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Engineering Industry, Corporate Ownership and Development: Are Indian Firms Catching up with the Global Standard?

Rajdeep Singha
K Gayithri

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ENGINEERING INDUSTRY, CORPORATE OWNERSHIP AND DEVELOPMENT: ARE INDIAN FIRMS CATCHING UP WITH THE GLOBAL STANDARD?

Rajdeep Singha [1], K Gayithri [2]

Abstract

The presence of multinational corporations (MNC) in the developing economies has to a certain extent, has enhanced efficiency across domestic firms, comparable to the advanced economies. This paper seeks to examine the extent of this convergence between the foreign and domestic firms in the context of the Indian engineering industry. This paper uses a stochastic production function technique to evaluate separately the efficiency of foreign and domestically owned engineering firms. Econometric models help explain not only the nature of convergence but also the factors underlying the variations in terms of efficiency.

This paper brings to the fore the difference between productivity and efficiency across foreign and domestic firms in that ownership has a significant effect on the performance of firms. This paper also reveals that domestic firms, which have achieved efficiency levels almost equaling foreign firms, are faring better than other firms. At the individual level, trade liberalisation has had a significant impact on the efficiency of firms.

Introduction

Growth of productivity and efficiency is the key driving factor in the development of any industry. It has been more than two decades since India initiated the industrial liberalisation process. One of the important objectives of the industrial liberalisation policy was to improve the efficiency of the industrial sector. These reforms have made imported inputs cheaper and more accessible to companies that have explored the advantages in the domestic and international markets. In addition, these policies draw more foreign firms/investment (FDI) to the economy. An efficient industry has significant impact on the economy. It is believed that the foreign firms are more efficient than the domestic ones and hence the spillover effect. Helpman, Melitz and Yeaple (2004) find that it is the most efficient firms in the advanced economies that engage in FDI, which make this point more significant. One can also assume that if the domestic firms are able to follow the productivity level of a foreign firm then they can attain global standards.

A number of empirical studies have been carried out concerning the effects of ownership (This ownership classification based on a continuous monitoring of company announcements and a qualitative understanding of the group-wise behaviour of individual companies by prowess) of the industrial

[1] PhD Fellow, Centre for Economic Studies and Policy, Institute for Social and Economic Change, Nagarabhavi, Bangalore-560072. E-mail: rajdeep.singha@gmail.com

[2] Associate Professor, Centre for Economic Studies and Policy, Institute for Social and Economic Change, Nagarabhavi, Bangalore-560072. E-mail: gayithri@isec.ac.in

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enterprises on productivity and efficiency. One group of studies observes that the foreign firms are more productive and efficient than indigenous firms. On the other hand, some studies deal with the differences between private and public sector firms. Nevertheless, our concern is centered on the efficiency of domestic and foreign firms. Foreign firms are supposed to be more efficient than domestic firms because it is only through greater efficiency that they can manage their production activities in some other country. Another important point is that in developing countries like India, foreign firms are assumed to be more efficient than domestic firms because they have access to modern and advanced technology. This is one of the reasons why governments try to attract more foreign firms - the expectation that capital inflows will bring in advanced technology and thus help improve productivity of the indigenous firms. In addition, there may be a number of other reasons like foreign firms generating more output from a given mix of inputs, inability on the part of domestic firms to charge higher prices due to lower product quality or inferior marketing facilities, fewer intangible assets, higher cost of capital, more inefficient vertical integrations etc.

