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STATEMENT OF THE PROBLEM

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COMPARING EFFICIENCY AND PRODUCTIVITY OF THE INDIAN AUTOMOBILE FIRMS – A MALMQUIST – META FRONTIER APPROACH

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ABSTRACT

Manufacturing industries in developing countries depends on intermediate inputs and technology. Both these factors play an important role in the productivity of industry. In the early phases of industrialization, the productivity in Indian industry was limited by the government policy such as reservation of production, high custom tariff, changes in domestic trade and excise duties. However, this situation is gradually changing during 1980s and 1990s due to the introduction of economic liberalization process. Therefore, it is essential to analyze the productivity of industry. In this study, an attempt has been made to assess the effects of economic reforms on productivity growth in Indian automobile companies using Malmquist Productivity Index, decomposes the TFP change in to technical and efficiency changes. The results of the study showed that most of the Indian automobile companies must increase their TFP and efforts must be made to provide a stable pattern to the productivity growth. However, the benefits of technological progress were not converted in to productivity gains, as there was no improvement in efficiency in the reform period. The results of the study suggest that there is need for the implementation of specific policies to improve technical progress and efficiency change, in order to precipitate a long-run balance in TFP growth.

KEYWORDS

Productivity, Scale Efficiency, Malmquist Productivity Index, Indian Automobile Industry, Technology adoption and Managerial Efficiency growth.

INTRODUCTION

Manufacturing industries in developing countries rely heavily on imported intermediate inputs and sophisticated technology. Availability of both these factors also plays a crucial role in the variation in productivity of concerned industry. In the early phases of industrialization, the productivity in Indian manufacturing sector was limited by the government policies, such as, the reservation of production, high custom tariff – distorting resource allocation and prohibiting Indian Industry's ability to compete in the international market, shutting down industries in response to normal competitive market forces and various types of distortions created by the structure of domestic trade taxes and excise duties. However, the situation is gradually changing since 1970 due to the introduction of economic liberalization process, but at a slow and halting pace. The first comprehensive economic reform policy statement was formulated for India in July 1991 in the form of industrial and trade sector liberalization. Over the years several measures were undertaken by them for boosting up the industrial productivity. Tariff rates have considerably been brought down; quantitative restrictions on imported goods have been removed to a great extent. These were adopted along with changes in technology-import policy, foreign direct investment policy, to make Indian industrial sector more efficient and productive, technology sounder and an able competitor in the front of world market.

Roderick and Subramanian (2004) categories the reforms of 1980s and 1990s as "Pro-business" and "Pro-market", respectively. The eighties' reforms focussed on increasing the profitability of existing firms by easing capacity restrictions and reducing corporate taxes, while the reforms of the nineties allowed more competition and increased provisions for the entry of new domestic firms and Multi-National Companies (MNCs) in the Indian manufacturing sector. Under these circumstances, there emerges a need for measurement of TFP and identification of the factors that account for productivity changes. Specifically, finding out the appropriate relationship between effective exchange rate and the other trade related variables such as, import substitution, effective rate of protection, non-tariff barriers, etc., and factor productivity growth is very important in the context of recent policies of reforms. Therefore, analyzing productivity and efficiency changes during the post reform periods becomes essential for providing strategic inputs to the producers, the government and other stake holders.

LITERATURE REVIEW

Several studies have attempted to estimate the relationship between economic reforms and productivity growth in Indian manufacturing sector. Estimation of TFPG of Indian manufacturing industries can be seen from **Goldar (1986), Ahluwalia (1991), Balakrishnan and Pushpangadan (1994), Fujita (1994), Rao (1996), Majumdar (1996), Joshi and Little (1997), Gangopadhyay and Wadhva (1998), Pradhan and Barik (1998), Krishna and Mitra (1998), Mitra (1999), Trivedi et al., (2000), Balakrishnan et al., (2000), Unni and Rani (2001), Forbes (2001), Srivastava (2001), Chand and Sen (2002), Hasan (2002), Goldar and Kumari (2003), Unel (2003), TSL (2003), Driffield and Kambhampatti (2003), Goldar (2004), Das (2004), Mukherjee (2004), Rani and Unni (2004), Pattnayak and Thangavelu (2005), Banga and Goldar (2007), Madheswaran et al., (2007), Milner et al., (2007), Soo (2008), Jabir Ali et al., (2009).** All of them examined the effect of reforms on industrial productivity. Some studies have reported that policies of liberalization improved the productivity of the manfuacturing industry **[For example, See Fujita (1994); Majumdar (1996); Krishna and Mitra (1998); Chand and Sen (2002); Unel (2003); TSL (2003); Pattnayak and Thangavelu (2005); Banga and Goldar (2007)]**, whereas some have detected negative effects, or at least no significant improvement, in productivity growth since the onset of economic reforms in 1991 **[for example, See Trivedi et al., (2000); Balakrishnan et al., (2000); Unni and Rani (2001); Goldar and Kumari (2003); Driffield and Kambhampatti (2003); Goldar (2004); Das (2004)]**. Thus, the topic of the effects of economic reforms on productivity growth remains a critical focus of research.

