## 1 Introduction

The objective of this paper is to analyse the determinants of the growth of firms in the Indian automobile industry during the period 1980-81 to 1995-96. It re-examines certain issues that have already been extensively studied in the literature, such as the relationship between growth, size, technology, and profitability of firms. When import substitution industrialisation strategy was adopted in India during the 1950s, the automotive industry was chosen as one of the prime candidates for launching the process. This is because it had great potential as a lead sector in stimulating the growth of other industries such as iron, steel, glass, plastics and rubber. With the recognition of the need to bring in a competitive atmosphere involving technological modernisation and high rates of output growth, the automobile industry in India has been subject to substantial policy changes over the last two decades. The policy changes were in two phases, and took the form of partial de-regulations introduced in 1985 and liberalisation measures launched since 1991. These changes dispensed with the bulk of controls and regulations and for the first time since independence assigned a central role to market forces. The automobile industry in India, as a result of these policy changes, witnessed a number of new entrants during the mid 1980s and early 1990s. Entry of firms, mostly with foreign capital and technology, threatened the market share and the rate of progress of most of the veterans in the Indian automobile industry. Foreign direct investment, resulting in transfer of latest technological configurations to produce/assemble vehicles involving technological up-gradation, raised serious questions about sustainability of growth in the already existing firms. In order to examine the impact of entry and transfer of new technology, the analysis of determinants of growth in this paper is carried out separately for the three different policy regimes (Licensing 1980-81 to 1984-85, De-regulation 1985-86 to 1990-91 and Liberalisation 1991-92 to 1995-96). Such analysis under different policy regimes and that too at the level of firms drawn from a single industry has not been the focus of attention in the earlier studies. To carry out this analysis, the paper largely follows the evolutionary theoretical approach of Nelson and Winter [1982], and Dosi, et al [1992].

The main motivation for the analysis of growth is provided by two major developments in the Indian automobile sector during the last decade. (a) liberalisation in Government policy measures resulting in entry of firms with expanded capacity and capability to produce vehicles involving technological up-gradation, and (b) massive inflow of direct foreign investment into

the automobile sector. Both these developments have important implications for the performance of individual firms. Although there is a considerable amount of empirical literature on the growth of firms, there has been no detailed examination of the impact of policy changes and the role of technology in determining the growth of firms in automobile industry or any other sector in India for this period.

This paper begins with a discussion [in section 2] of the trends in growth of Indian automobile firms during the three different policy regimes, viz., strict controls and licensing, de-regulation and liberal economic policy regime, chosen for the study. The theoretical background used to develop the hypotheses is presented in section 3. Section 4 enlistssents hypotheses concerning the determinants of growth. While section 5 discusses the methodology of analysis, the empirical results are presented in section 6. Section 7 summarises the major findings of this paper.

## 2 Trends in Growth of Firms

Growth of firms, in this analysis, is defined in terms of rate of change in the annual sales turnover at current prices. The sales turnover could not be converted into constant prices because most of the firms produce and market different models of cars and commercial vehicles. These models are priced differently, but data on model-wise sale of the number of vehicles is not available. Therefore, part of the changes in the rate of growth could also be attributed to changes in the models, differences in quality, product mix and fluctuations in prices. In analysing the determinants of growth, year dummies were introduced in order to adjust for year-to-year fluctuations. Impact of changes in price could partly be neutralised by the year dummies.

The average annual growth rate and the coefficient of variation [CV] of sales turnover in current prices of Indian automobile firms during the three periods, namely, strict controls and licensing, de-regulation and liberal economic policy regimes, are presented in table 1. The table clearly indicates large differences across firms and wide year-to-year fluctuations in growth during all the three periods of study. Although the average annual growth rate of all firms as a group increased from 13.08 per cent in the first period to 28.20 percent during the second, the variability during the second is much higher than that during the first period. However, both

growth rate as well as the CV were lower in the third period compared to the second, while the growth during the second period has been higher than that during the first period.

From the table it emerges that the rate of growth of four leading firms, Telco, Mahindra & Mahindra, Hindustan Motors and Ashok Leyland in the de-regulated and liberal economic policy regimes is much higher than their growth rate during the licensing regime. The variability in the growth rate of Telco, Hindustan Motors and Ashok Leyland is lower during the second and third periods, when compared to the first period.

Telco and Ashok Leyland, which were growing at a lower rate than the industry as a whole during first and second periods, improved their position during the liberal economic policy period. Both these firms operate in the heavy commercial vehicles segment of the automobile industry and both have long experience of being in this business. They have also brought about

**TABLE 1**

**AVERAGE ANNUAL GROWTH OF INDIAN AUTOMOBILE FIRMS AND ITS VARIABILITY [%]**

| **Firm** | **Policy Regime** | | | | | |
|---|---|---|---|---|---|---|
| | **Licensing [1981-2 to 84-5]** | | **De-regulation [1985-6 to 90-1]** | | **Liberalisation [1991-2 to 95-6]** | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| TELCO | 11.14 | 121.41 | 20.10 | 100.99 | 26.56 | 80.79 |
| MAHINDRA | 16.31 | 8.26 | 17.81 | 231.89 | 17.76 | 27.85 |
| PREMIER | 22.03 | 125.72 | 26.84 | 193.11 | -2.46 | 991.46 |
| HMOTOR | 7.78 | 184.57 | 14.84 | 178.37 | 14.31 | 84.49 |
| ASHLEY | 3.21 | 372.27 | 21.49 | 129.27 | 17.74 | 89.85 |
| SMOTOR | 9.03 | 205.98 | - | - | - | - |
| BAJAJ | 22.07 | 95.33 | 18.53 | 198.59 | 22.92 | 69.37 |
| MARUTI | - | - | 55.83 | 98.05 | 23.78 | 77.88 |
| SMAZDA | - | - | 43.44 | 162.94 | 11.69 | 193.07 |
| DAEWOO | - | - | 35.15 | 127.88 | 3.28 | 677.74 |
| EMOTOR | - | - | 134.89 | 154.29 | 15.86 | 155.61 |
| ALL FIRMS | 13.08 | 118.27 | 28.20 | 257.52 | 15.14 | 128.27 |

Note: Growth of firm is defined in terms of rate of change in the annual sales turnover. C.V. represents coefficient of variation in the respective growth rates. Blank boxes indicate non-existence of firms during the major part of the period.

technological paradigm shift with a change in the policy; while Ashok Leyland has gone in for intra-firm mode of technology acquisition through an enhanced foreign equity participation [it is a majority foreign equity holding company at present with 69% share held by the British based

Hinduja Group], Telco relied on its own in-house R & D efforts to facilitate a change in their basic artefact [technology]. Telco has also diversified into both LCV and the Car sector during the second and third periods respectively. De-regulation and broad-banding appear to have enabled Telco to diversify into the LCV sector and de-licensing of the Car sector enabled them to enter into that segment as well. This could be the most important reason why Telco, which had lower than the industry average growth rate during the first and second period, experienced very high growth rate during the third. Hindustan Motors, however, has only gained marginally by achieving a growth rate which is just one percent less than the industry average, inspite of a drastic decline in the C.V. of its growth rate from about 185% and 178% in the first and second periods respectively to 85% in the third.

