largest two- and three- wheeler manufacturer and the Bajaj brand is well-known across several countries in Latin America, Africa, Middle East, South and South East Asia. Founded in 1926, at the height of India's movement for independence from the British, the company has an illustrious history. The present Chairman of the group, Rahul Bajaj, took charge of the business in 1965. Under his leadership, the turnover of the Bajaj Auto the flagship company has gone up from Rs. 72 million to Rs. 120 billion, its product portfolio has expanded and the brand has found a global market.

The Product Mix of the Company includes: Two wheelers, Goods Carriers (Three wheeler), Passenger Carriers (Three wheeler).

Table 17: Domestic Production, Sales and Exports (Values are in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	NA	NA	NA
Mar-01	NA	NA	NA
Mar-02	NA	NA	NA
Mar-03	NA	NA	NA
Mar-04	NA	NA	NA
Mar-05	NA	NA	NA
Mar-06	NA	NA	NA
Mar-07	NA	NA	NA
Mar-08	9803.39	2,047.81	20.89
Mar-09	9590.25	2,640.40	27.53
Mar-10	1,2399.92	3,245.82	26.18
Average			**24.87**

Source: Compiled from CMIE *Prowess Dataset*.

3.4.2. Sources of Technology to the Firm

The firm has essentially used two sources of external technology. Embodied technology, through the importation of capital goods and disembodied through licensing agreements with a number of MNCs such as those with Kawasaki.

Table 18: Embodied vs. Disembodied External Sources of Technology

(Values are in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	NA	NA	NA	NA	NA	NA
Mar-01	NA	NA	NA	NA	NA	NA
Mar-02	NA	NA	NA	NA	NA	NA
Mar-03	NA	NA	NA	NA	NA	NA
Mar-04	NA	NA	NA	NA	NA	NA
Mar-05	NA	NA	NA	NA	NA	NA
Mar-06	NA	NA	NA	NA	NA	NA
Mar-07	NA	NA	NA	NA	NA	NA
Mar-08	49.28	15.14	64.42	9803.39	0.66	3.25
Mar-09	300.67	11.27	311.94	9590.25	3.25	26.68
Mar-10	32.11	10.56	42.67	1,2399.92	0.34	3.04
Average					**1.42**	**10.99**

Source: Compiled from CMIE *Prowess Dataset*.

Table 19: Internal Source of Technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average Propensity to Adapt
Mar-00	NA	NA	NA	NA
Mar-01	NA	NA	NA	NA
Mar-02	NA	NA	NA	NA
Mar-03	NA	NA	NA	NA
Mar-04	NA	NA	NA	NA
Mar-05	NA	NA	NA	NA
Mar-06	NA	NA	NA	NA
Mar-07	NA	NA	NA	NA
Mar-08	118.74	9803.39	1.21	7.84
Mar-09	114.87	9590.25	1.20	10.19
Mar-10	134.76	12399.92	1.09	12.76
Average				**10.27**

Source: Compiled from CMIE *Prowess Dataset*.

Bajaj is present in over 50 countries all over the globe. The firm has dominant presences in Africa, Latin America and South Asia with increasing market share every year. Bajaj is a market leader in motorcycles in Colombia, Central America, Sri Lanka, Bangladesh, Philippines, Nigeria, Uganda and Kenya.

3.5. Case Study 5: Mahindra and Mahindra

3.5.1. Brief History

Founded in 1945 as a steel trading company, Mahindra entered automotive manufacturing in 1947 to bring the iconic *Willys* Jeep onto Indian roads. Over the years, the company has diversified into many new businesses. It is now a US$7.1 billion multinational group with more than 112,000 employees in 79 countries across the globe. At present the company's portfolio comprises a wide spectrum of vehicles from two wheelers to heavy trucks, SUVs to schoolbuses.

The Product Mix of the Company includes: Aftermarket, Automotive & Farm Equipment, Defense Systems, Financial Services, Hospitality, Information Technology, Real Estate & Infrastructure, Systech, Two Wheelers and Mahindra Partners.

Table 20: Domestic Production, Sales and Exports (Values in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	4,320.79	74.13	1.72
Mar-01	4,277.87	92.22	2.16
Mar-02	3,936.05	114.72	2.91
Mar-03	4,499.71	203.05	4.51
Mar-04	5,888.84	217.46	3.69
Mar-05	7,654.77	312.42	4.08
Mar-06	9,362.26	465.10	4.97
Mar-07	11,651.16	614.96	5.28
Mar-08	13,552.47	795.38	5.87
Mar-09	15,186.15	639.13	4.21
Mar-10	20,323.63	736.68	3.62
Average			**3.91**

Source: Compiled from CMIE *Prowess Dataset*

3.5.2. Sources of Technology to the Firm

The firm has essentially used two sources of external technology. Embodied technology, through the importation of capital goods and disembodied through

licensing agreements with a number of MNCs such as those with Kawasaki.