PROBLEM STATEMENT

To meet the emerging challenges, there is an urgent need to bring efficiency to the production process, either through maximizing the output or minimizing the cost. While there have been numerous studies conducted on productivity growth, only a relatively few studies have concerned themselves with the sources of productivity growth in the Indian economy. The traditional Tornquist index, which is applied to calculate total factor productivity growth, is incapable of decomposing the productivity change into movements along and changes in frontier, because the Tornquist index assumes that the observed output is the consequences of the best practice frontier. Conversely, the nonparametric Data Envelopment Analysis (DEA) approach is used to compute the Malmquist Total Factor Productivity (TFP) change, which has been further decomposed into efficiency and technical change.

Total Factor Productivity can be increased by using its existing technology and factor inputs more efficiently – this is referred to as "efficiency change". The total factor productivity of an industry can also increase when the industry adopts innovations or technological improvements, and this process is referred to as "technological change". Therefore, changes in TFP from one period to the next are the products of both efficiency change and technological progress. Most previous studies conducted in India have failed to consider the sources of such changes in productivity growth. **(Sindhu and Balasubramanyam (2006).** This study has attempted to assess the effects of economic reforms on productivity growth in Indian automobile companies using the Malmquist Productivity Index, decomposes the TFP change in to technical and efficiency changes. In particular, this study intends to find the answers to the following question.

"Has the performance of the automobile companies in India improved since the market liberalization of the 1990s in terms of productivity and efficiency changes?"

METHODOLOGY

The study uses the Malmquist Productivity Index approach to analyze changes in the total factor productivity of selected firms in Indian Automobile Industry overtime. The total factor productivity change of a firm has two primary components; the shift in the production frontier over time, representing technical change, and the shift in the firm's efficiency relative to the production frontier over time, representing efficiency change. There are several other ways to measure the productivity change of a firm (**such as the Fisher Index or the Tornquist Index**), but the Malmquist index is adopt here because it permits the separation of technical change from efficiency change (**Fare, Grosskopf, Norris and Zhang, 1994**) and is consistent with the DEA efficiency estimation methodology.

The Malmquist index was introduced by **Caves et al., (1982 a, b)** who dubbed it the (output based) Malmquist index after Sten Malmquist, who earlier proposed constructing quantity indexes as ratios of distance functions (**See Malmquist, 1953**). The Malmquist index was calculated as follows ((**as outlined in Fare et al., (1997)**)).

The measurement of the Malmquist productivity index is predicated on distance functions. For simplicity, $z^t = (x^t, y^t)$ and $z^{t+1} = (x^{t+1}, y^{t+1})$, where x^t is the vector of inputs used in production and y^t is the vector of outputs. Now, for each time period $t = 1,.....T,$ the output distance function is defined as follows:

$$D^t(z) = \inf\{\theta : y^t / \theta \in P^t(x)\}$$
$$= [\sup\{\theta : y^t / \theta \in P^t(x)\}]^{-1} \quad (1)$$

where superscript *t* and D^t denote that technology in period *t* is used as the reference technology. θ is scalar, and its value is the efficiency score for each production activity. It satisfies $0 < \theta \leq 1$ for a non-negative output level, with a value of 1 indicating a point of the frontier, and thus a technically efficient production activity. This output distance function is defined as the reciprocal of the maximal proportional expansion of output vector y^t with the given input vector x^t in relation to the technology at *t*.

The Malmquist productivity index is defined as follows:

$$TFP = M^t = \frac{D^t(z^{t+1})}{D^t(z^t)} \quad (2)$$

This formulation is called the output-oriented Malmquist productivity index in period *t*, $M^t(z^{t+1}, z)$, where the technology in period *t* is the reference technology for two differing pairs of outputs and inputs. Alternatively, we can define M^{t+1} where the technology in period *t + 1* is employed as the reference technology.

Consistent with the study of **Fare et al., (1994)**, the output-based Malmquist productivity index is defined as the geometric mean of two output-distance functions, in order to avoid selecting an arbitrary benchmark:

$$M(z^{t+1}, z^t) = [M^t . M^{t+1}]^{1/2} = \left[\left(\frac{D^t(z^{t+1})}{D^t(z^t)}\right)\left(\frac{D^{t+1}(z^{t+1})}{D^{t+1}(z^t)}\right)\right]^{1/2} \quad (3)$$

Equation (3) can be rewritten as:

$$M(z^{t+1}, z^t) = \left(\frac{D^{t+1}(z^{t+1})}{D^t(z^t)}\right) \times \left(\frac{D^t(z^{t+1})}{D^{t+1}(z^{t+1})}\right)\left(\frac{D^t(z^t)}{D^{t+1}(z^t)}\right)^{1/2} \quad (3`)$$

where the ratio outside the brackets measures the change in relative efficiency between *t* and *t +1*, and the geometric mean inside the brackets measures the shift in frontier. That is, the Malmquist productivity index can be decomposed into change in efficiency and change in technical progress.

