Technology Adoption and Growth of Firms during Post Liberalisation: A Study of Indian Automobile Industry

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Abstract

The objective of this study is to examine the impact of government policies in transforming the technology and markets in the Indian automobile Industry. This study used fixed effect model to estimate the determinants of growth of firms across two different industrial policy regimes namely, liberalisation (1992-2002) and Auto-Policy (2003-2010). The results of fixed effect model showed that the differences in the technological strategies adopted that determined the differences in the growth of the firms in the liberalisation period. The results also showed that the import of capital goods is being still considered the main technology variable and play a significant role in contributing to the growth of firms in the same period. Growth of firms is also positively influenced by the foreign equity participation (which represents intra-firm technology transfer) in all the period. It is also found that the larger automobile firms are more likely to be dependent on foreign technologies for improving their firm-specific capabilities. During auto policy period, the coefficient of R&D variable has turned out to be positive but not significant indicating that although investment in R&D by automobile firms has improved, but it might not be very substantial degree for technology improvement. The sharpest rise in R&D investment is observed in only for large firms such as Tata Motors, Mahindra and Mahindra Ltd. and Maruti Suzuki Ltd etc. than smaller sized firms.

1. Introduction

The automobile industry grew under a highly regulated and protected economic environment over the period 1950 to 1980. They were subjected to strict product specific and capacity licensing and as a result very few firms dominated all the products. The policy environment during the period 1985-86 to 1990-91 permitted a limited role in technology inflow for technological upgradation. The Indian automobile industry embarked on a new journey in 1991 as a result of relaxed restrictions with the advent of liberalisation and globalisation. Though a few liberalisation measures had already been introduced in 1980s, the policy reforms initiated in 1991 were much more comprehensive. Indian government plays an important role in the development of the domestic automobile industry. The Government of India announced new automobile policy in June 1993 included measures, such as de-licensing of whole automobile segment, automatic approval for foreign holding of 51 per cent in Indian companies, abolition of phased manufacturing

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programme, reduction of excise duty, and commitment to indigenization schedules Mukherjee and Sastry, 1996). These policy measures considerably transformed the environment in which the firms had been operating. In the last two decades the Indian auto industry has emerged as one of the fastest growing industries with increasing level of technology and significant growth of firms. The policy decisions also changed the behaviour of the established firms with respect to technology acquisition and performance (Narayanan, 2001). The tariff structure for auto-related imports and for capital goods were reduced (Kathuria, 1996). As a result, the industry witnessed the entry of new firms, establishing joint ventures (JVs) with the domestic players and adoption of strategies by the already old firms to introduce technological change and improve their performance. The transfer of technology, flow of foreign direct investment and export liberalisation through expansion of market opportunities has increased interdependence and competition between the firms in the automobile market.

Since 2000, significant trade and investment restrictions were removed to speed up the momentum of liberalisation of the automotive industry. The turning point for the industry came in 2002, which Government of India formulated the Auto-Policy in March, 2002, with a vision to establish a globally competitive industry in India and to double its contribution to the economy by 2010.[2] It intended to promote R&D in the automotive industry by providing the provision of suitable fiscal and financial incentives. The export commitments for the already-existing foreign investors were abolished in August 2002. Coinciding with the second wave of liberalization, this phase from early 2002 till date has been marked by the removal of most import controls, entry of many more foreign players in the Indian automotive market and Indian companies gaining a global identity and acquiring foreign companies. The progressive reforms have brought higher in FDI inflows and number of foreign collaborations in the automobile manufacturing sector in India. The Indian government permitted automatic approval of foreign equity investment up to 100 per cent in automobile sector by lifting all equity caps for foreign investors.

The Automotive Mission Plan 2006-2016 was released in 2007, which visualizes India emerging as a destination of choice in the world for design and manufacture of automobiles and auto components.[3] The period from 2002 to till now is the most active phase of state policies encouraging cluster, increasing R&D support and infrastructure, establishing required institutions, etc. The important policy decisions during 1991-1992 to 20012-2002 are together grouped as 'liberalisation policy' and after 2002 known as 'Auto Policy 2002' (Ranawat and Tiwari, 2009). The purpose of this paper is to study the technological transfer with the help of government policies in the Indian Automobile Industry. In order to examine the effects of government policies on the behaviour of firms and drawing upon the knowledge, this paper has carried out to examine the nature of technological transfer in the firms across these two policies namely, liberalization policy (1992-2002) and Auto-Policy (2003-2010).

This paper is divided into six sections including introduction. Section 2 makes a discussion about the role played by the government in different stages of industry's development. Section 3 describes the trends in growth rate and the coefficient of variation of sales of firms in the Indian automobile industry. Section 4 presents the sources of data, sample, construction of variables and

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[2]GOI (2002), "Auto Policy, March 2002", Ministry of Heavy Industries & Public Enterprises, Department of Heavy Industry, Government of India, New Delhi.
[3]GOI (2006a), "Automotive Mission Plan 2006-2016", Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises, Government of India, New Delhi.

model. The empirical analysis and results are discussed in section 5. Section 6 summarises the major findings and conclusions with policy implications of this paper.

2. Literature Review: Theoretical Basis and Hypothesis

This section aims at discussing the influences of government policies on the development of India's automotive industry and an understanding of their impact on it. This paper briefly reviews the studies that cover wide variety of issues on firm's technology and development of industry under various policy regimes made by the government. Especially in the recent years, the Indian automobile sector is pushed forward to operate under huge competitive pressure both at home and world market due to the policy reforms it adopted. The issue of whether the government policy regime accelerates technological progress and growth of firms in Indian automobile industry is one of the debated issues in the literature. The theoretical models examining various aspects, through which government policy can affect technological progress and growth of firms. Thus, there are sound theoretical arguments supporting the move to more liberalised trade, but there are also equally sound theoretical arguments for protecting some industries from international competition; making the issue an important debate for empirical analysis (Hallak and Levinsohn, 2003).