Mahindra, which operates in both LCV as well as the utility vehicle segment [a part of the car sector], appeared to have maintained its growth rate at about 17% per annum throughout the period. The C.V. of its growth rate, however, has fluctuated with 8% in the first, 230% in the second and 28% in the third. This large fluctuation in the second is mostly because the firm were a bit slow to react to increased competition in the second period. Most of the technological advancements in Mahindra took place during the late 1980s and the 1990s only. Bajaj Tempo, which was a close competitor of Mahindra during the first period in the LCV sector, had very high growth rate during the first period [9% higher than the industry average], maintained the same position in the third period as well. De-regulation period turned out to be the most turbulent for this firm as well. Bajaj brought about a great deal of improvement in the technological configuration of its LCV during this period. However, entry of new firms with foreign collaboration [equity participation] in the LCV segment could have brought down its performance.

Premier automobiles, which had the second largest market share in the car sector, during the first period, also maintained a growth rate higher than the industry average to begin with. Its growth rate in the second period was quite close to that of the all-firm average. However, it made a drastic change and started shrinking the moment, the car sector was de-licensed. Entry of new multinationals and introduction of technologically superior cars was the most important reason for the decline of Hmotor. Smotor, which grew at the rate of 9% per annum in the first period, completely went out of the market and closed down its production during the late 1980s.

Nine per cent growth of Standard Motors could largely be due to increase in price, rather than actual sale of vehicles. This company started facing problems by the 1984-85 it self.

The table also reveals that all firms that entered the Indian market during the second half of 1980s experienced above average growth rate during the second period, but barring Maruti and Eicher Motors, the others were growing at a lower rate during the liberalisation period. The variability of sales growth of these firms [Smazda and Daewoo] also increased between the second and third period. The CV of Eicher motor has marginally increased, while that of Maruti has actually declined. Maruti's growth rate during the second period was almost twice that of the industry average. In the liberal economic policy period, however, Maruti's growth rate is lower than that of Telco's, although it continues to be above the industry average. Maruti has also diversified into various assembly lines [variety of cars for different market segments, vans and other utility vehicles], but Telco has the distinction of operating in all the three markets [light, medium and heavy commercial vehicles and cars] and is a market leader in both LCV as well as MHCV sectors.

To summarise, although the growth rate of the Indian automobile sector fluctuated drastically [increasing from 13% in the first sub-period to 28% in the second and declining to 15% in the third], there are large variations in the growth rates of individual firms. Most of these variations in the growth rates could possibly be due to changes in the policy framework in which the firms have been operating and its impact on the conduct of firms.

Apart from large differences in inter-firm growth rates, since the analysis deals with panel data, there could also be year-to-year fluctuations in the growth rates of firms within a given policy period. The possible fluctuation in the growth rate [inter-temporal] within any policy regime is examined by running the following regression.

If $Y_{it} = a + c_t + e_{it}$ .....(1)

where i = 1,2,...n [number of firms] and t = 1,2,....T [number of years] and $Y_{it}$ growth rate for firm i in period t. The $c_t$'s indicate degree of change [increase or decrease] in the growth rate of automobile firms as a group in year t in relation to that of the base year. Equation (1) is estimated for the pooled data for the three policy regimes separately. The estimated fluctuations in the growth rates are presented in Table 2.

Table 2 indicates large year-to-year fluctuations in the growth of Indian automobile firms. During the licensing regime itself, the growth of firms in 1982-83 declined by 28% in relation to 1981-82. The growth in 1983-84 over 1981-82 again fell by 16%. However, it appears to have picked up momentum in 1984-85 with an increase of about 72%. During the de-regulation period also the growth rate does not appear to be stable. There are large fluctuations in the growth rates of firms during 1987-88, 1988-89 and 1989-90 relative to 1985-86. The fluctuations in the growth rates during the liberalisation period appear to have abated and after the initial decline during 1992-93, the growth rate remained substantially above that in the initial year 1991-92. On the whole, Table 2 indicates considerable year-to-year fluctuations in growth rates during all the three policy periods.

**TABLE 2**

**INTER-TEMPORAL GROWTH RATE OF AUTOMOBILE FIRMS DURING THE THREE DIFFERENT POLICY REGIMES**

| Years | Licensing [1980-81 to 1984-85] | Years | De-regulation [1985-86 to 1990-91] | Years | Liberalisation [1991-92 to 1995-96] |
|---|---|---|---|---|---|
| 1982-83 | -28.04 | 1986-87 | 8.84 | 1992-93 | -3.57 |
| 1983-84 | -15.94 | 1987-88 | 38.49 | 1993-94 | 21.82 |
| 1984-85 | 71.94 | 1988-89 | -52.27 | 1994-95 | 22.93 |
| | | 1989-90 | 90.01 | 1995-96 | 15.37 |
| | | 1990-91 | -3.78 | | |

## 3 Theoretical Background Linking Technology and Firm Growth

Economic analysis of the role of market structure and non-price variables in determining growth and performance of firms dates back to Joseph Schumpeter. Schumpeterian theory demonstrated the role of technology and innovation in stimulating growth and development [Schumpeter, 1943]. According to Schumpeter, "a competition which commands a decisive cost or quality advantage and which strikes not at the margin of the profits and outputs of the existing firms but at their foundations and their very lives" [1] is more effective than the traditional price competition. Later economic theorists like Baumol (1959) argued that, other things being equal, the larger the size of the firms, the better will be their ability to grow. This argument was based on the premise that "large capital holding of firms have the option

[1] Schumpeter, J.A. (1943) p. 84.

of competing with smaller enterprises but the smaller firms cannot always reciprocate" [2], because the large capital holder has an option of investing either in a chain of small business or in a large, centrally located, shop. Further, large firms with their ability to operate in all the lines in which smaller firms can operate, as well as in lines in which the smaller ones cannot operate due to the presence of scale advantages, will enjoy higher growth rate.

In the orthodox neo-classical approach, growth is an incidental factor in an analysis of the firm. The focus of most of these studies was on profit maximisation, given the demand and cost conditions. The main constraint on the firm is provided by the production function to define the technically efficient region [Layard and Walters 1978]. In this approach, one needs to introduce optimum size to determine the growth path of a firm. Technology was introduced in the form of short-run cost curves representing costs associated with firms of different size. For a given short run cost curve, firms tend to operate at a point where marginal cost equals the price of the product.

Marris (1964) was the first to develop a rigorous model to analyse the growth and profits of firms. In the Marris model there is no optimum firm size. He deals with optimum growth path given by the demand and supply of growth functions, rather than the static demand and supply functions. According to this model, a firm's ability to shift the demand and supply functions [growth-profit frontier] depends on the environment in which it operates. Solow (1971) also introduced time dimension in the theory of firm and pointed out the role of environment. According to Solow, dynamic equilibrium of profits and growth of firms is determined not only by the environment in the present period but environment in all future periods within the firm's time-horizon. Growth, however, continues to be just incidental to the main analysis, and focus is largely on the response of the firm to change in exogenous environment. Marris model, on the other hand, could be interpreted to analyse the role of technological factors, along with size, in determining inter-firm differences in growth. Firms could change the super-environment by focusing on building technological capabilities to shift to a higher growth-profit frontier. The policy framework, in which they operate, themselves, could influence technological efforts of firms.