In a previous empirical work, **Fare et al., (1994)** utilized non-parametric linear-programming techniques. As can be seen in (3`), it must solve four different linear programming problems: $D^t(z^t), D^t(z^{t+1}), D^{t+1}(z^t), and\ D^{t+1}(z^{t+1}).$ Calculating the Malmquist index relative to the variable returns to scale technology, $D_j^t(z^t)$ for each industry, $j \in k = 1,...., K,$ one of the four different linear programming problems, can be stated as:

$$\left[D_j^t(z_j^t)^{-1} = \max_{\theta, w} \theta_j\right] \quad (4)$$

subject to

$$\theta_j y_{m,j}^t \leq \sum_{k=1}^{K} w_k^t y_{m,k}^t \quad m = 1,...., M \quad (4a)$$

$$\sum_{k=1}^{K} w_k^t x_{n,j}^t \leq x_{n,j}^t \quad n = 1,....., N \quad (4b)$$

$$w_k^t \geq 0 \quad k = 1,....., K \quad (4c)$$

where *n = 1, ..., N* are inputs, *m = 1, ..., M* are outputs, and w_k^t is an intensity variable indicating the production intensity of a particular activity. (Here, each industry is an activity). These intensity variables are used as weights in taking convex combinations of the observed outputs and inputs in both (4a) and (4b).

From Equation 4, the reciprocal of the output distance function can be used to find the maximum of θ, which gives the maximal proportional expansion of output given constraints (4a) – (4).

For the other distance functions, the computation of $D^{t+1}\left(z^{t+1}\right)$ is exactly the same as (4), where *t + 1* is substituted for *t*. Two other distance functions require information from two periods, $D^{t}\left(z^{t+1}\right)$ can be computed by replacing $y_{m,j}^{t}$ and $x_{n,j}^{t}$ in (4a) and (4b) with $y_{m,j}^{t+1}$ and $x_{n,j}^{t+1}$, respectively and $D^{t+1}\left(z^{t}\right)$ is the same as $D^{t}\left(z^{t+1}\right)$, where the *t* and *t + 1* superscripts are exchanged.

RESEARCH DESIGN

Keeping in view the scope of the study, it is decided to include all the companies under automobile industry working before or from the year 1996-97 to 2008-09. There are 26 companies operating in the Indian automobile industry. But, owing to several constraints such as non-availability of financial statements or non-working of a company in a particular year etc., it is compelled to restrict the number of sample companies to 20. The companies under automobile industry are classified into three sectors namely; Commercial vehicles, Passenger Cars and Multiutility vehicles and Two and Three wheelers. For the purpose of the study all the three sectors have been selected. It accounts for 73.23 per cent of the total companies available in the Indian automobile industry. The selected 20 companies include 5 under commercial vehicles, 6 under Passenger cars and Multiutility vehicles and 9 under two and three wheeler sectors. It is inferred that sample company represents 98.74 percentage of market share in commercial vehicles, 89.76 percentage of market share in Passenger Cars and Multiutility vehicles and 99.81 percentage of market share in two and three wheelers. Thus, the findings based on the occurrence of such representative sample may be presumed to be true representative of automobile industry in the country.

Out of 20 selected companies under Indian Automobile Industry, the productivity performance of three Multinational Companies (MNC's) namely Hyundai Motors India Ltd, Honda Siel Cars India Ltd and Ford India Private Ltd computed separately because these companies established their operations in India in different accounting years. In order to have uniform period, the productivity performance of the three MNC's were computed from the year 2000-01 to 2008-09 (9 years only).

DATA

The study is mainly based on secondary data. The major source of data analysed and interpreted in this study related to all those companies selected is collected from "PROWESS" database, which is the most reliable on the empowered corporate database of Centre for Monitoring Indian Economy (CMIE). Besides prowess database, relevant secondary data have also been collected from BSE Stock Exchange Official Directory, CIME Publications, Annual Survey of Industry, Business newspapers, Reports on Currency and Finance, Libraries of various Research Institutions, through Internet etc.