In the Indian context, a number of studies have been done on the impact of industrial policy regimes on the technology acquisition and growth of firms in Indian automobile industry. In all of the studies, the growth story of Indian automobile industry is broadly characterized by three industrial policy regimes: protection (1947-1980), deregulation (1981-1990) and liberalization (1991 onwards), each regime marked by a specific macroeconomic environment, market structure and technology and external institutions. This phase of industrialisation during 1947-1980 was governed strictly by product-specific licensing system and also characterised by lack of technological capabilities in the Indian automobile industry. During 1980-1990, the industrial policy statements of 1977 and 1980 marked the beginning of deregulation in the Indian industrial sector.[4] The government allowed entry of domestic manufacturing in the passenger car segment, permitted increased foreign capital and overseas collaborations, and finally reduced the impact of production licenses on the scope of manufacturing operations. The nineties in contrast were marked by a broad array of reforms the effects of, which on aggregate growth were much more gradual. Under each policy regime, intensity of regulation is seen to be changing which provided different types of policy environment for development of the industry as shown in Table 1.

Table 1 shows the important policy decisions of different Industrial Policy Regimes since independence to its present day on the development of India's automotive industry. Various studies have evaluated the policy relevance for the development of Indian automobile industry and suggested that protection and other regulatory measures facilitated to build an indigenous technology (Hamaguchi, 1985; Agarwal, 1987; Narayana, 1989; Ranawat and Tiwari, 2009). Every shift in policies made by the government the automobile industry has come out stronger and better (Ranawat and Tiwari, 2009).

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[4]Deregulation in the industrial sector was done by relaxing the regulations pertaining capacity licensing, foreign collaborations, and the scope of industrial operations. Imports of capital goods, technology and raw-materials/components required for the modernisation were also treated more liberally.

Table 1: India's Industrial Policy Regimes and Technology

Phases	Main features.
Protective Policy Phase (1947-1980)	• Closed market • Restrictions on the manufacturing of automobiles by capacity and product licensing • Tariff barriers on vehicles imported in the CBU form. • Restrictions on capital imports, or foreign direct investment (FDI and import of components. • Barriers of entry for foreign firms • Emphasis on ancillaries development • Stricter controls on foreign equity collaborations
Deregulation Phase (1981-1990	• Relaxations in licensing system • Modernisation programme for automotive industry included relaxations in new entries, foreign equity collaborations and imports of technology and machinery. • Policy of broad bandin • Promotion of automotive exports • Joint ventures between domestic and foreign automobile manufacturers.
Liberalisation Phase (1991 onwards	• Dismantlement of industrial licensing • Automatic FDI approval up to 51% equity through automatic route • abolition of phased manufacturing programme (PMP) • Relaxation in imports of capital goods, raw materials and technology • Removed conditions like foreign exchange neutrality, license for imports,local content requirement etc. Foreign exchange neutrality • Rationalisation of tariff structure: reduction of excise duty and import duties of CKD and CBU • Major MNC Original Equipment Manufacturers (OEMS) commenced assembly in India • New 'Auto Policy' announced in 2002 - a separate policy, removal of most import controls and allowing foreign investment upto 100 per cent through automatic route. • Launch of NATRIP project • AMP 2006-2016 • Government's role reduced to providing direction to the industry. • Most active phase of state policies encouraging cluster, increasing R&D support and infrastructure, establishing required institutions, etc.

Source: Compiled by the author.

The studies by (D'Costa, 1995; Kathuria, 1996; Narayanan, 1998) argued that that policy measures could not maintain a balance between the degree of indigenization and technology development. Policy changes initiated in the 1980s induced competition which led to a complete restructuring of the automobile industry. Using the firm level data, Narayanan (1998) examines the effects of deregulation policy on technology acquisition and competitiveness in the Indian automobile industry during the 1980s. De-regulated policy regime allowed firms to get access to the modern technology which would not have been possible during the protective policy regime. Narayanan (2004) analyses the determinants of growth of Indian automobile firms during three different policy regimes, namely, licensing (1980-1981 to 1984-1985), deregulation (1985-1986 to 1990-1991) and liberalization (1991-1992 to 1995-1996). This study finds that vertical integration is detrimental for growth in a liberalized regime as it potentially limits diversification

The important policy decisions made in the first phase provided complete protection to the government enabling it to develop the industrial sector according to the national priorities (A. Singh, 2009). India's automobile industry's output was strictly controlled by licensing regulation, requiring the automobile firms to get prior permission from the licensing authority not only for raising their production capacity but also for product diversification.[5] So that government wanted to develop the indigenous technology from restricting industries from competition. The different industrial policy regimes influenced firm level learning processes and shaped technological capability accumulation (Saripalle, 2012). Although the policies adopted during this phase were related to protection, indigenisation and regulation of the automotive industry, but these policy decisions played a significant role in determining the initial structure, growth and performance of the industry and it led to mediocre industry performance (Narayana, 1989). Subrahmanium (1991) addresses that protectionist and regulated regime failed to provide a competitive environment for the firms to operate in the business. On the other hand policies eighties although helped the import of technology, increased the dependency on it and gradually reduced the internal learning through R&D efforts.

Post-1980's policy changes facilitated exploration and upgradation of technological capabilities. In the protection regime, in the absence of major acquisitions of diversifications, firms with foreign equity grew faster than others because of the resource advantage they possessed. Porter (1990) identifies government as an important variable that influences the competitive advantage of an industry by influencing the national environment in which it operates. It suggests a varying role for the government as an industry progresses through consecutive stages of competitive development. In 1985, policy of broad banding was introduced by the government.[6] Once firms got license for the broad category they were not required to get any additional clearance for diversifying within their product group, provided the diversification would not require any new investment in machinery (Mani, 2011; Kale, 2012; Saripalle, 2012).