Empirical studies carried out in the context of developed industrialised countries reveal that foreign firms are more productive (e.g. Canyon *et al* 2002; Collins and Harris 1999; Grima *et al* 1999). However, the studies regarding the developing countries have thrown up with mixed results. Some of the studies find that there is no influence on productivity and efficiency (e.g. Stener, 1990) while some studies claim that foreign firms are more efficient. Therefore, in the present context, it is very important to examine the case of the Indian engineering industry. In the context of India, very few studies are available, which try to address the efficiency as part of foreign and domestic firms. However, in general, there are a number of studies which deal with the changes in the efficiency of the different sectors in India (Mitra 1999; Agarwal 2001; Kambhampati 2003) (See Appendix 1)

Economic development is often viewed as a process through which inefficient firms converge on efficient firms. A necessary condition for this convergence is that inefficient firms should get some benefits or spillovers from the efficient firms. Very few studies look at efficiency as a part of the Indian engineering industry. However, Goldar, Renganathan and Banga used the Stochastic Frontier Analysis (SFA) to measure efficiency and the level of convergence for the period 1990-91 to 1999-00 in the Indian engineering industry.

Keeping the above background in view, the paper is organised as follows: in the second section, we discuss the methodology adopted for the analysis. Details about the data sets used and the results are outlined in the penultimate section. The concluding section sums up the findings.

Methodology

1. Methodology for production function approach

1.1. Comparison between foreign and domestic firms

To examine, whether or not foreign firms are more productive, or in other words to verify the relationship between foreign ownership and productivity we follow the model developed by Aiken and Harrison (1999). They used the augmented production function to examine the effect of foreign

ownership on the productivity of firms within a region or an industry. Here, we use the log-linear production function to identify the nature of the relationship.

$$\ln Y_{it} = \alpha + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 OW_i + \varepsilon_{it} \quad (1)$$

The log of output is regressed on a vector of inputs and a share of foreign ownership. The variable OW_i refers to ownership. This variable is taken as value one for foreign owned firms or zero otherwise. Here the expectation is that the coefficient of OW_i is positive and significant. Inputs consist of capital stock K_{it}, labour L_{it} measured by total salaries and wages and materials M_{it}. The above equation is estimated by using panel data. To verify whether there is any change in output before after liberalisation a time dummy variable is included. The time dummy variable is equal to one from 1990-91 to 1993-94 and for the rest of the period it is zero. In addition, another benefit of using the time dummy variable is that it will control the time effect also.

1.2. Dimension of Vertical Integration

To estimate the dimension of vertical integrations or spillover effects we have included another variable in the equation 1. The production function is, with vertical integration as a variable apart from the equation 1's variable; the model can be represented as follows.

$$\ln Y_{it} = \alpha + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 OW_i \beta_4 + \ln Vertical_{it} + \varepsilon_{it} \quad (2)$$

The variable vertical integration captures the link between the firms and their suppliers. The above equation (2) is estimated by using panel data with the random effect model because in the equation (2) we have individual specific dummy variables. After estimating the model, randomness is checked by Breusch and Pagan Lagrangian multiplier test.

2. Methodology for efficiency analysis

The importance of efficiency in use of resources has been recognised since long, but the mainstream neoclassical economists assume that efficient firms in a given industry always make efficient use of resources. In reality, however, not all firms are always efficient. Two identical firms never produce the same output and costs and profits are also not the same. This difference in output, cost and profit can be explained in terms of technical and allocative inefficiency. Given the resources, a firm is assumed to be technically inefficient if it fails to produce the maximum possible output with a given mix of inputs.

The technical efficiency scores for foreign and domestic firms are arrived at by estimating a stochastic frontier production function (SFPF) using parametric techniques. SFPF, independently proposed by Aigner, Lovell, and Schmidt(1977) and Meeusen and Van Den Broeck (1977), includes an additional random error term in the frontier production function and, therefore, captures the random factors in addition to the deterministic components (labour, capital and material). The parametre of SFPF can be estimated using the maximum likelihood method.