RESULTS AND DISCUSSION

MALMQUIST TOTAL FACTOR PRODUCTIVITY

Table 1 shows mean values of change in Malmquist total factor productivity index and its components (efficiency change and technology change) for the period 1996-97 to 2008-09. The malmquist index value greater than one implies positive TFPG and the value less than one indicates TFPG decline. Note that while the product of the efficiency change and technology change components must be definition equal the Malmquist index, those components may be moving in opposite directions. For all the companies put together, the TFP has decreased by 1.05 per cent during the study period. An important question to investigate is whether the TFPG has been achieved by improvement in technical efficiency (catch-up) and / or improvement in technology (shift in production frontier)?. The decomposition of TFPG in to efficiency change and technical change also reported in the Table 1 shows that technological efficiency change has been the main contributor to TFPG. The average technological efficiency was 2.24 per cent, while the average technical efficiency change was negative (-3.20 per cent). This suggests that, in the companies studied, technical efficiency has been the main barrier to achieving high level of TFP during the period under consideration. Further, the analysis of total factor productivity of three sectors revealed that the overall TFP growth is positive in passenger cars and multiutility sector (2.5 per cent) due to improvement in both technical efficiency of 0.6 per cent and technological efficiency of 1.9 per cent.

Another significant results from the Table 1 that the efficiency change tends to be a negative contributor to total factor productivity in the commercial vehicles and two and three wheeler sector (i.e, it is less than unity), and technological change tends to be a positive contributor (i.e., it is greater than unity) suggesting that improvement in these sectors is due to their productivity based on production frontier effect. The overall technical efficiency change in these sectors is less than one which is the main cause in dampening the total factor productivity for whole industries.

Technical efficiency change is the result of pure technical efficiency change and scale efficiency change. With regards to pure efficiency change, it is more than one in cars and multiutility vehicles sector only. In case of scale efficiency change, a value close to unity shows that all the sectors are operating at optimum scale. Therefore scale efficiency has only contributed to the improvement in technical efficiency in all the three sectors and the whole Indian automobile industry during the study period.

Another interesting finding is that only 10 out of 17 companies had registered growth in TFP during the period 1996-97 to 2008-09 (Table 1). Further, all the companies except LML Ltd under two and three wheeler sector recorded technological efficiency improvement. But only 6 out of 17 companies had recorded technical efficiency improvement. However, not all the companies registered a similar performance during the period. Some companies, for instance, Ashok Leyland Ltd and Tata Motors Ltd (under commercial vehicles sector), Hindustan Motors Ltd (under passenger cars and multiutility vehicles sector) and Bajaj Auto Ltd, Hero Honda Motors Ltd and Majestic Auto Ltd (under two and three wheeler sector) have experienced an increase in overall technical efficiency during the period, while remaining companies experienced a negative growth in technical efficiency. But for technological efficiency is concerned, all the selected companies except LML Ltd have experienced a big increase in overall technological efficiency ranges from 1.002 to 1.048 during the period. Only in case of Ashok Leyland Ltd and Tata Motors Ltd (commercial vehicle sector), Hindustan Motors Ltd (passenger cars and multiutility vehicles sector) and Bajaj Auto Ltd, Hero Honda Motors Ltd and Majestic Auto Ltd (two and three wheeler sector), improvement in these industries is due to their productivity based both catching up effect and production frontier effect.

The technical efficiency change is further decomposed into pure technical efficiency change and scale efficiency change given in the last two columns in Table 1. With regards to pure efficiency change, it is one or more than one in Ashok Leyland Ltd, Tata Motors Ltd and Swaraj Mazda Ltd (Commercial vehicle sector), Hindustan Motors Ltd, Mahindra and Mahindra Ltd and Maruti Udyog Ltd (Passenger cars and Multiutility vehicles sector) and Bajaj Auto Ltd, Hero Honda Motors Ltd and Majestic Auto Ltd (Two and three wheeler sector) during the study period. Scale efficiency indicates whether the firm can increase its productivity by becoming larger. It is evident from the table that incase of scale efficiency change, value close to unity shows that most of the companies are operating at optimum scale. The results of the study show that both the pure and scale efficiency have contributed to the growth of overall efficiency. This suggests that, in achieving high levels of technical performance over time, technical efficiency is not a long-run constraint. From the Table 1, the comparison of total factor productivity change in different companies shows that Hero Honda Motors Ltd on average has the highest growth in TFP (12.1 per cent), followed by Majestic Auto Ltd (5.7 per cent) and Bajaj Auto Ltd (4.1 per cent) total factor productivity growth. The worst performers in terms of total factor productivity growth is Maharashtra Scooters Ltd. (-28 per cent) followed by Kinetic Motors Ltd (-9 per cent). Both the best and worst performer in terms of total factor productivity growth has been found in two and three wheeler sector of Indian Automobile industry during the study period.