Most of the studies explaining growth of firms limited themselves to an analysis of the relationship between growth and firm size [see Hart 1962, Samuels and Chesher 1972, Singh

[2] Baumol, W.J. (1959) p. 35.

and Whittington 1975, and Kumar 1984, for example]. Siddharthan and Lall (1982) analysed the growth and profit behaviour of top seventy-four US multinationals for the period 1976-79 in the Marris framework. They examined the role of R & D, expenditures on product diversification and multinationality in shifting growth-profit frontier and their results highlight the role of R & D in fostering the growth of these multinationals. Hall (1987), for a panel data for the period 1976-83 on publicly traded US manufacturing firms, also analysed the impact of R & D on probability of a firm's survival and growth rate. He compared the relative importance of physical investments and R & D in analysing growth and found that R & D expenditure was a more important predictor of growth than physical investment. His result was robust across size classes.

Since technological activities of firms in developing countries consist not only of in-house R & D efforts but also technology imports through licensing [disembodied technology imports], import of capital goods [embodied technology] and intra-firm transfers [through foreign equity participation], some studies included all these technology import variables, along with R & D, in explaining growth of firms [Siddharthan 1988, Siddharthan et al 1994 and Pandit and Siddharthan 1997]. Siddharthan (1988) in a study of Indian firms covering both privately held as well as publicly quoted companies considered imports of capital goods and expenditures on R & D in determining the growth of sales. His results supported the view that both import of capital goods and R & D activity influenced growth positively. R & D activity, according to this study, appears to have long-term implications for growth.

Siddharthan et al (1994) analysed inter-firm variations in the performance of the large 385 public limited (privately owned) Indian companies for the period 1981-84. This paper used the Marris managerial framework to analyse growth, profits, investment rates, inventory investment rates, external financing and dividend rates. Apart from technology purchases from abroad against royalties, or lump sum and technical fee payments, and foreign equity participation, their study also included certain technology output variables like royalty, lump sum and technical fee receipts, awards won for R & D activities, and patents registered - in the determination of growth and profitability of firms. The result of their econometric exercise revealed that while foreign equity participation and technology import through the market had a significant [positive] influence on profit martins, they did not turn out to be significant in explaining growth. On the other hand, technology receipts turned out to be

important in explaining growth of sales. The other two technology factors, namely, awards won for R & D and patents did not emerge significant in determining either growth or profits. The regulated economic policy regime in which the firms have been operating, where most of the technology imports have been for modernisation and not for diversification, was considered by them as a possible explanation for this result. Pandit and Siddharthan (1997) based on data for firms across different industries in India for the post 1985 deregulated economic policy regime period found important role for technology acquisition in explaining inter-firm variation in the growth of capital stock. Technology acquisition, in this study, was captured by in-house R & D efforts, arm's length purchase of technology, and intra-firm transfer of technology. Some of the recent studies dealing with Indian firms [Basant and Fikkert 1996, Haksar 1995 and Raut 1995] also analysed the role of technology in determining the performance of firms. All the three studies measured performance of firms by productivity growth and highlight the role of technology spillovers in its' determination.

Penrose's (1959) theory of growth of the firm also discusses the role of technological innovations, along with demand preferences and alterations in market conditions in providing the impetus for growth. These, according to Penrose, were external factors for the firm. However, in explaining the internal factors, Penrose states that "it is never resources themselves that are the 'inputs' in the production process, but only the services that the resources can render" [3]. These services exist because of indivisibility in the resources and are a function of the experience and knowledge that have been accumulated within the firm. Services, according to Penrose, are largely firm specific and therefore are themselves a source of uniqueness of each individual firm. These firm specific services could be interpreted as technological trajectory advantages developed by a firm through its adaptation and assimilation process. It is in this interpretation that Penrose's theory could be considered as a pre-runner for the evolutionary approach. Evolutionary microeconomic theory of firm behaviour [Nelson and Winter 1982, Dosi et al 1992, etc] assume that technological differences are the prime source of heterogeneity between firms.

The literature presented above suggests an important role for technology in determining growth of firms. However, the possible difference in the role of technology variables in different policy environments in which a firm operates has not been examined so

[3] Penrose (1959) p. 25.

far. With a change in the policy regime, allowing entry and expansion of capacity, the technological conditions in the Indian automobile industry have changed. Following Geroski (1995) it could be argued that "the growth and survival prospects of new firms will depend on their ability to learn about their environment, and to link changes in their strategy choices to the changing configuration of that environment" [4]. This strategy choice could be in terms of adapting their process and product technologies to suit the local resource and market conditions. The firm, in this approach, could be viewed as an information processor. The information that the firm need to obtain is about the state of technology of the existing manufacturers and the uniqueness of their vehicles in the given market conditions.

In the context of automobile industry in India, most of the new entrants were world leaders in automobiles who would have acquired technological capabilities from their learning processes. It is the post-entry performance of new firms that could affect the growth of already existing firms. The present study, therefore, attempts to analyse the determinants of growth of Indian automobile firms [both old and new] operating under different policy regimes. In analysing inter-firm and inter-temporal differences in growth of sales, the study would examine the role of technology acquisition, along with size, profits, age, capital intensity and vertical integration and highlight the relative importance of all these variables in determining growth across the three different policy regimes, namely strict controls and regulation, de-regulation and liberal economic policy. In examining the role of technology variables, however, the present study broadly follows the evolutionary approach.

## 4. Determinants of Growth of Firms: Hypotheses

Studies explaining growth of firms, as mentioned in section 3, mostly defined growth in terms of rate of change in the annual sales turnover of the firm and examined the role of size, age and technology variables in its determination. This study also defines growth in terms of annual sales turnover and examines the role of firm size, age, profits and technological factors in determining inter-firm differences in growth, but it postulates changing nature of the role of these explanatory variables in determining growth. While changes in the role of size, age and profits are largely governed by the policy regime in which the firms operate, differences in the nature and direction of the technology variables are

[4] Geroski, Paul A. (1995) p. 21.

guided by changes in the technological regime. This is largely due to the ways in which a firm changes its technology strategy. It is now widely established that a firm's technology strategy is influenced by the technological regime in which it operates and the technological regime itself is determined by the policy framework in which the industry operates[5].