Further, the policy relaxations encouraged entry of many new firms and provided incentives for export promotion and ensured a flexible use of the installed capacity. The passenger car and commercial vehicle segment also witnessed a major change during this phase. During the deregulation period, firms relied on technology imports and growth through spillovers from new

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[5]Firms had no threat of losing market to any competitor, nor any incentive either to upgrade existing technology or to introduce new products. Protective policy regime till 1980s helped indigenization of production activities. It led to inadequate development on the front of technology.

[6]In 1985, the broad-banding grouped passenger cars, CVs and UVs into one product group named 'on-road four-wheelers'. This meant that an automotive firm could diversify its product range from commercial vehicles to car manufacturing. It allows firms to invest in several product lines which resulted in firm learning.

competitors. The policy changes thus led to substantial flexibility in the functioning and also induced competition in the automobile industry. In line with 1980s' policy changes, a comprehensive reform package was announced in early 1990s allowing entry of foreign firms along with the removal of restrictions on the import of raw material and technology. These relaxations were aimed at developing a modern and competitive automobile industry in India. The liberalization of policies like abolition of industrial licensing, automatic approval for inward foreign investment, technology imports and liberal approach to trade, put this sector on a dynamic process of technological acquisition at the firm level.[7]

Several studies have found that technology plays an important role in growth of firms. It is hypothesized that technology acquisition has a positive impact on growth of firms. Technology acquisition by a firm can be facilitated through imports (technology transfer from abroad) and in-house R&D. Following Basant (1997) and Narayanan (1998), it could be argued that the technological strategies adopted by a firm could be different during varying policy regimes. Many authors (Basant, 1997; Siddharthan and Safarian, 1997; Pandit and Siddharthan, 1998; Narayanan, 1998; Narayanan, 2004) have empirically analyzed the technological strategies, competitiveness, and growth of manufacturing firms in India during various policy regimes. These studies have specifically tried to understand how the differences in the firm characteristics may determine the competitiveness of the firms in Indian manufacturing industries including Automobile Sector. The main technological strategies from external sources considered are imports of embodied technology (in the form of import of capital goods), import of disembodied technology (from the market through lump sum payments, royalties, and technical fees) and from domestic sources in house R&D.[8]

In modern industrial world, firms' investment in R&D is an important source of technological progress. Investment in R&D is required not only for introducing innovations, but also for adapting and absorbing technology from outside sources (Cohen and Levinthal, 1989). Further, policy makers are usually told that with the liberalisation of trade, firms would have no choice but to modernise their techniques and cut their costs in order to compete with the foreign producers. Likewise, imported plants and machinery may also require adaptations and modifications to suit local conditions, raw materials and usage pattern, making some investment in in-house R&D necessary (Basant, 1997). In this context, mode of technology import and policy environment are

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[7]Under liberal policy regime, development of the industry is not only influenced by the internal conditions of the economy but external factors are very critical in developing technological capabilities and achieving growth of automobile industrial sector. Technological capabilities of the automobile firms improved and directly stimulated the export intensity by adding to the competitiveness under the liberal policy regime.

[8] Embodied technology: Embodied' technology is identified with 'hardware' and consists of tools, machinery, equipment and vehicles, which together make up the category of capital goods. Disembodied technology: Disembodied technology is identified with 'software' and encompasses the knowledge and skills required for the use, maintenance, repairs, production, adaptation and innovation of capital goods. The payments for royalty, technical fees (for know-how, of drawings, designs, etc.), professional and consultation fees and others is taken as a measure of disembodied technology or technology imports intensity (MT). These payments can be taken to understand the purchase of disembodied technology from abroad. R&D expenditure statistics partial accounts for the actual research activities that happen in firm. In India, Department of Science and Technology (DST) gives R&D expenditures statistics at industry level and Centre for Monitoring India Economy (CMIE) at the firm level. Despite all these shortcomings, R&D expenditure statistics given by both DST and CMIE, is widely used in the Indian literature as proxy variable for innovative effort. Research and development intensity is measured by research and development expenditure as a proportion of sales (R&D).

emphasized as factors determining the relationship between technology import and local R&D effort (Subrahmanian, 1991).

With shifts in plan priorities, technology has acquired a stronger focus. Restrictions on technology imports and foreign equity participation are being relaxed. At present, foreign participation is allowed in almost all sectors (not reserved for the government). However, some of the technologies may be obtainable only through majority ownership or project specific joint ventures. Thus, the technology advancement through foreign collaboration is also an important means of transfer of technology. Indeed, foreign collaboration in equity seems to bring relatively efficient technologies into host country and thus increase the growth of firms of the host country. Companies will be averse to unbundling and selling knowledge or products if there are important incentives for internalisation and thus companies will prefer foreign collaboration for transferring knowledge. Studies have found that foreign equity participation have a positive impact on growth of firms (Blomstrom and Persson 1983). Mani (2011) analyse the performances of domestic and MNCs within Indian automobile with respect to 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. Kumari (2012) has analysed the impact of globalisation on growth of firms in Indian manufacturing industry during post reform period. The study shows an important finding that among various aspects of globalisation, the imported capital goods considered to be the main source of technology transfer that has a positive and significant role in generating growth of firms.

Kathuria's (1996) studies on the technology acquisition capabilities by various automobile manufacturers in the Indian industry and highlights the competitive strategies of various four wheeler manufacturers in the acquisition of know-how (production) and know why (R&D) capabilities during various policy regimes. It can be seen that in early 1990s, majority of automotive firms in India hardly had any significant in-house spending on R&D activities. The sharp competition from inward FDI and imports and stringent requirements from global buyers by mid-1990s have forced a significant proportion of them into R&D investment. According to SIAM (2008), the Auto Policy of 2002 has spelt out the direction of growth for the auto sector in India and addresses most concerns of the automobile sector, including-Promotion of R&D in the automotive sector to ensure continuous technology upgradation, building better designing capacities to remain competitive. In August 2006, a Draft of Automotive Mission Plan by the Ministry of Heavy Industries and Public Enterprises suggested measures such as setting up of a National Auto Institute, streamlining government/educational/research institutions to the needs of the auto industry, upgrading infrastructure, considering changes in duty structure and fiscal incentives for R&D.