The mean values of changes in Malmquist total factor productivity index and its components (efficiency change and technology change) for the three Multinational companies in Indian automobile industry for the period 1996-97 to 2008-09 were computed and presented in Table 2. The analysis of total factor productivity of three MNC revealed that the overall TFP growth is positive in Ford India Private Ltd and Honda Siel Cars India Ltd, but it is negative in Hyundai Motors India Ltd during the study period. The overall TFP growth is highest in Ford India Private Ltd (27 per cent) due to improvement in technical efficiency of 24 per cent and technological efficiency of 2.3 per cent. Similarly, in Honda Siel Cars India Ltd, the productivity growth was 2.7 per cent with technical efficiency

growth of 1.2 per cent and technological efficiency change of 1.5 per cent. Another significant result from the Table 2 that technological change tends to be a negative contributor to total factor productivity in the Hyundai Motors India Ltd (i.e., it is less than unity) which is the main cause in dampening the total factor productivity in Hyundai Motors India Ltd. The analysis of two components of technical efficiency change presented in the table revealed that pure efficiency change is more than one in Ford India Private Ltd only. In case of scale efficiency change, in all the three MNCs, scale efficiency which is one or more than one, have contributed to the improvement in technical efficiency. The table also revealed that Hyundai Motors India Ltd did not show any change in terms of pure efficiency change and scale efficiency change during 1997-2009.

MANAGERIAL EFFICIENCY GROWTH

Technical efficiency change can make use of existing input to produce more of same product. As one gets more experience in producing some product, it becomes more and more efficient in it. Labour finds new ways to produce by making minor modifications in the process of manufacturing which contribute to higher productivity. Therefore, to understand the contribution made by technical efficiency in the productivity growth, year-wise technical efficiency movement is presented in Table 3.

In general these results suggest that technical efficiency is an important contributor in the total factor productivity. The average efficiency change of whole automobile industry is equal or greater than one in 9 out of 12 years of the study period. During the years 1999-00 and 2000-01, the technical efficiency change for majority of the selected companies are positive and overall automobile industry efficiency increased by 10.2 per cent during 1999-00, being the second highest efficiency growth in entire period. The year 2008-09 was also most favourable for all the selected companies where technical efficiency change increased by 11.2 per cent i.e., highest for the whole automobile industry during 1997-2009. In the year 2004-05, again a tangle up trend can be seen where only two out of seventeen companies has their technical efficiency change more than 1, which was also the most unfavourable for overall automobile industry where the technical efficiency change decreased by 25.1 per cent i.e., highest for the entire period during 1997-98 to 2008-09. The results in the table also explain that Maruti Udyog Ltd did not show any change in terms of efficiency during 1997-2009. The LML Ltd, Hero Honda Motors Ltd and Majestic Auto Ltd under two and three wheelers sector has performed relatively better than all other companies in terms of efficiency change. Other good performing companies in terms of efficiency change are Hindustan Motors Ltd (passenger cars and multiutility vehicles) and Bajaj Auto Ltd and Majestic Auto Ltd (two and three wheelers). These companies have their efficiency change in positive for seven years out of twelve years.

The year wise movement of technical efficiency of three MNC's is presented in Table 4. The results presented in Table 6 revealed that technical efficiency change of three MNC's is an important contributor in the TFP. The mean efficiency change of all the three companies is greater than one during the study period. During 2002-03 and 2006-07, all the three companies showed positive growth in their technical efficiency change.

TECHNOLOGY ADOPTION

The second important source of total factor productivity growth is the change in the technology. Technological change is the development of new technologies or new products to improve and shift production frontier upward. Table 5 presents the comparative technical change for all companies during the period 1997-2009. It is observed from the table that the technical change can be seen in whole automobile industry greater than one during 1998-99 and 2001-02 to 2005-06, where technical change increased by 6.2 per cent, 7 per cent, 22.4 per cent, 7.8 per cent 45.8 per cent and 3.1 per cent respectively. Further, during 2001-02, 2002-03, 2004-05 and 2005-06, all the selected companies has performed better in terms of technical change, because their technical change is greater than one. The mean values of technical change of all the selected companies showed that all the companies have a relatively stable and overall technical change. However, in the terminal years 2006-07 and 2008-09 were a dreadful years for all the selected companies where technical change drop for all the companies. Maharashtra Scooters Ltd, TVS Motor Company Ltd, Majestic Auto Ltd and Hero Honda Motors Ltd under two and three wheeler sectors are the most stable companies in terms of technological change as having its change more than unity for seven out of twelve years.

Table 6 showed the comparative technical change for all the three MNC's during the study period. It is observed from the table that the mean technical change was more than one in Ford India Private Ltd and Honda Siel Cars India Ltd. Further, Honda Siel Cars India Ltd has a relatively stable in its technical change because it was more than one in six out eight years during the study period. However, technical change growth was decreased in the terminal years of the study period (2005-2009) in case of Hyundai Motors India Ltd. Table 7 presents the ranking of all the selected companies in terms of total factor productivity growth, technical change and technical efficiency change. This table also presents the ranking in terms of pure efficiency change and scale efficiency change being the components of technical efficiency change.