### 4.1 Technology Acquisition and Growth

This section explores the possible link between technology acquisition and growth of firms. Role of technology in explaining the growth of firms has been well documented in the literature following Marris model or the evolutionary approach. While the studies following Marris framework interpreted technological efforts of a firm as a route through which it can change its "super environment", Penrose and evolutionary models discuss the role of firm specific tacit technological capabilities, developed through knowledge and experience, in providing the impetus for growth. Acquisition of technological capabilities, therefore, is the centre of focus of both the approaches in explaining firm growth. This study also hypothesises an important role for technology acquisition in determining inter-firm variation in growth. However, since acquisition of technological capabilities in firms in developing countries is carried out through imports of technology as well as by in-house R & D efforts, along with possible interaction between imported technology and in-house efforts, this paper examines the importance of all the variables capturing technological efforts [RD, IMTECH, IMCAP, FE, FE*RD, IMTECH*RD and IMTECH*RD] to explain growth. In doing so, this paper hypothesises differences in the nature and direction of the effect of technology variables [imports and domestic efforts] in determining growth across the three different policy regimes. Changes in the policy environment and the resultant change in the nature of technological activity are the most important reason for this difference.

In a highly regulated policy regime, where firms were subjected to strict product specific capacity licensing, foreign equity participation [representing intra-firm technology transfer] would be the only variable likely to provide a positive impetus for growth. This is because multinational enterprises may be better equipped to undertake expansion, integration and diversification due to the ownership advantages. Although all Indian firms [with and without foreign equity both] would have to acquire an industrial license from the government before effecting any plans of substantial expansion of existing product line, integration,

[5] See Basant (1997) for example.

diversification or acquisition, firms with foreign equity participation have an edge over the others in terms of the resources for growth. All other technological factors like expenditures on R & D, imports of disembodied and embodied technology as well as the technology interaction variables, which are all very vital in accumulating technological capabilities, may not emerge significant in determining growth. This is because of the limits imposed on the growth of firms by the government.

With a change in the policy regime [especially with respect to the relaxation of restrictions on entry, capacity expansion and technology acquisition from abroad] and a resultant shift in the technological regime, technology factors are expected to play a crucial role in determining growth of firms. As has been observed in Narayanan (1998), firms in this industry witnessed a change in basic technology configuration of the production process during this period. The change was in the form of a shift from batch method to conveyor belt method of production, along with introduction of micro-electronic parts in the production processes. This paradigm shift took place through FE, IMTECH, and IMCAP[6]. As a result of this paradigm shift, fresh R & D efforts were needed to facilitate adaptation of the new technology. The adaptation could be in the form of making their vehicles suit local market and resource conditions[7]. It can, therefore, be argued that firms that are successful in complementing the new and updated imported technology with their in-house R & D efforts are likely to grow faster than the others during this period. However, as observed from the results of determinants of market share change [Narayanan, 1998] and exports [Narayanan, 1999], firms in this industry during the de-regulation period appear to have used technology imports to acquire large domestic market share. These technology imports and its adaptation to suit the local resource conditions seem, if at all, to have limited the scope for exports. Firms appear to have got caught in a prisoners' dilemma situation whereby if they do not import technology or spend on R & D, they will lose, but investment in these technology variables may not actually enable them to grow. As a result, the variables capturing technology imports and in-house R & D efforts may not emerge significant in determining growth. In the presence of prisoners' dilemma situation, RD, FE, and IMTECH may even emerge significant with a negative sign during this period. IMCAP, which also captures investment in physical capital, may determine growth positively. Since R & D in this case is

[6] Telco was the only automobile firm to use their own R & D efforts to facilitate a paradigm shift.
[7] The adaptation requirements of the imported technology in a developing country context are well documented in the literature. See Cohen and Levinthal (1989), Kumar and Siddharthan (1997) and Bell and Pavitt (1997) for the literature on this.

used to locate capital goods imports, its interaction term may even emerge with a negative coefficient.

During the liberal economic policy regime [1991-92 to 1995-96], with the entry of world leaders in the Indian automobile sector, FE and RD may assume greater prominence. While the degree of foreign presence [which FE captures] may influence firm growth positively, increased competition may push the local firms to use their R & D not only to adapt the imported technology, but also to bring about improvements in them. This would mean that firms are using in-house R & D not only to facilitate adaptation requirements imposed by domestic market and resource conditions, but also to make developments in them. However, whether this would give a decisive advantage for firms to grow is difficult to predict. In the case of firms with foreign ownership, with the freedom of having majority equity participation, it is difficult to predict the direction in which foreign participation would influence technology choices of firms. This is because, foreign equity participation may enhance the inflow of the tacit component of technology without necessarily changing the level of expenditure on R & D [Teece 1977]. The existence of a weak patent regime may, on the other hand, encourage multinational enterprises to transfer part of their process technology licenses and undertake related adaptive R & D in the host country [Basant 1997]. As a result, while firms with foreign equity are likely to grow at a higher rate than their local counterparts, it difficult to predict an exact sign for FE*RD during the liberalisation period. All other technology variables, IMTECH, IMCAP and their interaction [with R & D] terms may not emerge significant in determining growth during this period.

### 4.2 Firm Size and Growth

Most of the literature dealing with growth of firms assigned an important role for firm size in its determination. Role of firm size in determining growth is a complex one and the evidence in this relationship is mixed. Baumol (1962) hypothesised a positive relationship between firm size and performance. However, most of the empirical literature found either size to be unimportant in determining growth [Buckley et al 1978] or observed an inverse relationship between firm size and growth [Evans 1967, Rowthorn and Hymer 1971, Singh and Whittington 1975, Siddharthan and Lall 1982 and Kumar 1984]. One possible explanation for this inverse relationship is that the large firms may have grown beyond the optimum, and so would be growing less fast compared to their smaller counterparts, which

are moving towards the optimum. On the other hand, following Siddharthan et al (1994), it could be argued that size is a catchall variable that could capture effects of multinationality, technological capabilities, age, capital intensity and vertical integration advantages. If these variables were introduced separately, would the inverse relationship still hold true? Siddharthan et al (1994) found a positive relationship between firm size and growth in the presence of these variables in the equation determining growth. This study also considers the role of technology and other variables in explaining the growth of firms. It, therefore, may not be inappropriate to predict a positive coefficient for firm size in determining inter-firm variation in growth during all the three periods.

### 4.3 Profits and Growth

Apart from examining the relationship between firm size and growth extensively, many efforts have also been made to analyse the relationship between profits [or profitability] and growth. In the Marris (1964) framework[8], there is a direct relationship between profitability and growth because profitability determines a firm's ability and willingness to grow. This is because, higher the level of profits, better would be the position of the firm to grow and also higher the level of current profitability, better would be the position of the firm to raise external funds on favourable terms. Kumar (1984) tested for a linear relationship between profitability and growth of U.K. firms and found a positive and statistically significant coefficient for current profitability in determining current growth for 16 out of 19 industries. Automobile firms in India have been enjoying a protected market with favourable demand conditions for a long time. Until 1975 there were price and rates of return restrictions. However, during the period of this study firms did not confront such restrictions and were free to maximise profits. As a result, it may not be inappropriate to hypothesise a positive role for profit-margins in determining growth in the first period. With a change in the policy, especially when firms undertake heavy investments, profits may have a lagged effect on growth via investment. As a result, PCM, which represents current profits, may not emerge significant during the second and third period.

[8] In the original Marris model, there is an optimum growth path and it deals with demand for and supply of growth functions. While the supply of growth function assumes a direct relationship between profitability and growth, the demand for growth expects an inverted U shaped relationship between profits and growth. Marris presents a simultaneous relationship between growth and profitability. Siddharthan et al (1994) developed the Marris framework and analysed growth-profit determinants for large Indian frims. The present analysis tests the hypothesis that growth is a linear function of profit-margins.