From our founding in 1945, we've been connected internationally by business partnerships, a multinational workforce, and the boundless ambition to integrate ourselves with global communities and bring opportunity to customers across the world.

Table 21: Embodied vs. Disembodied External Sources of Technology (Values are in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	74.67	0.81	75.48	4,320.79	1.75	92.19
Mar-01	79.67	0.42	80.09	4,277.87	1.87	189.69
Mar-02	27.06	0.56	27.62	3,936.05	0.70	48.32
Mar-03	24.96	0.98	25.94	4,499.71	0.58	25.47
Mar-04	3.11	0.18	3.29	5,888.84	0.06	17.28
Mar-05	42.06	0.13	42.19	7,654.77	0.55	323.54
Mar-06	29.07	0.01	29.08	9,362.26	0.31	2,907.00
Mar-07	82.72	0.07	82.79	11,651.16	0.71	1,181.71
Mar-08	144.88	0.06	144.94	13,552.47	1.07	2,414.67
Mar-09	84.49	0.73	85.22	15,186.15	0.56	115.74
Mar-10	246.72	5.27	251.99	20,323.63	1.24	46.82
Average					**0.85**	**669.31**

Source: Compiled from CMIE *Prowess Dataset.*

Table 22: Internal Source of Technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average Propensity to Adapt
Mar-00	0	4,320.79	0	0
Mar-01	0	4,277.87	0	0
Mar-02	68.96	3,936.05	1.75	123.14
Mar-03	74.4	4,499.71	1.65	75.92
Mar-04	86.76	5,888.84	1.47	482.00
Mar-05	110.58	7,654.77	1.44	850.62
Mar-06	139.64	9,362.26	1.49	13,964.00
Mar-07	166.85	11,651.16	1.43	2,383.57
Mar-08	248.3	13,552.47	1.83	4,138.33
Mar-09	594.43	15,186.15	3.91	814.29
Mar-10	678.72	20,323.63	3.34	128.79
Average			**1.67**	**2,087.33**

Source: Compiled from CMIE *Prowess Dataset.*

3.6. Case Study 6: TVS Motors

TVS Motor Company (TMC) is the third largest two-wheeler manufacturer in India and one among the top ten in the world, with annual turnover of more than US$1 billion in 2008-2009, and is the flagship company of the US$4 billion TVS Group.

TVS Motor currently manufactures a wide range of two-wheelers from mopeds to racing inspired motorcycles. Motorcycles(Apache RTR 180, Flame DS 125, Flame, TVS Jive, StaR City, Sports)Variomatic Scooters(TVS Wego, Scooty Streak, Scooty Pep+, Scooty Teenz) Mopeds(TVS XL Super, TVS XL Heavy Duty). The company has 4 plants - located at Hosur and Mysore in South India, in Himachal Pradesh, North India and one at Indonesia. The company has a production capacity of 2.5 million units a year. TMCs strength lies in design and development of new products - the latest launch of 7 products on the same day seen as a first in automotive history. TMC has combined both internal external sources of technology. Some of the major technological milestones achieved by the company are summarized in Table 23.

The Product mix of the company includes: Two Wheeler and Three Wheeler.

Table 23: Major Technological Milestones Achieved by TVS Motors

1980	Launched TVS 50, India's first 2 seater 50 cc moped
1984	First Indian company to introduce 100 cc Indo - Japanese motorcycles
1994	Launched India's First indigenous scooterette (sub - 100 cc variomatic) - TVS Scooty
1996	Introduced India's first catalytic converter enabled motorcycle, the 110 cc Shogun
1997	Introduced India's first 5 speed motorcycle, Shaolin
2000	Launched India's first 150 cc, 4 stroke motorcycle - The Fiero
2001	Launched India's first fully indigenously designed and manufactured motorcycle.
2004	Launched the revolutionary VT-I engine for the best in class mileage in TVS Centra
2006	Launched TVS Apache - first bike to win 6 awards in a row
2007	Apache RTR - first two wheeler in India to have racing inspired engine and features.
2008	TVS Flame, TVS Scooty Electric Vehicle and Three wheeler TVS King launched.
2009	TVS Apache RTR 180 and TVS Streak launched.