CONCLUSION

The empirical estimates on the Indian automobile industry Productivity performance yielded several results that appear striking. The overall automobile industry improved technical (technological) change efficiency by 2.2 per cent while technical efficiency change put a negative effect on the productivity, as a result the overall total factor productivity during 1997-2009 decreased by 1.4 per cent. Among the three sectors, both technical efficiency change and technical change put a positive effect on the productivity only in the case of passenger cars and multiutility vehicles sector. However, in case of commercial vehicles sectors, technical progress leads to an increase of productivity by 0.4 per cent during the study period. The results from individual companies show that TFP growth is mainly contributed by technological change while technical efficiency change is only positive for ten out of twenty companies. It suggests that Indian automobile industry are lacking in terms of managerial efficiency growth. Except few companies which have relatively stable productivity includes Hero Honda Motors Ltd and Ford India Private Ltd, all other companies have a mixed trend over 1997-2009 which affects the productivity and ranking of companies. Ford India Private Ltd is at the top in ranking in terms of TFP followed by Hero Honda Motors Ltd due to highest technical change and technical efficiency. Maharashtra Scooters Ltd and Kinetic Motor Company Ltd are among the worst performer in terms of productivity over 1997-2009. The main reason for this worst performance is less improvement in managerial efficiency.

The research result suggests that Indian Automobile Companies must increase total factor productivity in most of the companies under study and efforts must be made to provide a stable pattern to the productivity growth. The reform process has increased access to superior technology in the manufacturing sector through higher foreign participation, as well as greater access to importation of higher quality of raw materials and capital equipment. However, the benefits of technological progress were not converted into productivity gains, as there was no improvement in efficiency in the reform period. **Goldar and Kumari (2003)** have presented econometric evidence indicating that slow down in TFP growth in Indian manufacturing in the post reform period is attributable, to a large extent, to deterioration in capacity utilization. It could, therefore, be concluded that there must have been a corresponding increase in efficiency to convert technological progress into productivity growth. The results of this study suggest the need for the implementation of specific policies to improve technical progress and efficiency change, in order to precipitate a long-run balance in TFP growth. Technological progress should be encouraged in industries with slow technical progress, industries, with slow efficiency change rates should be encourage to use existing technology more effectively via increased training and education.

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TABLES

TABLE 1: CHANGES IN TOTAL FACTOR PRODUCTIVITY AND ITS COMPONENTS OF SELECTED INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09. (MALMQUIST INDEX SUMMARY OF COMPANY MEANS)

Company	TFP Change	Components of TFPG		Components of Technical Efficiency Change	
		Technological Change	Technical Efficiency Change	Pure Technical Efficiency Change	Scale Efficiency Change
Ashok Leyland Ltd	1.030	1.022	1.008	1.012	0.996
Tata Motors Ltd	1.026	1.020	1.006	1.000	1.006
Bajaj Tempo Ltd	0.975	1.009	0.966	0.965	1.001
Eicher Motors Ltd	0.981	1.007	0.974	0.977	0.997
Swaraj Mazda Ltd	1.007	1.026	0.981	1.000	0.981
Hindustan Motors Ltd	1.026	1.002	1.024	1.025	0.999
Mahindra and Mahindra Ltd	1.034	1.039	0.995	1.022	0.974
Maruti Udyog Ltd	1.015	1.015	1.000	1.000	1.000
Bajaj Auto Ltd	1.041	1.017	1.024	1.000	1.024
LML Ltd	0.937	0.990	0.946	0.964	0.981
Maharashtra Scooters Ltd	0.723	1.044	0.692	0.708	0.978
TVS Motor Company Ltd	1.019	1.040	0.980	0.970	1.010
Kinetic Motor Company Ltd	0.910	1.027	0.885	0.891	0.994
Hero Honda Motors Ltd	1.121	1.048	1.070	1.060	1.009
Kinetic Engineering Ltd	0.953	1.011	0.943	0.961	0.981
Majestic Auto Ltd	1.057	1.030	1.026	1.054	0.974
Scooters India Ltd	0.967	1.033	0.936	0.935	1.001
Commercial Vechicles	**1.004**	**1.017**	**0.987**	**0.991**	**0.996**
Passenger Cars and Multiutility Vechicles	**1.025**	**1.019**	**1.006**	**1.016**	**0.991**
Two and Three Wheelers	**0.963**	**1.027**	**0.938**	**0.943**	**0.995**
Whole Automobile Industry	**0.986**	**1.022**	**0.964**	**0.970**	**0.994**

TABLE 2: CHANGES IN TOTAL FACTOR PRODUCTIVITY AND ITS COMPONENTS OF THREE MNC IN INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09 (MALMQUIST INDEX SUMMARY OF COMPANY MEANS)