### 4.4 Vertical Integration and Growth

Following Siddharthan et al (1994) and Marris (1964) it could be argued that vertical integration does not enable a firm to diversify into other sectors, and this in turn would curb the possible avenues for growth. Exploitation of internalisation advantages may enable a firm to earn higher profits and raise exports[9], but need not necessarily improve its growth rate. Therefore vertical integration is hypothesised to be significant with a negative sign in explaining inter-firm variation in growth in the first period. Entry of Japanese multinationals, who preferred to encourage parallel transfer of technology, may continue to give VI a negative sign. However, these Japanese firms may take sometime to accomplish this parallel transfer of technology and, as a result, VI may not turn out to be significant in determining growth in the second and third period.

### 8.4.5 Capital Intensity and Growth

Efficient utilisation of capital stock, with a corresponding reduction in the marginal cost of its output, is likely to influence growth rate favourably. In a given industry, firms, which are better in utilising their capital stock, are likely to have an advantage over the others to grow. Capital intensity, as a result, is likely to be inversely related to growth of firms. In the Marris model, capital intensity was expected to influence growth positively. Siddharthan et all (1994), in analysing the growth and profit behaviour of large Indian firms using the Marris framework, found a positive coefficient for capital intensity in determining growth. This, according to them, is because growth of the firm along with the demand for growth curve would increase capital-output ratios. Their data set consisted of large public limited Indian companies drawn from different industries. In a particular industry study, with a given increase in capital-output ratio, however, efficient utilisers of capital stock are likely to grow at a higher rate. This condition is likely to hold true especially during the de-regulated and liberal economic policy regimes and therefore, an inverse relationship between capital intensity and growth is hypothesised for these two periods. During the first period, absence of competitive atmosphere might result in a positive coefficient for CI in determining growth.

[9] Kathuria (1996) reports an important role for vertical integration in determining competitiveness of firms in this industry. The results of determinants of export competitiveness in Narayanan (1999) also confirm a positive role for vertical integration, but only for the licensing period (1980-81 to 1984-85). For the other two periods it had a negative coefficient [though with insignificant t value]. In the case of market share changes, VI emerged significant with a negative sign in all the three periods.

### 4.6 Firm Age and Growth

Age of the firm, measured in terms of the age of the plant and machinery, is considered as a general proxy for learning. However, the longer the time the firm has already spent in the same line of business, more difficult it would be for the firm to grow. Until about the early 1980s, older firms have also been the ones which had high growth rates. As a result, there would be very limited scope for them to keep growing at high rates starting from a higher base value. With a change in the policy and entry of new firms, the learning advantages of older firms have been more than matched by the enterprises holding foreign equity. These firms are, therefore, likely to have an edge over the older ones to grow. This chapter, therefore, hypothesises an inverse relationship between the age of the firm and the growth rate during all the three policy periods.

In summary, on the basis of the theoretical background, empirical literature and drawing from the knowledge of firms presented in section 2, the study examines the changing nature of the role of variables capturing technology acquisition, firm size, profits, vertical integration, capital intensity and age of the firm in determining growth of Indian automobile firms. That is, the study attempts to examine the following functional form:

Growth = f (Technology Acquisition, Size, Profits, VI, CI, AGE).

The methodology used to carry out this analysis and the results of the empirical estimation are presented in section 5 and 6 respectively.

## 5. Sample, Data and Methodology of Analysis

Data for this analysis is drawn mostly from the balance sheets and annual reports of individual companies and publications of Automobile Components Manufacturers Association [ACMA], and Association of Indian Automobile Manufacturers [AIAM]. The data set contains firm level data for 11 automobile manufacturing firms for the period 1980-81 to 1995-96. Most of the earlier studies, attempting to analyse the determinants of growth have used a linear specification and estimated the equation using ordinary least squares[10]. In doing so, these studies relied upon the standard assumptions of absence of serial correlation and hetroscedasticity. To analyse the determinants of growth, in this chapter, we estimate the following fixed effect model with “firm” and “year” effects:

$$Y_{it} = a + b_i + c_t + d X_{it} + w_{it} \quad .....(2)$$

with i = 1,2,....n [number of firms]

t = 1,2,....T [number of years]

where Y is the dependent variable [growth] and X is the vector of explanatory variables, d is the vector of regression coefficients and wit is the disturbance term; bi represents the firm effect and ct represents the year effect. It is assumed that the errors wit follow a normal distribution iid (0, σu2) for all i and t. This implies that the errors are serially uncorrelated and homoscedastic. The term a + bi is the intercept for firm i. Similarly, a + ct is the intercept for year t. By definition b1 = c1 = 0 [Johnston and DiNardo 1997]. In the fixed effects model, estimates of the slope parameters are based on the within group [firm - year] variation and the between group variation is ignored. Under certain assumptions the fixed effects estimates of the slope parameters are consistent even if the explanatory variables and the fixed effects are correlated. This method is called the least squares with dummy variable [LSDV].[11] The least squares dummy variable approach involves introduction of (n-1) number of firm dummies and (T-1) number of time-specific effects.

## 6. Empirical Results

The LSDV estimates of the slope parameters are presented in Table 3. The standard errors are corrected for potential hetroscedasticity, using White's method[12]. The coefficients and their t values of the explanatory variables are provided in three different columns for three policy regimes in Table 3. The estimates of the firm and year effects are provided in Tables 4 and 5, respectively. The results broadly indicate that technological factors play an important role in determining the growth of firms in this industry. The nature of effect, however, appear to vary across different technological regime.

During the strict controls and licensing regime, FE is the only technological variable that emerged significant with a positive coefficient. This implies that even during a highly regulated regime, firms with foreign equity participation tend to grow faster than the others

[10] Siddharthan et al (1994), have attempted simultaneous determination of growth and profits, and used two stage least square estimation technique.

[11] The fixed effects estimation is not without problems. One major limitation of this technique is measurement error. If the difference in two observations of a firm is largely due to measurement error, fixed effect can lead to a biased estimation. The extent of bias would be dependent on the extent of measurement error, and the extent to which the X's are correlated across time. One needs to interpret the results presented here with this precaution in mind.

[12] The use of this method to correct for the possible presence of hetroscedasticity is given in Greene (1993).

due to ownership and/or resource advantages that these firms enjoy. All other technological variables, though are very important for firms to facilitate accumulation of technological capabilities, did not emerge significant in explaining growth. R & D did take a positive sign, but its t value was insignificant. This could possibly be due to the limits imposed on the growth of firms by the Government.

During the de-regulation period, most of the technology acquisition variables turned out to be significant in explaining the growth of firms. FE, IMTECH and RD emerged as significant with negative coefficients and technology interaction variables, FE*RD and IMTECH*RD both were statistically insignificant, although they both had a positive coefficient. This result indicates that firms in this industry may have been caught in a prisoners' dilemma situation. The dilemma could be that no firm can afford not to import technology but technology imports may not positively affect growth. Despite this firms imported technology, possibly because these imports might have allowed them to use the brand names of the collaborating firm. Similar result was observed in the determination of exports also for this period [Narayanan 1999]. In the case of market share changes, however, these technology interaction variables emerged significant with positive coefficients indicating strong complementarity.