In line with these above technological variables, thus an understanding of firm specific variables such as firm size, age and profit of the firm and vertical integration are important for growth of firms. The empirical literature has shown mixed results on relationship between size and growth of firms (Singh and Whittington, 1975). Thus, increase in the age of the firm is expected to possess a positive or negative effect on growth of firm. Profit is also an important indicator of the financial performance of an industry. On the basis of the Downie-Penrose-Marris approach one would expect there to exist a dual relationship between growth and profitability. Capital intensity is expected to be positively related to growth of firm (Hay and Morris, 1991) on the ground that higher capital intensity facilitates better machinery and thus will be more competitive. Siddharthan et al (1994) found a positive coefficient for capital intensity in analysing the growth of firms. Firms often produce their intermediate products in-house rather than procuring from outside in order to

ensure quality and timely supplies of inputs and intermediate products. Vertical integration is then expected to have a positive effect on growth of firms. Patra and Rao (2012) have attempted to analyse the effects of trade liberalisation on productivity growth performance of Indian automobile industry. Their study finds that the economic reforms in 1991 were helpful to automobile industry by increasing access to foreign technology and cheaper capital goods and raw materials during post liberalisation period.

3. Policy Regimes and Growth of Sales of Firms

The Indian automobile industry has shown increasing levels of technological upgradation and growth of firms over the last two decades. The entry of many global players that made the Indian automobile industry more efficient and domestic markets very competitive. It is the post-entry performance of new firms that could affect the growth of already existing firms. During this period, the Indian automobile industry is dominated mainly by diversified and large business groups such as Tata Group and Mahindra and Mahindra. Growth is a necessary condition for the long run survival of the firm in an uncertain and constantly changing policy environment. Growth of firm is subjected to various dynamic and strategic processes. Growth of firms, in this analysis, is defined in terms of rate of change in the annual sales turnover at current prices. This study is confined to the manufacturers of commercial and passenger vehicle sectors. The average annual growth rate and the coefficient of variation of sales turnover in current prices of Indian automobile firms during the two periods, are presented in table 2.

Table 2: Average Annual Growth of Indian Automobile Firms and its Variability

Firms	Policy Regimes			
	Liberalisation policy period (1992-93 to 2001-2002		Auto Policy period (2002-03 to 2009-2010	
	Mean	CV	Mean	CV
ALL	12.31	149.11	14.09	140.23
EML	15.89	142.08	15.41	367.55
FML	10.77	193.22	6.12	303.88
SML	15.44	115.51	11.82	146.83
TATA	14.48	193.80	18.62	96.36
HML	12.81	97.68	-2.29	1747.14
M&M	15.77	77.24	17.25	70.87
MSI	20.25	103.52	12.88	66.73
DMI[*]	3.28	677.74	-	-
PAL[*]	-2.46	991.4	-	-
All Firms	15.33	122.50	14.40	91.40

Source: Computed. Prowess Data Base, CMIE, 2009.

Note: CV. represents coefficient of variation in the respective growth rates. ALL: Ashok Leyland Ltd, FML: Force Motor Ltd, Eicher Motors Ltd. (EML); TATA: Tata Motors Ltd, SML: Swaraj Mazda Ltd, HML: Hindusthan Motors Ltd., M&M: Mahindra and Mahindra Ltd and MSI: Maruti Suzuki Ltd. DMI: Daewoo Motors ltd., PAL: Premier Automobiles ltd. Blank boxes indicate non-existence of firms during the major part of the period. * denotes calculation by Narayanan (2004).

Table 2 shows the industry leader is Maruti Suzuki Ltd (MSI) followed by Tata Motors and Mahindra & Mahindra. In the last two decades these firms have emerged as India's leading

automobile manufacturers and innovators in the passenger car segment. There is a large difference in terms of growth across the firms in the first period, whereas the differences among the firms have been declined in the second policy period. It is clearly revealed by the average annual growth rate and the coefficient of variation (CV) of sales turnover of all firms. While the average annual growth rate of all firms and CV are 15.33 and 122.5 per cent in the first policy period, the average annual growth rate of all firms and CV in the second policy period are 14.04 and 91.40 per cent. It shows that firms in the Indian automobile industry had higher annual average growth rates in the liberalisation policy period, while the annual average growth rates of firms started to decline in the Auto Policy period. However, both growth rates as well as the coefficient of variations were lower in the Auto policy period. For individual firm wise, the growth rate of Hindustan Motor is negative during second period and its variability is very large because the company had remained confined to only one brand. By the late 1980's MUL became the market leader over HML. HML was unable to create barrier for potential new entrants of new firms to compete with their existing strategies. Both Ashok Leyland and Tata Motors operate in the heavy commercial vehicles segment of the automobile industry and have long experience of being in this business. Similarly Maruti Suzuki and Mahindra and Mahindra operate in the passenger cars and utility vehicles. Maruti has also diversified into various assembly lines (variety of cars for different market segments, vans and other utility vehicles), but TATA has the distinction of operating in all the three markets (light, medium and heavy commercial vehicles, and cars including Nano cars) and is a market leader in both LCV as well as MHCV sectors. They had significant influence on development of technological capabilities. In 2008 Tata Motors launched Tata Nano, the world's cheapest car. Tata Nano was a product of Tata R&D and involved innovative design to keep cost down. In the same year another Indian firm, 'Mahindra and Mahindra' launched a sports utility vehicle, 'Scorpio', again a product of the indigenous design and development effort. PAL and DMI were out of business in mid1990 after the entry of new firms. But in the protection regime Indian automobile industry was dominated by two manufacturers: Hindustan Motors (HM) and PAL.