Company	TFP Change	Components of TFPG		Components of Technical Efficiency Change	
		Technological Change	Technical Efficiency Change	Pure Technical Efficiency Change	Scale Efficiency Change
Hyundai Motors India Ltd	0.976	0.976	1.000	1.000	1.000
Honda Siel cars India Ltd	1.027	1.015	1.012	1.000	1.012
Ford India Private Ltd	1.270	1.023	1.241	1.224	1.014

TABLE 3: COMPARATIVE TECHNICAL CHANGE OF ALL THE SELECTED INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09

Company	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Mean
Ashok Leyland Ltd	0.995	0.992	0.978	0.824	1.055	1.234	1.051	1.475	1.029	0.85	0.999	0.928	1.034
Tata Motors Ltd	0.960	1.076	0.967	0.815	1.047	1.206	1.044	1.485	1.030	0.852	1.003	0.909	1.033
Bajaj Tempo Ltd	1.030	0.996	0.996	0.750	1.024	1.140	1.031	1.555	1.033	0.856	1.010	0.869	1.025
Eicher Motors Ltd	0.985	1.028	0.969	0.855	1.111	1.308	1.122	1.083	1.016	0.837	0.988	0.878	1.015
Swaraj Mazda Ltd	0.860	1.109	0.999	1.095	1.121	1.237	1.206	1.081	1.013	0.922	0.894	0.865	1.034
Hindustan Motors Ltd	0.976	1.066	1.068	0.720	1.020	1.184	0.974	1.865	1.056	0.731	0.958	0.792	1.034
Mahindra and Mahindra Ltd	0.863	1.120	0.952	0.923	1.127	1.305	1.064	1.428	1.026	0.845	0.994	0.964	1.051
Maruti Udyog Ltd	0.962	1.044	1.061	0.732	1.016	1.166	0.992	1.925	1.059	0.802	0.994	0.799	1.046
Bajaj Auto Ltd	1.015	0.987	0.980	0.789	1.047	1.219	1.048	1.458	1.026	0.842	0.992	0.945	1.029
LML Ltd	0.963	0.944	0.982	0.751	1.027	1.182	1.050	1.481	1.033	0.866	0.990	0.792	1.005
Maharashtra Scooters Ltd	0.925	1.150	0.936	0.936	1.124	1.305	1.067	1.417	1.027	0.847	0.996	0.941	1.056
TVS Motor Company Ltd	0.936	1.139	0.944	0.889	1.130	1.324	1.085	1.391	1.025	0.846	1.001	0.913	1.052
Kinetic Motor Company Ltd	0.986	1.046	0.974	0.834	1.062	1.230	1.044	1.494	1.030	0.850	1.000	0.926	1.040
Hero Honda Motors Ltd	0.947	1.151	0.946	0.997	1.109	1.226	1.376	1.185	1.016	0.877	0.939	0.920	1.057
Kinetic Engineering Ltd	1.037	1.022	1.018	0.731	1.026	1.159	1.010	1.624	1.036	0.867	1.027	0.800	1.030
Majestic Auto Ltd	0.887	1.118	1.122	0.755	1.021	1.183	0.974	2.215	1.058	0.811	0.958	0.792	1.074
Scooters India Ltd	0.851	1.092	0.999	1.131	1.144	1.228	1.272	1.096	1.013	0.921	0.894	0.865	1.042
Whole Automobile Industry	**0.950**	**1.062**	**0.992**	**0.846**	**1.070**	**1.224**	**1.078**	**1.458**	**1.031**	**0.847**	**0.978**	**0.874**	**1.022**

TABLE 4: COMPARATIVE TECHNICAL CHANGE OF THREE MNC IN INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09

Company	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Mean
Hyundai Motors India Ltd	1.031	0.964	1.033	1.189	1.501	0.910	0.797	0.942	0.642	**0.976**
Honda Siel cars India Ltd	1.148	1.029	1.076	1.120	1.509	0.952	1.045	0.959	0.556	**1.015**
Ford India Private Ltd	0.926	0.903	1.126	1.047	1.517	0.845	0.761	1.092	1.173	**1.023**
	1.035	**0.965**	**1.078**	**1.117**	**1.509**	**0.902**	**0.868**	**0.998**	**0.790**	**1.005**

TABLE 5: COMPARATIVE TECHNICAL EFFICIENCY CHANGE OF ALL THE SELECTED INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09