**TABLE 3**

**FIXED EFFECTS ESTIMATION OF THE DETERMINANTS OF GROWTH [PANEL DATA WITH FIRM AND YEAR DUMMIES] BY POLICY REGIME**

| **Variable** | **Licensing [1980-81 to 1984-85]** | **De-regulation [1985-86 to 1990-91]** | **Liberalisation [1991-92 to 1995-96]** |
|---|---|---|---|
| Constant | -3.5941 (-1.257) | -8.816 (-1.503) | -6.1029 (-2.091) |
| Size | 0.4676 (1.946) | 1.0039 (2.202) | 0.4866 (2.331) |
| PCM | **7.2638** (2.912) | 0.8706 (0.199) | 2.5491 (0.802) |
| VI | **-11.652** (-3.280) | -3.2189 (-0.775) | 0.1853 (0.551) |
| CI | 0.0569 (0.246) | -2.3325 (-2.513) | -0.3089 (-2.529) |
| RD | 52.765 (1.410) | -84.956 (-1.934) | 5.1199 (0.860) |
| IMTECH | -4.7252 (-0.485) | -10.633 (-2.279) | -1.8701 (-0.502) |
| FE | **0.2638** (11.606) | -0.0184 (-2.214) | 0.0061 (2.036) |
| IMCAP | -2.3027 (-0.870) | **15.738** (5.932) | -2.0934 (-1.370) |
| AGE | **-0.2134** (-4.952) | -0.9129 (-0.705) | -3.9509 (-2.244) |
| FE*RD | -1.6606 (-1.262) | 1.2328 (1.245) | -0.3120 (-1.447) |
| IMTECH*RD | -141.02 (-0.131) | 3579.9 (0.652) | -358.96 (-0.981) |
| IMCAP*RD | 475.05 (0.349) | **-2605.5** (-5.656) | 369.27 (1.420) |
| P SQR | 0.997 | 0.815 | 0.705 |
| ADJ. R SQR | 0.99 | 0.654 | 0.398 |
| F | 134.41 | 5.709 | 2.296 |

| | | | |
|---|---|---|---|
| NOBS | 29 | 57 | 50 |
| NO. OF FIRMS | 8 | 10 | 10 |

**Notes:** (i) Figures in parentheses represent t values.
(ii) Coefficients printed in bold are significant at 1% level and those underlined are significant at 5% and above level by two-tailed test.
(iii) Coefficients of firm dummies and year dummies are presented in Tables 8.3 and 8.4 respectively.

These results may not be strictly comparable to the growth of market share analysis, because market share change was defined in terms of sectoral shares, whereas the rate of growth is the rate of change in overall sales [domestic + exports] put-together. Firms using IMCAP to accomplish paradigm shifts during this period appear to be an exception, though. IMCAP is the only variable that emerged significant with a positive sign in determining growth of firms during this period. This could be because IMCAP represents investment in capital stock and following Marris model, increase in investment usually enables a firm to step-up its growth prospects. IMCAP*RD emerged significant with a negative sign possibly indicating that imports of embodied technology could straightaway provide a firm with some competitive growth advantage and the adaptation process could only slow down the process of growth. This result could also be because both Maruti and Eicher Motor, who were growing at much higher rate than the others during this period, relied mostly on imports of capital goods. Moreover, in-house R & D could also be used to locate imports of embodied technology, as very little scope is there to adapt the imported capital goods. Alternatively, since there is very little scope for R & D activity on IMCAP, most R & D could be directed to locate their imports.

Liberalisation in economic policies, however, seems to have changed the role played by these technological factors. FE and RD both emerged with a positive sign [though the coefficient of RD was insignificant]. This implies that firms with foreign equity participation [which represents intra-firm transfer of technology] have some specific advantage over the others in achieving high rates of growth. This could largely be due to greater degree of transfer of technology with majority equity participation by the parent company during this period. Maruti, Ashok Leyland and Eicher Motor all have high degree of foreign equity participation and have also grown at higher than industry average rate during this period. Although the R & D activity of some of these firms have also gone up during this period, it may still not be adequate enough to result in improving the growth prospects. IMTECH and IMCAP were statistically insignificant, although with a negative sign. IMTECH*RD and

FE*RD also emerged with a negative sign [although both were insignificant]. IMCAP*RD took a positive sign [but insignificant]. Overall, the results confirm the changing nature of the effect of technology variables in determining inter-firm variation in growth. The nature and direction of the effect of technology variables are governed largely by the technological regime in which a firm operates.

Firm size appears to be positively influencing growth in all the three periods. The coefficient of size was significant in all the periods. This would imply that if the effect of technology, vertical integration and age are separated, large firms were able to grow faster due to economies of scale irrespective of the policy regime in which they operate. Similar results; i.e., a positive coefficient for firm size was also reported by Siddharthan et al (1994).

The results also confirm a positive relationship between profits and growth, although the coefficient of profits emerged significant only in the first period [with positive sign in all the periods]. This could be because, higher the level of profits, firms may find themselves in a better position to raise funds needed for investment and diversification from external sources and that too at favourable terms. Following Marris, it could be stated that profits determine the ability and willingness of the firm to grow. Kumar (1994) also reported a positive relationship between profits and growth for U.K. firms. With a change in the policy, however, firms may concentrate more on establishing themselves in the market, rather than making high profits, to grow. Moreover, since firms in this industry made heavy investment during these two periods, profits may actually have been used to fund these investments. In such situation, profit may have a lagged effect on growth. This could perhaps explain why PCM, representing current profits, did not turn out significant in determining growth during the second and the third periods.

Vertical integration emerged significant in the first period with a negative coefficient. The relationship between growth and VI was inverse during the second period also, but its' coefficient was not significant. 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. Most of the automobile firms are vertically integrated to facilitate quality and timely delivery of their components and these parts and components could be more specific to suit a particular vehicle assembled by the firm. As a result, a less integrated

firm could diversify much more easily and therefore, has ample scope for growth. Siddharthan et al (1994) also found VI to be inversely related to growth of firms. With de-regulation and liberalisation, however, VI turned out to be insignificant, although it had a negative and positive sign respectively in these two periods.

Capital intensity also turned out to be significant with a negative coefficient in the second and third period. This implies that efficient utilisation of capital stock, with a corresponding reduction in the marginal cost of production, does enable a firm to grow at a higher rate than the others. Efficient utilisation of capital appears to be very important, especially with relaxation in controls and regulations, for firms drawn from a particular industry. In the first period, however, the coefficient of CI had a positive sign, but was not significant. Similarly, the age of the firm also took a negative sign, though was significant only during the first and third periods, indicating that new firms are growing at a faster rate than their older counterparts. Ability of the new firms to facilitate technological paradigm shifts speedily and access to foreign capital and technology could both be possible explanation for this inverse relationship.