4. Sample, Data and Methodology of Analysis

The analysis explained in this study is based on secondary data. The main sources of the data used are from Centre for Monitoring of Indian Economy (CMIE). The data set contains firm level data for ten automobile manufacturing companies for the period 1991–1992 to 2009– 2010. The data relate to firms assembling or producing cars and other four wheeled drives, light commercial vehicles, and the heavy commercial vehicles. The time period of industrial policy regimes is divided into two different policy regimes namely liberalisation Policy (1992-2002) and auto-Policy (2003-2010). The study attempts to examine the determinants of growth of firms in the following functional form:

Growth = f (IMCAP, MT, RD, FE, S, PCM, VI, CI, AGE EX)   (1)

4.1. Measurement of Variables

Growth of firm (G): growth of firms defined in terms of rate of change in annual sales turnover;

Import Intensity (IMCAP): The ratio of import of capital goods to sales is taken as a measure of capital goods import intensity.

Technology Imports intensity (MT): The ratio of payments for royalty, technical fees professional and consultation fees and others to sales is taken as a measure of technology imports intensity.

RD intensity (*RD*): measured by research and development expenditure as a proportion of sales.

Foreign Equity Participation (FE): percentage of foreign equity shares to the total paid up capital of the firm.

Size (S): The logarithm of sales is taken as the size variable.

Price-cost margin (PCM); is defined by gross profits as a proportion of sales turnover;

Vertical Integration (VI): The ratio of gross value added to gross sales is used as a measure of vertical integration.

Capital Intensity (CI): Capital intensity is measured as a ratio of gross fixed assets to value added.

AGE: Age of machinery is measured as ratio of accumulated depreciation to fixed assets.

Export Intensity (EX): Export intensity is measured as ratio of exports to sales.

This study estimates fixed effects models to analyse the determinants of growth of firms during two different policy regimes. The Hausman's test statistic is conducted and it rejects the null hypothesis of zero correlation between firm specific factors with size. The random effect model assumes that firm-specific factors are correlated with size and age. Hence, the study uses a two-way fixed effect model to estimate the coefficients. Thus, this study employs a fixed effects panel data model which allows for both firm fixed effects and time fixed effects within the same model. The fixed effect model is written in the following functional form:

$$y_{it} = \alpha + X'_{it}\beta + \mu_i + \lambda_t + v_{it} \qquad (2)$$

where i denotes cross sections and t denotes time periods with i = 1, 2.., N, and t = 1, 2,…,T. α is a scalar, β is K×1 and X_{it} is the it[th] observations on K explanatory variables. μ_i captures all of the variables that affect y_{it} cross-sectionally but do not vary over time. λ_t is a time-varying intercept that captures all of the variables that affect y_{it} and that vary over time but are constant cross-sectionally. The term $\alpha+\mu_i$ is the intercept for firm i. Similarly, $\alpha+\lambda_t$ is the intercept for year t. Here, we can easily allow for the (fixed effect) intercept to vary among the firms and time by using the dummy variable technique. This model is known as fixed effect least-squares dummy variable regression model (LSDM).[9] The least squares dummy variable approach involves introduction of (n-l) number of firm dummies and (T-l) number of time- specific effects. v_{it}'s are the usual classical IID random variables with 0 mean and variance $\sigma^2 v$.

4.2. Testing for Fixed effects

Restricted F-test is performed to conduct the joint significance of these dummies, i.e., H_0: $\mu_{1=}\mu_2 = \cdots = \mu_{N-1} = 0$. This is a simple Chow test with the restricted sum of squares being that

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[9]B. H. Baltagi (1995), "*Econometric Analysis of Panel Data*", John Wiley and Sons, New York.

of OLS on the pooled model and unrestricted sum of squares being that of the LSDV regression. It would involve incorporating the restriction that all of the intercept dummy variables have the same parameter.

5. Discussion of Empirical Results

The Least Square Dummy Variable results of the slope parameters are presented in Table 3. The coefficients and their t values of the explanatory variables are provided in two different columns for two policy regimes in Table 4.

Table 3: Fixed Effects Estimation of Determinants of Growth* by Policy Regime (Dependent Variable: Sales Growth)*

Variable	Liberalisation Policy (1992 -2002)	Auto-Policy (2003 - 2010)
C	74.121(2.39)**	19.705(1.95)**
S	80.018 (4.62)***	62.912 (7.66)***
CI	0.176 (4.69)***	-1.425(8.21)***
AGE	-1.844 (0.88)	-5.011(3.97)***
IMPCAP	0.824 (1.69)*	5.290 (2.27)**
MT	-15.512 (1.71)*	0.200(0.42)
PCM	0.978 (3.78)***	0.702 (1.61)
VI	-4.945 (4.00)***	-1.523 (2.03)**
RD	-10.886 (1.88)*	3.309 (1.41)*
EX	-2.003 (2.11)**	0.587 (1.27)
FE	0.387 (1.68)*	0.206 (1.69)*
R^2	0.72	0.76
F	10.00	10.91
NOBS	90	81
No of Firms	9	9

* Panel data with firm and year dummies.
Notes: t-ratios in parentheses; *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

Table-3 shows the fixed effect estimation results of determinants of growth by policy regimes in Indian automobile industry. The estimated results shows that the technological variables such as import of embodied technology (IMPCAP) and foreign equity (FE) have significantly positive impact on growth of firms during both the periods. This implies that the firms might import more capital goods and equipment's for processing the technology. The increase in imports of capital intensive goods was facilitated by trade liberalisation, which might increases growth performance of the automobile Industry in India (Narayanan and Joseph, 1993). It might be possible that the import of capital goods by automobile firm increased since 1991, and these probably could be optimally utilised. Foreign equity participation (which represents intra-firm transfer of technology) has significantly positive impact on growth of firms indicating that foreign equity participation and spillovers resulting from inter-firm relations have some specific advantage achieving high rates of growth during the periods as it was also observed by (Markusen, 1995). According to Siddharthan and Lal (2003), the industry appears to experience certain technology spillover effects (of the FDI) during the same period. With liberalisation multinational firms could have majority equity holdings and therefore influence management of the firm as well. Foreign participation in management may improve company efficiency. The coefficients of MT and RD Have turned out to be negative and statistically significant impact on growth of firms during first period. This may indicate that the

large firms might purchase the technology both in embodied and disembodied technologies from external sources and R&D intensity by automobile firms are very low during this period. Panda and Oba, (2000) in their study reported that though there has been an increase in the technology import intensity since 1991 but R&D by automobile firms has been generally low till 2000. Fluctuations are observed in the number of firms investing in R&D, the reasons for this is unknown. It should be noted all the firms are listed firms, thus this data unfortunately does not capture small firms.