This study estimates a panel data set using the translog stochastic production function for the period 1990-91 to 2006-07. Using the time varying inefficiency model developed by Battese and Coelli (1995), we measure the technical efficiency of the ith firm in the industry at tth year. This model is

equivalent to the Khumbhakar, Ghose and McGukin (1991) specification. The Battese and Coelli (1995) model specification may be expressed as:

$$Y_{it} = X_{it} + (V_{it} - U_{it}) \quad (3)$$

where i = 1, ..., N , t = 1,.....,T

Where Yit is the log of sales of ith firm in the tth time period, Xit is a (k x1) vector of log input quantities of the ith firm in the tth time period. The Vit is a random variable which is assumed to iid, $N(O,\sigma u^2)$ and independent of the U_{it} which is a non-negative random variable, assumed to account for technical inefficiency in production. U_{it} is independently distributed as truncations at zero of the $N(m_{it},\sigma u^2)$ distribution; where mit = $z_{it}\delta$ and z_{it} is a (1 x P) vector of variables which may influence efficiency of firms. Here we have identified seven important variables like capital-labour ratio, export intensity, capital goods import intensity that may influence efficiency of firms. So δ is a (1 x P) vector of parameters to be estimated. Moreover, by this we can explain the reason behind inter-firm variations in technical efficiency. The computer program "FRONTIER 4.1" developed by Coelli (1996) has been used to estimate the SFPF.

3. Modeling efficiency convergence among firms

To study the convergence in technical efficiency between foreign and domestic firms, we adopted the Barro model. Barro and Sala-i-Martin (1992, 1995) and Barro (1991, 1997) came out with a series of articles and books for testing convergence. These works examine the American states and other international data. They test the regression model specified as:

$$\text{Income Growth}_i = \text{Constant} + \beta \ln (\text{initial income})_i + \varepsilon_i \quad (4)$$

Income Growth I is the annual growth rate of income of the ith state over the period. The independent variable ln (initial income) I is the natural log of the initial income of the ith state. Here the logic is if the coefficient of ln (initial income) I i.e. β is negative and significant then the low income states are growing faster than high income states. This means there is a convergence between the states and vice versa.

The same logic is applied in the context of foreign and domestic firms also. Here we categorise and match the domestic firms with foreign firms according to their products. The dependent variable is the growth rate of the difference of technical efficiency between foreign and domestic firms and the independent variable is the gap in the technical efficiency in the initial year. The regression equation of this convergence model is:

$$\text{Growth of the difference in TE}_i = \text{Constant} + \beta \ln (\text{initial difference in TE})_i + \varepsilon_i \quad (5)$$

Here, Growth of the difference in TE I is the growth of the difference in Technical Efficiency (TE) between foreign and domestic firms, correspondent to ith domestic firms. The independent variable is the initial differences from the foreign firms of the ith domestic firms. Here, as mentioned above if β is negative and significant then we can infer that there is a divergence or there is a convergence.

Data and Variables

1. Source of Data

The data used in this study is based on the PROWESS database provided by the Center for Monitoring Indian Economy (CMIE). The PROWESS data set contains information on about 9,800 firms registered with the Bombay Stock Exchange. PROWESS documents a large database with detailed quantification and diagnosis of the growth, profitability and liquidity of the Indian manufacturing sector which is disaggregated by industry, ownership, size, age etc. over the years (Economic Intelligence service, 2002). Approximately, the coverage of this database is 70 per cent of the economic activity of the country. For our study, the data is considered for electrical and non-electrical sector firms, resulting in a sample of around 490 firms. We have restricted our analysis to 62 firms for which data is available for all the years considered. These 62 firms form the sample base for the analysis, within which 45 firms are domestically owned and 17 are foreign. The data covers the period 1990-91 to 2006-07 for this analysis.

Information available includes data from the companies' profit and loss accounts, balance sheets and also fund flow accounts. Key variables, on which data is collected for this study, include value of output, salary and wages, cost of raw materials, plant and machinery, land and building and other fixed assets etc.