Table 4 presents the coefficients and t values of all the firm specific dummies introduced in the equation. Since the intercept term turned out to be significant in only the third period, the coefficients of firm dummies for the first and second periods could be interpreted directly. For the third period, the coefficients of firm dummies [statistically significant ones] are added to that of the intercept term. These firm dummies were introduced in order to capture the firm specific characteristics, if any, that could not be captured by the explanatory variables. As it emerges from the table, during the first period, all the firm specific dummies emerged as significant, although with different signs, while in the second period, none of them turned out to be significant. During the third period, while some of the dummies became significant, the others were all insignificant. The significant coefficients for these dummies do indicate the presence of inter-firm differences in determining growth.

**TABLE 4**

**FIXED EFFECTS ESTIMATION OF THE DETERMINANTS OF GROWTH [PANEL DATA WITH FIRM AND YEAR DUMMIES] BY POLICY REGIME: COEFFICIENTS OF FIRM DUMMIES**

| Variable | Licensing [1980-81 to 1984-85] | De-regulation [1985-86 to 1990-91] | Liberalisation [1991-92 to 1995-96] |
|---|---|---|---|
| Constant | -3.5941 (-1.257) | -8.816 (-1.503) | -6.1029 (-2.091) |
| DMAHINDRA | **-3.2021** (-11.648) | -0.0337 (-0.070) | 0.4051 (2.554) |
| DPREMIER | **1.4721** (4.161) | **1.8607** (3.509) | **0.9443** (2.712) |
| DHMOTOR | **0.7939** (3.411) | 0.7441 (1.406) | **0.8149** (2.767) |
| DASHLEY | **-11.680** (-15.351) | 1.0396 (1.986) | 0.4037 (1.287) |
| DSMOTOR | **0.9174** (4.128) | -- | -- |
| DBAJAJ | **-5.5247** (-13.621) | **2.1971** (2.581) | 1.3210 (2.320) |
| DMARUTI | -- | -0.4715 (-0.777) | 0.2319 (0.707) |
| DSMAZDA | -- | 2.4129 (1.367) | 1.7827 (1.794) |
| DDAEWOO | -- | 2.5059 (1.646) | 1.7769 (1.968) |
| DEICHER | -- | 3.1804 (1.590) | 1.7144 (1.966) |
| F-STATISTIC | 23.1486 | 1.3748 | 0.9559 |

**Note:** (i) The null hypothesis that the firm effects are equal was tested by using the F - test.
$H_0$ : b2 = b3 =.....=bn = 0; H1 : not $H_0$.
(ii) The null hypothesis was for the first period and not for the second and third periods.

Table 5 gives the coefficients of year dummies. These were introduced in order to control for annual fluctuations in the growth of firms during all the policy periods. Some of the coefficients emerged as significant [although with both positive as well as negative signs] indicating the role of inter-temporal changes in the growth of firms during every policy period considered in the analysis. However, their magnitudes are much smaller compared to those in Table 2.

## TABLE 5

## FIXED EFFECTS ESTIMATION OF THE DETERMINANTS OF GROWTH [PANEL DATA WITH COMPANY AND YEAR DUMMIES] BY POLICY REGIME: COEFFICIENTS OF YEAR DUMMIES

| Variable | Licensing [1980-81 to 1984-85] | De-regulation [1985-86 to 1990-91] | Liberalisation [1991-92 to 1995-96] |
|---|---|---|---|
| Constant | -3.5941 (-1.257) | -8.816 (-1.503) | -6.1029 (2.091) |
| D1982-83 | **-0.214** (-2.995) | -- | -- |
| D1983-84 | -0.1496 (-1.645) | -- | -- |
| D1984-85 | -0.0982 (0.738) | -- | -- |
| D1985-86 | -- | -- | -- |
| D1986-87 | -- | -0.0158 (-0.176) | -- |
| D1987-88 | -- | -0.3359 (1.337) | -- |
| D1988-89 | -- | **-0.6276** (-5.905) | -- |
| D1989-90 | -- | -0.0037 (-0.009) | -- |
| D1990-91 | -- | **-1.2277** (-2.854) | -- |
| D1991-92 | -- | -- | -- |
| D1992-93 | -- | -- | -0.0007 (-0.012) |
| D1993-94 | -- | -- | 0.0449 (0.678) |
| D1994-95 | -- | -- | -0.1197 (-1.050) |
| D1995-96 | | | -0.2853 (-1.712) |

| | | | |
|---|---|---|---|
| F-STATISTIC | 1.6845 | 10.2076 | 1.4663 |

**Note:** (i) The null hypothesis that year effects are equal was also tested.
$H_o$ : c2 = c3 = ….. = cT = 0 ; H1 : not $H_o$ .
(ii) The null hypothesis was rejected for second period indicating cyclical fluctuations in the growth of firms during this period. For the first and third periods, however, the null hypothesis was not rejected implying absence of cyclical effects on growth.

In sum, the results broadly confirm the major argument of the study that growth rate of firms are, by and large determined by non-price factors like technology, firm size, vertical integration, capital intensity and the age of the firm. The role played by these variables in determining growth, however, varies across the policy regimes in which the firms operate. These results would, perhaps, have to be interpreted with caution considering the unsatisfactory measure of growth that it relies on.

## 7. Summary of Findings

This paper has attempted to analyse the determinants of growth of Indian automobile firms during three different policy regimes, namely licensing [1980-81 to 84-85, de-regulation 1985-86 to 1990-91 and liberalisation 1991-92 to 1995-96]. The analysis broadly followed the evolutionary theoretical framework. It is argued that differences among firms in terms of technology acquisition explain much of the firm level differences in growth. An analysis of trends in growth rates of firms points out large variation not only between the firms, but also for the same firm across different policy regimes. Further, there also seem to be large year-to-year fluctuations in the growth of firms in this industry. A part of this fluctuation could also be due to the price factor. To incorporate these firm specific and inter-temporal changes, the study used two-way fixed effect estimation of the growth function. The results of the estimated fixed effect model support the view that inter-firm differences in growth in this industry in India are determined by variables capturing technology paradigm and trajectory shifts. It is evident that even in an era of strict controls and regulations, with policy imposing limits on growth, firms with foreign equity tend to grow at a higher rate than the others. This is largely due to the resource advantage they enjoy over others for growth. With a change in the policy, however, imports of capital goods was the only technology variable which enabled firms to achieve high growth rate. When it comes to other modes of technology acquisition, firms appear to have been in prisoner's dilemma like situation, whereby expenditure incurred

on these activities may not give them any advantage to secure growth, but not spending on these activities could also harm them and make them feel “left-behind”. In a liberal economic policy regime, firms, which relied mostly on intra-firm transfer of technology through foreign equity participation, grew faster than the others did. Thus the changing role of technology acquisition variables in determining growth is borne out by the results of this exercise. The result broadly confirms the basic tenets of Penrose (1959), Marris (1964), Geroski (1995) and the evolutionary theorists.