There are other explanatory variables (i.e., firm specific variables) such as firm size, capital intensity and profit are turned out to be positively significant whereas age of the firm, vertical integration and export intensity are found to be negative impact on growth of firms in the Indian automobile industry. This implies that big firms may have market power or may enjoy economies of scale which is associated with profit of firms. This result shows a positive relationship between firm size and growth of firms as similar results were reported by Siddharthan et al (1994). Following Morris, it could be stated that profits determine the ability and willingness of the firm to grow. Liberalisation and change in the macroeconomic environment, profit margins of firms can be expected to have gone up. This is because most of the firms in the automobile sector would have already been established and new firms would not have captured a large market share. The coefficient of capital intensity is positive and statistically significant. Capital intensity is expected to be positively related to growth of firm because higher capital intensity facilitates better machinery and thus will be more competitive (Hay and Morris, 1991). Siddharthan et al (1994) reported a positive relationship between capital intensity and growth of firms. Age of the firm has turned out to be negative and not statistically significant. The coefficient of vertical integration has emerged negative and highly statistically significant. Narayanan (1998) reported that VI is detrimental effect on growth of firms during liberalisation regime in the Indian automobile industry. It might be stated that liberalisation of economic and trade policies might lead to higher costs of imported components and parts. Export intensity is found to be negative coefficient and significant in this period indicating that although liberalisation policies helped the automobile firms to be technologically active and promote exports, but the quality of the product is not to the international standard.

During the auto policy period, the coefficient of MT is found to be positive and have no influence on growth of firms. This implies that firms spend more on import of capital goods and might spend least on purchasing disembodied technology from abroad. The coefficient of RD emerged positive and not significant. With more open policy environment, increasing competition and higher costs of technology's imports forced firm to direct their efforts to build capabilities for technology generation, rather than depend on imports. Though 'Auto policy' offered better incentives to firms to invest in RD, but the investment by firms in RD is not very substantial. This study also has found that the large firms have consistently emphasized in-house R&D than smaller sized firm during this period while selectively importing technology. The coefficient of age of the firms is found to be negatively significant. Thus, firms which acquired new machinery have been found to have larger growth than the firms with old machinery because new machinery is more productive and efficient. However, capital intensity has been found negatively significant role in the growth of firms.Vertical integration has come out as significant with negative sign. Following Williamson (1985), it could be argued that vertical integration takes place in order to minimise the transaction cost. This inverse relationship between VI and growth could largely be due to the limits that VI imposes on the firms to diversify into other sectors within the automobile industry during this 'Auto Policy' period. The coefficient of export intensity has turned out to be positive and significant. Export intensity of automobile industry has been found to be more consistent and

visible only since 2001. Passenger vehicles sector seems to be the only segment which has experienced considerably high growth and improvement in export intensity as well. The coefficients and t values of all the firm specific dummies introduced in the equation are given in Table 4.

Table 4: Fixed Effects Estimation of the Determinants of Growth* by Policy Regime: Coefficients of Firm Dummies

Variable	Liberalisation Policy (1991-92 to 1999-02)	Variable	Auto-Policy-2002 (2002 -03to 2009-10)
Constant	83.332 (3.23)***	Constant	19.705 (1.84)
DALL	39.477 (2.37)**	DALL	15.552 (1.14)
DFML	47.761(1.91)	DFML	10.861 (0.79)
DSML	29.681(2.92)	DSML	35.410 (1.42)
DTATA	44.919(2.02)	DTATA	16.231 (1.11)
DM&M	29.373 (2.48)	DM&M	23.683 (1.56)
DHML	21.117 (2.93)	DHML	24.446 (1.95)
DMSI	59.573 (1.14)	DMSI	21.151 (1.46)
DDMI	82.803 (0.02)	DEML	40.541 (2.07)
F-Statistics	$F(8, 81)= 9.75$***		$F(10, 78)= 11.20$***

*Panel Data with Firm and Year Dummies. t-ratios in parentheses; *, ** and *** denote significance at the 1%, 5% and 10% levels respectively.
Notes: (i) The null hypothesis that the firm effects are jointly zero was tested by using the F – test. $H_0 : \eta_i = 0$; H_1 : not H_0. The null hypothesis that the firm effects are jointly zero ($H_0 : \eta_i = 0$) is rejected at the 1% level of significance for the first and second period indicating that differences in the growth among the firms during this period.
(ii) The p-value of the Hausman test statistic is zero indicating that the random effect model is not appropriate and that the fixed effects specification is to be preferred.

Since the intercept term turned out to be significant in this period, the coefficients of firm dummies (statistically significant ones) are added to that of the intercept term. The significant coefficients for these dummies do indicate the presence of the differences in terms of growth across the firms. The results find that most firm dummies except few are significant suggesting that there is firm effect in the first period but not pronounced in the second period. Similarly, all time dummies are introduced in order to control for annual fluctuations in the growth of firms during this two policy regimes in India. The results found that none of the time dummies are significant suggesting that there is no time effect in this period, but there is only individual firm effect. Hence, we have not reported the coefficients of time dummies here.