Source: TVS Motor Company.

Table 24: Domestic Production, Sales and Exports (Values are in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	1,541.77	16.07	1.04
Mar-01	1,820.98	15.56	0.85
Mar-02	2,213.59	16.75	0.76
Mar-03	3,111.28	24.43	0.79
Mar-04	3,260.01	68.24	2.09
Mar-05	3,321.25	120.32	3.62
Mar-06	3,731.75	176.66	4.73
Mar-07	4,472.01	250.29	5.60
Mar-08	3,683.53	308.14	8.37
Mar-09	4,008.91	499.03	12.45
Mar-10	NA	517.18	
Average			**4.03**

Source: Compiled from CMIE *Prowess Dataset.*

Table 25: Embodied vs. Disembodied External Sources of Technology (Values are in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	31.84	18.7	50.54	1,541.77	3.28	1.70
Mar-01	10.06	17.24	27.3	1,820.98	1.50	0.58
Mar-02	21.33	15.76	37.09	2,213.59	1.68	1.35
Mar-03	71.32	2.88	74.2	3,111.28	2.38	24.76
Mar-04	51.25	0	51.25	3,260.01	1.57	
Mar-05	60.51	0	60.51	3,321.25	1.82	
Mar-06	17.99	0	17.99	3,731.75	0.48	
Mar-07	42.67	0	42.67	4,472.01	0.95	
Mar-08	14.19	0	14.19	3,683.53	0.39	
Mar-09	3.17	0	3.17	4,008.91	0.08	
Mar-10	8.13	0	8.13			
Average					**1.41**	**7.10**

Source: Compiled from CMIE *Prowess Dataset.*

Table 26: Internal source of technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average Propensity to Adapt
Mar-00	15.01	1,541.77	0.97	0.80
Mar-01	16.13	1,820.98	0.89	0.94
Mar-02	29.88	2,213.59	1.35	1.90
Mar-03	58.65	3,111.28	1.89	20.36
Mar-04	75.63	3,260.01	2.32	
Mar-05	71.74	3,321.25	2.16	
Mar-06	67.69	3,731.75	1.81	
Mar-07	85.03	4,472.01	1.90	
Mar-08	70.35	3,683.53	1.91	
Mar-09	77.71	4,008.91	1.94	
Mar-10	83.55	NA		
Average			**1.71**	**6.00**

Source: Compiled from CMIE *Prowess Dataset.*

3.7. Case study 7: Asia Motor Works

Asia Motor Works is a manufacturer of off-the-road vehicles. It was established in 2005 and has its plant at Bhuj in the north western state of Gujarat. The company has a number of foreign collaborations.

The Product mix of the company includes: Tippers, Tractors, Fully Built Vehicles, Haulage, Concrete Pumps and Transit Mixers.

Table 27: Domestic Production, Sales and Exports (Values are in Rs Crores)

Year	Sales	Exports	Export Intensity (%)
Mar-00	N A	N A	N A
Mar-01	N A	N A	N A
Mar-02	N A	N A	N A
Mar-03	N A	N A	N A
Mar-04	N A	N A	N A
Mar-05	N A	N A	N A
Mar-06	5.82	N A	N A
Mar-07	117.6	N A	N A
Mar-08	615.92	N A	N A
Mar-09	765.69	N A	N A
Mar-10	N A	N A	N A
Average			**N A**

Source: Compiled from CMIE *Prowess Dataset.*

Table 28: Embodied vs. Disembodied External Sources of Technology (Values in Rs Crores)

Year	Embodied Technology Imports	Disembodied Technology Imports	Total Technology Import	Sales	Import Intensity	Ratio of Embodied to Disembodied
Mar-00	N A	N A	N A	N A	N A	N A
Mar-01	N A	N A	N A	N A	N A	N A
Mar-02	N A	N A	N A	N A	N A	N A
Mar-03	N A	N A	N A	N A	N A	N A
Mar-04	N A	N A	N A	N A	N A	N A
Mar-05	N A	N A	N A	N A	N A	N A
Mar-06	N A	N A	N A	5.82	N A	N A
Mar-07	N A	N A	N A	117.60	N A	N A
Mar-08	N A	N A	N A	615.92	N A	N A
Mar-09	N A	N A	N A	765.69	N A	N A
Mar-10	N A	N A	N A	N A	N A	N A
Average					**N A**	**N A**