Further, the positive relationship between firm size and growth also confirms the existence of certain scale advantages in achieving high rates of growth. Firm size, had remained a catch-all variable for most of the studies and if one accounts for the role of technology, vertical integration, capital intensity and the age of the firm, size of the firm does provide a firm with positive advantages to grow. The results of this paper also confirm the hypothesis of the Marris model that profitability determines a firm's ability and willingness to grow. Higher the level of profits, the better would be a firm's ability to raise funds externally at favourable terms.

Apart from technology, firm size and profits, degree of vertical integration and capital intensity also emerged as significant [with negative signs] in determining the growth of Indian automobile firms. Vertically integrated firms face severe restrictions in diversifying to other sectors. Inability to diversify could possibly be the most important reason for lower growth of vertically integrated firms. The negative sign of VI confirms the Marris model. Efficient utilisation of capital stock, with a corresponding reduction in the marginal cost, enables a firm to grow at a faster rate. Liberalisation in economic policy and the emergence of a competitive atmosphere appear to be the most important reason for the firms to utilise their capital stock more efficiently. The results also confirm that new firms grow at a faster rate than their older counterparts. Most of the new firms set up during the second and third periods of this study have gone in for intra-firm mode of technology transfer through foreign equity participation. Access to brand names and good will of the technology supplier could be a possible reason for them to grow.

To sum up, the analysis carried out in this paper clearly highlights the changing nature of the role of technology variables in influencing growth of firms. The role of technology is

largely governed by the technological regime in which the firm operates. Some of these changes in actual technological configuration, however, need to be examined much more thoroughly. Such an exercise is possible only through a case study approach, which is beyond the scope of this study. Moreover, one major limitation of this exercise could be the calculation of growth at current prices. The differences, if any, in the role of firm size, profits, vertical integration, capital intensity and the age of the firm are also brought out by the findings of this study.

## References


Association of Indian Automobile Manufacturers [AIAM] (1996): ***Profile of the Automobile Industry***, New Delhi, AIAM.

Association of Indian Automobile Manufacturers [AIAM] : Various annual reports.

Automotive Component Manufacturers Association [ACMA]: Facts and Figures, Bombay, Various issues.

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

Basant, Rakesh and Brian Fikkert (1996): 'The effects of R & D, foreign technology purchase, and domestic and international spillovers on productivity in Indian firms', ***The Review of Economics and Statistics***, 78, 187-99.

Baumol, W.J. (1959): ***Business Behaviour, Value and Growth***, New York, Macmillan.

Baumol, W.J. (1962): 'On the Theory of Expansion of the Firm', ***American Economic Review***, 52, 1078-87.

Bell, Martin and Keith Pavitt (1997): 'Technological accumulation and industrial growth: contrasts between developed and developing countries', in Archibugi, Daniele and Jonathan Michie (eds.) ***Technology, Globalisation and Economic Performance***, Cambridge, Cambridge University Press.

Buckley, Peter J., John H. Dunning and Robert D. Pearce, (1978): 'The Influence of Firm Size, Industry, Nationality and Degree of Multinationality on the Growth and Profitability of the world's largest firms, 1962-72', ***Weltwirtschafliches Archiv***, 614, 243-57.

Cohen, W.M. and D. A. Levinthal (1989): 'Innovation and Learning: the two faces of R & D', ***Economic Journal***, 99, 569-96.

Dosi, Giovanni , Keith Pavitt and Luc Soete (1992): ***The Economics of Technical Change and International Trade***, Brighton, Harvester-Wheatsheaf.

Evans, M.K. (1967): 'A study of Industry Investment Decisions', ***Review of Economics and Statistics***, 49 (2).

Geroski, Paul A. (1995): 'What do we know about entry?', ***International Journal of Industrial Organization***, 13, 421-40.

Greene, W. (1993): ***Econometric Analysis*** 2nd Edition, London: Macmillan.

Haksar, Vikram (1995): 'Externalities, Growth and Technology Transfer: Applications to the Indian Manufacturing Sector, 1975-90', ***mimeo***, Washington, D.C., International Monetary Fund.

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.

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

Johnston J. and J. Di Nardo (1997): ***Econometric Methods***, 4th Edition, New York, Macmillan.

Kathuria, Sanjay (1996): ***Competing Through Technology and Manufacturing Strategy: A Study of the Indian Commercial Vehicles Industry***, New Delhi, Oxford University Press.

Kumar, Manmohan S. (1984): ***Growth, Acquisition and Investment: An analysis of the growth of industrial firms and their overseas activities***, Cambridge, Cambridge University Press.

Kumar, Nagesh and N. S. Siddharthan (1997): ***Technology, Market Structure and Industrialization: Issues and Policies for Developing Countries***, London and New York, Routledge.

Layard, R. G. and A. A. Walters (1978): ***Micro Economic Theory*** 2nd Edition, New York, McGraw Hill.

Marris, R. (1964): ***The Economic Theory of Managerial Capitalism***, London, Macmillan.

Narayanan, K. (1998): 'Technology Acquisition, De-regulation and Competitiveness: A Study of Indian Automobile Industry', ***Research Policy,*** 27 (2), 215-228.

------- (1999): "Technology, Modernisation and Growth in Indian Manufacturing: A Study of the Automobile Sector", unpublished Ph.D., thesis, Delhi School of Economics, University of Delhi, Delhi.

Nelson, Richard R. and S.G. Winter (1982): ***An Evolutionary Theory of Economic Change***, Cambridge MA, Harvard University Press.

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.

Penrose, (1959): ***The Theory of the Growth of the Firm***, Oxford, Blackwell.

Raut, Lakshmi (1995): 'R & D Spillover and Productivity Growth: Evidence from Indian Private Firms', ***Journal of Development Economics***, 48, 1-23.

Rowthorn, R. and S. Hymer (1971): ***International Big Business 1957-1967: A study of Comparative Growth***, Cambridge, Cambridge University Press.

Samuels, J.M. and A.D. Chesher (1972): 'Growth, Survival and size of companies 1960-69', in Cowling (ed) (1972): ***Market Structure and Corporate Behaviour***, London, Gray Mills.

Schumpeter, Joseph A. (1943): ***Capitalism, Socialism and Democracy***, London, Guye Allan and Unwin.

Siddharthan, N.S. (1988): 'Technology, Modernisation and Growth: A study of the Indian corporate sector, 1975-83', ***Economic and Political Weekly***, 23 (31), 1587-90.

Siddharthan, N.S., B.L. Pandit and R. N. Agarwal (1994): 'Growth and Profit Behaviour of Large Indian Firms', ***Developing Economies***, 32, 188-209.

Siddharthan, N.S. and Sanjaya Lall (1982): 'The recent growth of the largest U.S. Multinationals', ***Oxford Bulletin of Economics and Statistics***, 44(1), 1-13.

Singh, A. and G. Whittington (1975): 'The size and growth of firms', ***Review of Economics Studies***, XlII (1), 129, 15-26.

Solow, R. (1971): 'Some implications of alternative criteria for the firm', in Marris and Wood (eds.) (1971): ***The Corporate Economy***, London, Macmillan.

Teece, D. (1977): 'Technology transfer by multinational firms: The resource cost of transferring technological know-how', ***Economic Journal***, 87, 242-61.