6. Conclusion and Policy Implications

Empirical analysis is broadly divided into two policy periods. The results of fixed effect model showed that the differences in the technological strategies adopted that determined the differences in the growth of the firms in the liberalisation period as also observed in (Narayanan, 2004). The import of capital goods is being considered the main technology variable in contributing to growth of firms during both the policy periods. Technology licensing has turned out to be negatively significant since the firm purchases least on import of disembodied technology, they tend to substitute for in- house RD to develop technologies. Therefore, the relationship between technology licensing and in- house RD may be substituting type or complementary, depending

upon these two opposite effects. The RD variable also has significantly negative impact on growth of firms. It also indicates that although RD by auto firms are increased as the 'Auto policy' offered better incentives to promote it, but it might not be adequate for technology improvement. Large firms have consistently emphasized in-house R&D than smaller sized firm. The sharpest rise in R&D investment is observed for large firms such as TATA, MSI and M&M etc. However, there has been an increase in the technology imports since 1991 but R&D by auto firms was low during this period. The technology through intra-firm transfer of technology in equity form seems to bring relatively efficient technologies and thus increase the growth and efficiency of firms in the industry. The ability to influence the management skill may have led change of design and drawings which increased the diffusion of technological knowledge to improve the growth of firms. As evident from the analysis, technological capabilities of the automobile firms are enhanced and promotes the growth of firms under the liberal policy regimes. It is also found that the larger automobile firms are more likely to be dependent on purchase of foreign technologies (both embodied and disembodied) for improving their firm-specific capabilities during these policy regimes (see Appendix, Table 1).

Firm's growth is also significantly associated with some of firm specific variables such as firm size, profit etc. and export intensity of firms. Increasing technological capabilities can directly stimulate the export intensity by adding to the competitiveness. It is found that relaxing the restrictions on access to foreign technology that has widened the choices of technology that Indian firm can avail. However, we find evidence that firms in the automobile industry imported sophisticated process technologies and developed in- house R&D capabilities to adapt them to the local environment during post liberalisation period. This study may suggest that in order to increase the domestic technology and become more competitive as comprised in 'Auto Policy', the firm may transform themselves by increasing more R&D investment in the long term in a liberal policy environment. The main challenge for Indian automobile firms is to establish a reputation for world class technology, which requires substantial and long term investments. All these policy changes had a significant impact on the development of firm level capabilities, domestic market and industrial structure. However, it also indicates the key role of managerial vision, influence of MNC firms, linkages to knowledge sources outside firms and entrepreneurial skill and firm's ownership play significant role in developing technological capability and growth of firms.

Acknowledgments

References

Agarwal, R. N. 1991. Profitability and Growth in Indian Automobile Manufacturing Industry. *Indian Economic Review* 26:1, 82-97.

Baltagi, B. H., 1995. *Econometric Analysis of Panel Data*, John Wiley and Sons, New York.

Basant, R. 1997. Technology Strategies of Large Enterprises in Indian Industry: Some Explorations. *World Development* 25:10, 1683-1700.

Blomstrom, M. and H. Persson. 1983. Foreign Investment and Spillover Efficiency in an under developed Economy: Evidence from the Mexican Manufacturing Industry. *World Development* 11: 6, 493-501.

Cohen, Wesley M. and Daniel A. Levinthal. 1989. Innovation and Learning: The Two Faces of R&D. *The Economic Journal* 99, 569-596.

D'Costa, A. 1995. The restructuring of the Indian automobile industry: Indian state and Japanese capital. *World Development* 23:3, 485-502.

GOI. 2002. Auto Policy, March 2002, Ministry of Heavy Industries & Public Enterprises, Department of Heavy Industry, Government of India, New Delhi.

GOI. 2006b. *Report of Working Group on Automotive Industry - Eleventh Five Year Plan (2007-2012)*, Department of Heavy Industry, Ministry of Heavy Industries & Public Enterprises, Government of India, New Delhi.

Hall B.H. 1987. The Relationship between Firm Size and Firm Growth in the U.S. Manufacturing Sector. *Journal of Industrial Economics* 35:4, 583-606.

Hallack, Juan Carlos., and James Levinsohn. 2003. *Fooling Ourselves: Evaluating the Globalisation and Growth Debate*, mimeo, Department of Economics, University of Michigan.

Haller, S. 2004. The Impact of Multinational Entry on Domestic Market Structure and R and D, European University Institute working paper No. 2005/16.

Hamaguchi, T. 1985. Prospects for self-reliance and indigenization in automobile industry (case of Maruti-Suzuki project. *Economic and Political Weekly* 20:35, M115-M122.

Hart, P. 1962. The Size and Growth of Firms. *Economica*, 24:113, 29-39.

Hay Donald A. and Morris, D. J. 1991. *Industrial economics and organisation: Theory and Evidence*, Oxford University Press.

IBEF, 2008. Automotive market & opportunities, India Brand Equity Foundation, New Delhi. The India Brand Equity Foundation (IBEF) is a Public Private Partnership between the Ministry of Commerce and Industry, Government of India and the Confederation of Indian Industry.

Kale, D. 2012. Sources of innovation and technology capability development in the Indian automobile industry, *International Journal of Institution and Economics*, 4:2, 121-150.

Kathuria, S. 1996. *Competing through technology and manufacturing. A study of the Indian commercial vehicles industry,* Delhi: Oxford University Press.

Kumar, Nagesh and N.S. Siddharthan, 1994. Technology, Firm Size, and Export Behavior in Developing Countries: the Case of Indian Enterprise. *Journal of Development Studies* 31:2, 289-309.

Kumari, A. 2012. Impact of Globalisation on Growth of Firms – An Empirical Analysis of Indian Manufacturing Industry. *Interdisciplinary Journal of Contemporary Research in Business* 3:11, 360-371.