Source: Compiled from CMIE *Prowess Dataset.*

Table 29: Internal Source of Technology (Values are in Rs Crores)

Year	R&D Expense	Sales	Research Intensity	Average propensity to adapt
Mar-00	N A	N A	N A	N A
Mar-01	N A	N A	N A	N A
Mar-02	N A	N A	N A	N A
Mar-03	N A	N A	N A	N A
Mar-04	N A	N A	N A	N A
Mar-05	N A	N A	N A	N A
Mar-06	0	5.82	0	N A
Mar-07	0.14	117.6	0.12	N A
Mar-08	0	615.92	0	N A
Mar-09	7.87	765.69	1.03	N A
Mar-10	N A	N A	N A	N A
Average			**0.29**	**N A**

Source: Compiled from CMIE *Prowess Dataset.*

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APPENDIX

Table A1: List of Automobile Firms in India

Company Name	Owner	Product	Ownership
Andhra Pradesh Scooters Ltd.		Scooters	Domestic
Ashok Leyland Ltd.	Hinduja (Ashok Leyland) Group	Heavy commercial vehicles	Domestic
Asia Motor Works Ltd.	Private (Indian)	Heavy commercial vehicles	Domestic
Atul Auto Ltd.	Private (Indian)	Three wheelers	Domestic
Bajaj Auto Ltd.	Bajaj Group	Motorcycles	Domestic
Defence Land Systems India Pvt. Ltd.	Mahindra & Mahindra Group	Commercial vehicles	Domestic
Eicher Motors Ltd.	Eicher Group	Motorcycles	Domestic
Electromags Automotive Products Pvt. Ltd.	Wadia (Bombay Dyeing) Group	Automobiles	Domestic
Force Motors Ltd.	Firodia Group	Light commercial vehicles	Domestic
Gujarat Narmada Auto Ltd.		Scooters	Domestic
Hindustan Motors Ltd.	Birla C.K. Group	Passenger cars	Domestic
International Cars & Motors Pvt. Ltd.	Private (Indian)	Utility Vehicles incl. jeeps	Domestic
Kabirdass Motor Co. Ltd.	Private (Indian)	Automobiles	Domestic
Kerala Automobiles Ltd.		Three wheelers	Domestic
Kinetic Engineering Ltd.	Firodia Group	Mopeds	Domestic
Kinetic Motor Co. Ltd.	Firodia Group	Scooters	Domestic
Kranti Automobiles Ltd.	Private (Indian)	Three wheelers	Domestic
L M L Ltd.	LML Group	Scooters	Domestic
Maestro Motors Ltd.	Private (Indian)	Passenger cars	Domestic
Maharashtra Scooters Ltd.	Bajaj Group	Scooters	Domestic
Mahindra & Mahindra Ltd.	Mahindra & Mahindra Group	Utility Vehicles incl. jeeps	Domestic
Mahindra Navistar Automotives Ltd.	Mahindra & Mahindra Group	Light commercial vehicles	Domestic
Mahindra Nissan Allwyn Ltd. [Merged]	Mahindra & Mahindra Group	Light commercial vehicles	Domestic
Mahindra Two Wheelers Ltd.	Mahindra & Mahindra Group	Two wheelers	Domestic
Majestic Auto Ltd.	Hero (Munjals) Group	Mopeds	Domestic
Man Force Trucks Pvt. Ltd.	Firodia Group	Commercial vehicles	Domestic
Monto Motors Ltd.	Private (Indian)	Two wheelers	Domestic
New Holland Fiat (India) Pvt. Ltd.	Vinod Doshi Group	Passenger cars	Domestic
Pal-Peugeot Ltd.	Vinod Doshi Group	Passenger cars	Domestic
Scooters India Ltd.		Three wheelers	Domestic
Shree Chamundi Mopeds Ltd.	Private (Indian)	Mopeds	Domestic
Shriram Automall India Ltd.	Shriram Transport Group	Commercial vehicles	Domestic
Sooraj Automobiles Ltd.	Private (Indian)	Motorcycles	Domestic
Standard Motor Products Of India Ltd.	Private (Indian)	Light commercial vehicles	Domestic
Sunku Auto Ltd.	Private (Indian)	Three wheelers	Domestic
T V S Motor Co. Ltd.	T.V.S. Iyengar Group	Two wheelers	Domestic
Tata Motors Ltd.	Tata Group	Heavy commercial vehicles	Domestic
V C C L Ltd.	LML Group	Scooters	Domestic
V E Commercial Vehicles Ltd.	Eicher Group	Commercial vehicles	Domestic
Yamaha Motor India Pvt. Ltd.	Private (Indian)	Motorcycles	Domestic
Daewoo Motors India Ltd.	Private (Foreign)	Passenger cars	MNC
Ford India Pvt. Ltd.	Private (Foreign)	Passenger cars	MNC
General Motors India Pvt. Ltd.	Private (Foreign)	Passenger cars	MNC
Hero Honda Motors Ltd.	Hero (Munjals) Group	Motorcycles	MNC
Honda Motorcycle & Scooter India (Pvt.) Ltd.	Private (Foreign)	Scooters	MNC
Honda Siel Cars India Ltd.	Private (Foreign)	Passenger cars	MNC
Hyundai Motor India Ltd.	Private (Foreign)	Passenger cars	MNC
Maruti Suzuki India Ltd.	Private (Foreign)	Passenger cars	MNC
Mercedes-Benz India Pvt. Ltd.	Private (Foreign)	Passenger cars	MNC
Swaraj Mazda Ltd.		Light commercial vehicles	MNC
T V S-Suzuki Ltd. [Merged]	T.V.S. Iyengar Group	Two wheelers	MNC
Yamaha Motor Escorts Pvt. Ltd.	Private (Foreign)	Motorcycles	MNC