Company	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Mean
Ashok Leyland Ltd	0.817	1.025	1.331	1.142	0.956	0.875	1.190	0.856	1.112	1.167	0.926	0.844	**1.020**
Tata Motors Ltd	0.754	0.815	1.400	1.036	1.042	1.178	1.138	0.869	1.042	1.166	0.914	0.889	**1.020**
Bajaj Tempo Ltd	0.905	0.966	1.172	1.147	1.089	1.181	1.172	0.602	0.821	0.994	0.876	0.871	**0.983**
Eicher Motors Ltd	0.871	1.032	1.322	1.316	0.928	1.075	1.043	0.770	0.733	1.225	0.954	0.681	**0.996**
Swaraj Mazda Ltd	1.000	0.787	1.270	1.000	1.000	1.000	0.986	0.974	0.839	0.999	1.182	0.836	**0.989**
Hindustan Motors Ltd	1.029	1.089	1.089	1.205	0.939	1.072	0.846	0.914	0.745	1.208	0.962	1.335	**1.036**
Mahindra and Mahindra Ltd	1.240	0.832	1.127	0.938	0.853	0.933	1.161	0.914	0.985	1.081	0.979	0.982	**1.002**
Maruti Udyog Ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	**1.000**
Bajaj Auto Ltd	0.923	1.236	1.021	1.239	1.334	1.259	1.130	0.969	0.959	0.689	0.724	1.044	**1.044**
LML Ltd	1.157	1.646	0.638	1.000	0.803	1.521	0.826	0.447	0.483	0.182	9.711	1.097	**1.623**
Maharashtra Scooters Ltd	0.990	1.024	1.000	0.571	0.526	0.560	0.618	0.669	0.907	0.306	0.484	1.279	**0.745**
TVS Motor Company Ltd	1.281	0.909	1.190	0.906	1.256	1.000	0.870	0.773	0.924	1.036	0.754	1.021	**0.993**
Kinetic Motor Company Ltd	1.061	0.964	1.306	1.223	0.714	0.789	0.643	0.625	0.796	1.239	0.307	2.073	**0.978**
Hero Honda Motors Ltd	1.381	1.058	1.347	1.089	1.046	0.924	1.082	1.000	1.000	1.000	1.000	1.000	**1.077**
Kinetic Engineering Ltd	1.021	1.372	0.989	1.446	0.878	0.837	0.800	0.547	0.670	1.132	0.545	1.854	**1.007**
Majestic Auto Ltd	1.197	1.144	0.817	1.231	0.886	1.198	1.290	0.404	0.967	0.918	1.126	1.795	**1.081**
Scooters India Ltd	1.143	0.886	1.050	0.709	0.839	0.891	0.825	0.852	1.055	1.061	0.838	1.208	**0.946**
Whole Automobile Industry	**1.032**	**1.028**	**1.102**	**1.047**	**0.927**	**0.995**	**0.958**	**0.749**	**0.868**	**0.882**	**0.935**	**1.112**	**0.964**

TABLE 6: COMPARATIVE TECHNICAL EFFICIENCY CHANGE OF THREE MNC IN INDIAN AUTOMOBILE COMPANIES DURING 1996-97 TO 2008-09

Company	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Mean
Hyundai Motors India Ltd	1.000	1.000	1.000	0.988	0.663	1.076	1.070	0.817	1.625	**1.000**
Honda Siel cars India Ltd	0.897	1.102	1.130	1.000	1.000	1.000	1.000	1.000	1.000	**1.012**
Ford India Private Ltd	4.332	0.923	1.067	1.136	0.692	0.907	2.019	1.137	1.000	**1.241**
	2.076	**1.008**	**1.067**	**1.041**	**0.785**	**0.994**	**1.363**	**0.985**	**1.208**	**1.084**

TABLE 7: RANKING OF COMPANIES BASED ON MALMQUIST TFP AND ITS COMPONENTS

Company	Ranks				
	TFP Change	Tech. Change	TE Change	PE Change	SE Change
Ashok Leyland Ltd	6	10	7	6	13
Tata Motors Ltd	8	11	8	7	6
Bajaj Tempo Ltd	15	16	15	15	7
Eicher Motors Ltd	13	17	14	13	12
Swaraj Mazda Ltd	12	8	12	8	15
Hindustan Motors Ltd	9	18	4	4	11
Mahindra and Mahindra Ltd	5	4	11	5	19
Maruti Udyog Ltd	11	13	9	9	9
Bajaj Auto Ltd	4	12	5	10	1
LML Ltd	18	19	16	16	16
Maharashtra Scooters Ltd	20	2	20	20	18
TVS Motor Company Ltd	10	3	13	14	4
Kinetic Motor Company Ltd	19	7	19	19	14
Hero Honda Motors Ltd	2	1	2	2	5
Kinetic Engineering Ltd	17	15	17	17	17
Majestic Auto Ltd	3	6	3	3	20
Scooters India Ltd	16	5	18	18	8
Hyundai Motors India Ltd	14	20	10	11	10
Honda Siel Cars India Ltd	7	14	6	12	3
Ford India Private Ltd	1	9	1	1	2

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