Mani, S. 2011. The Indian Automotive Industry: Enhancing Innovation Capability with External and Internal Resources, in: Intarakumerd, P. (Eds.), *How to Enhance Innovation Capability with Internal and External Sources*. ERIA Research Project Report, Jakarta, 1-39.

Morris, R. 1964. *The Economic Theory of Managerial Capitalism*, Macmillan, London.

Mukherjee, Avinandan and Trilochan Sastry (1996). Automotive Industry in Emerging Economies: A Comparison of South Korea, Brazil, China and India. *Economic and Political Weekly* 31:48, M75-M78.

Narayana, D. 1989. *The motor vehicle industry in India (Growth within a regulatory policy environment*, Oxford & IBH Publishing Co. Pvt. Ltd. and Centre for Development Studies, New Delhi and Trivandrum.

Narayanan K. 1998. Technology Acquisition, De-regulation and Competitiveness: A Study of Indian Automobile Industry. *Research Policy* 27:2, 217-230.

Narayanan, K. 2001. Liberalisation and the differential conduct and performance of firms: A study of the Indian automobile sector. The Institute of Economic Research, Hitotsubashi University and United Nations University Institute of Advanced Studies.

Narayanan, K. 2004. Technology Acquisition and Growth of Firms: Indian Automobile Sector under Changing Policy Regimes. *Economic and Political Weekly* 39:6, 461-470.

Panda, H. and H. Oba, 2000. Liberalisation and Strategy of Growth of the Indian Automobile Firms. *Reitaku International Journal of Economic Studies* 8:2, 1-22.

Pandit, B.L. and N.S. Siddharthan, 1997. Technological Acquisition and Investment: Lessons from Recent Indian Experience. *Journal of Business Venturing* 13:1, 43-55.

Patra, T. and J. M. Rao 2012. Trade Liberalisation and Productivity Growth of Indian Automobile Industry, in: Ahmed, S. and S. Ashraf (Eds.), *International Trade in Emerging Economics*. Bloomsbury Publishing India Pvt. Ltd., New Delhi, 269-290.

Pingle, V. 1999. *Rethinking the Developmental State,* New York: St. Martin's Press.

Porter, M. E. 1990. The competitive advantage of nations, New York: The Free Press.

Ranawat, Mahipat and Rajnish Tiwari, 2009. *Influence of Government Policies on Industry Development: The Case of India's Automotive Industry,* Wp. No. 57, Hamburg University of Technology, Institute of Technology and Innovation Management.

Saripalle, Madhuri, 2012. *Learning and Capability Acquisition: A Case Study of the Indian Automobile Industry*, Working Paper 65/2012. Madras School of economics.

SIAM, 2006. *The Indian Automobile Industry: Statistical Profile 2005-06*, Society of Indian Automobile Manufacturers, New Delhi.

Siddharthan, N. S. and Krishna, K.L. 1994. *Determinants of Technology Imports: Evidence for Indian Firms, Institute of Economic Growth,* Working Paper Series E/161/94.

Siddharthan, N. S. and A.E. Safarian, 1997. TNCs, Technology Transfer and Import of Capital Goods: Recent Indian Experience. *Transnational Corporations* 6:1, 31-49.

Siddharthan, N. S. and B.L. Pandit, 1998. Liberalisation and Investment: Behaviour of MNEs and Large Corporate Firms in India. *International Business Review* 7:5, 535-548.

Siddharthan, N.S. 1988. In-house R&D, Imported Technology and Firm Size: Lessons from Indian Experience. *Developing Economics* 26:3, 212-221.

Siddharthan, N.S. and K. Lal, 2004. Liberalisation, MNE and Productivity of Indian Enterprises. *Economic and Political Weekly* 39:4, 448-452.

Singh, A. 2009. The past, present, and future of industrial policy in India: Adapting to the changing domestic and international environment, In M. Cimoli, G. Dosi and J. E. Stiglitz (eds.) *Industrial Policy and Development: The Political Economy of Capability Accumulation,* New York: Oxford University Press.

Singh, A. and G. Whittington, 1975. The Size and Growth of Firms. *Review of Economics Studies* Vol. 13:1, 15-26.

Singh, J. 2014. India's automobile industry: Growth and export potential. *Journal of Applied Economics and Business Research*, 4:4, 246-262.

Subrahmanian, K.K. 1991. Technological Capability under Economic Liberalism: Experience of Indian Industry in Eighties. *Economic and Political Weekly* 26:35, 87-89.

Appendix

Table A1. Trends and Patterns of technology intensity (%)

Firms	Liberalisation Policy (1991-92 to 2001-02)				Auto Policy (2002-03 to 2009-10)			
	IMCAP	MT	*RD*	TC	IMCAP	MT	*RD*	TC
ALL	1.34	0.78	0.61	38.86	1.72	1.74	2.16	69.55
FML	2.28	0.38	1.72	101.11	0.78	0.57	2.34	248.07
SML	0.04	0.62	0.41	25.11	0.42	0.27	0.66	139.59
TATA	1.94	1.05	1.46	76.66	1.19	0.91	1.85	95.15
M&M	1.19	0.78	0.81	25.88	0.59	0.79	2.35	173.78
MSI	3.73	1.12	0.36	117.1	1.17	1.31	0.26	131.51
HML	0.82	0.57	0.48	55.75	0.36	0.51	0.54	66.84
EML	0.35	0.68	0.47	154.75	0.57	0.44	1.86	586.28
DMI	10.01	0.47	2.18	48.42	-	-	-	-

Source: Computed by Author from CMIE, PROWESS data base, Embodied technology (IMCAP): the ratio of import of capital goods to sales, Disembodied technology (MT): the ratio of payments in the form of royalties or lump-sum, technical fees and others to sales, R&D intensity (RD) is measured by research and development expenditure as a proportion of sales and cost of purchasing technology (TC) from abroad signifying relate importance of domestic technology generating efforts is defined as ratio of R&D expenditure to technology purchase from abroad.