Source: Centre for Monitoring Indian Economy, *Prowess Dataset.*

Table A2: Summary Data on Export, Research and Import Intensity, 2000-2009

Year	Ashok Leyland			Tata Motors			Force Motors			Mahindra		
	Export Intensity	Research Intensity	Import Intensity	Export Intensity	Research Intensity	Import Intensity	Export Intensity	Research Intensity	Import Intensity	Export Intensity	Research Intensity	Import Intensity
Mar-00	5.62		0.33	7.07	1.24	1.99	1.23	1.01	1.27	1.72	0	1.75
Mar-01	6.08	0.86	1.16	9.13	1.14	0.22	0.76	0.00	0.05	2.16	0	1.87
Mar-02	5.87	0.93	0.86	7.18	1.07	0.48	0.67	2.18	2.91	2.91	1.75	0.70
Mar-03	6.48	0.97	0.95	4.49	1.35	0.93	1.49	2.28	0.37	4.51	1.65	0.58
Mar-04	7.36	1.22	0.50	6.62	1.00	0.39	1.05	2.32	1.35	3.69	1.47	0.06
Mar-05	10.65	1.88	1.27	7.19	1.95	1.50	1.10	2.80	1.70	4.08	1.44	0.55
Mar-06	7.28	1.69	1.33	9.37	2.03	1.52	1.48	5.20	4.36	4.97	1.49	0.31
Mar-07	7.39	1.84	3.18	8.67	2.57	2.13	2.50	3.51	2.32	5.28	1.43	0.71
Mar-08	8.22	2.20	1.93	8.49	3.69	4.58	3.53	2.60	0.49	5.87	1.83	1.07
Mar-09	12.64	3.89	6.12	7.74	5.18	3.58	3.38	2.48	0.00	4.21	3.91	0.56
Mar-10	7.48	2.90	3.90							3.62	3.34	1.24
Average	**7.73**	**1.84**	**1.96**	**7.59**	**2.12**	**1.73**	**1.72**	**2.44**	**1.48**	**3.91**	**1.67**	**0.85**

Year	TVS Motors			Bajaj Auto			Asia Motor Works		
	Export Intensity	Research Intensity	Import Intensity	Export Intensity	Research Intensity	Import Intensity	Export Intensity	Research Intensity	Import Intensity
Mar-00	1.04	0.97	3.28						
Mar-01	0.85	0.89	1.50						
Mar-02	0.76	1.35	1.68						
Mar-03	0.79	1.89	2.38						
Mar-04	2.09	2.32	1.57						
Mar-05	3.62	2.16	1.82						
Mar-06	4.73	1.81	0.48					0	
Mar-07	5.60	1.90	0.95					0.12	
Mar-08	8.37	1.91	0.39	20.89	1.21	0.66		0	
Mar-09	12.45	1.94	0.08	27.53	1.20	3.25		1.03	
Mar-10				26.18	1.09	0.34			
Average	**4.03**	**1.71**	**1.41**	**24.87**	**1.17**	**1.42**		**0.29**	

Source: Centre for Monitoring Indian Economy, *Prowess Dataset*.