2. Measurements of Variables

a) Output

The value of output has been taken as a measure of output. The data on value of output have been deflated by the Wholesale Price Index (WPI). The base of the WPI has been shifted to 1993-94 before deflation.

b) Capital Input

Land and buildings, plant and machinery and other fixed assets together are taken as a measure of capital. To estimate the real capital stock, we have employed the perpetual inventory method (PIM) which requires bench-year estimates of capital stock at 1993-94 prices and real gross investment at 1993-94 prices over successive years for the period under consideration.

Selection of a bench-year is an ad-hoc procedure (for details see Balakrishnan, P, K Pushpangadan and M S Babu (2000) appendix). For our study, we selected a bench-year with the maximum number of firms, i.e. 2002. Fixed investment for each year is calculated and deflated by the capital goods price deflator of that year in order to arrive at real investment. Here for PIM another important assumption is about depreciation; capital goods last for a maximum 20 years with no depreciation and after that it disappears. So, for our analysis we have considered those firms that were incorporated before 1981-82 and have assumed their age to be 20 years and for other firms, the respective age.

c) Labour Input

The total number of employees directly or indirectly connected to the production process is taken as a measure of labour input. The CMIE Prowess database does not contain data on the number of employees though it provides data on salaries and wages. Deflated salaries and wages by consumer price index (CPI) of industrial workers are used as a labour input variable.

d) Raw materials

We follow the Balakrishnan *et al* (2000) methodology for constructing materials' variable. The value of materials is deflated by the materials input-price index. The input-output coefficients for 1997 have been used as weights for combining the wholesale prices of relevant materials. The source of weights is CSO's input-output Table for 1997-98 and the relevant price indices are taken from 'Index Numbers of Wholesale Prices in India, base 1993-94=100', Ministry of Industry, Government of India.

e) Capital Labour ratio

The ratio of real gross capital stock to labour is taken as a measure of capital labour ratio. Companies with relatively high capital labour ratio are the ones with a better chance of being endowed with technical progress (Ahluwalia, 1991). We, therefore, hypothesise that companies with a better capital-labour ratio attain higher rates of efficiency.

f) Technology Imports

The ratio of payments to royalty, technical fees (for knowhow, drawing, designs etc.) professional and consultancy fees and others to sales turnover are taken as a measure of technology import. The import of technology can increase the efficiency of firms.

g) Export Intensity

Export intensity is computed by the ratio of export to sales. It is hypothesised that higher export intensity induces companies to making efforts to be efficient.

h) Intermediate Inputs Import Intensity

Imported inputs generate value additions. Another benefit of imported inputs relates to advanced embedded technology. The ratio of imported materials, spares, components etc., to total materials is taken as a variable for the intermediate inputs import intensity.

i) Capital Goods Import Intensity

Technology import is one way of technology inflow. Another source of this is capital goods imports. Imported capital goods can improve the technology level. The ratio of imported capital goods to total fixed investment is taken as a variable for capital good import intensity.

j) Vertical Integration

Vertical integration refers to the incorporation of the upstream and/or downstream firms within the production systems. In other words, they incorporate mainly the supplier firms in the production process. The vertical integration of a firm is measured by the ratio of gross value added (inclusive of salaries and wages, profit before depreciation, interest and tax, and rent income) to total value of output (indicates the net total income inclusive of changes in stocks), as pointed out by several earlier studies. Vertical integration can have both positive and negative effects on the technical efficiency of a firm. The negative effect may arise due to a firm supplying its own input and not buying from the competitive market. The positive effect of vertical integration can occur due to various benefits arising out of integration like assured supply of inputs, better monitoring of up-stream or downstream firms' activities, etc.

k) Central Excise Duty Rate

This is the ratio of central excise duty paid by a firm to its total value of output. A higher central excise duty can have a negative impact on firms, unless they are able to shift the burden of tax to their consumers.

Empirical Results

1. Comparison between foreign and domestic firms

The estimated results of Equation 2 are presented in Table 6. As expected, the coefficient of the variable of ownership (OWit) is positive and significant. This result clearly supports the hypothesis that firms owned by foreign companies are more productive than the domestically owned firms.

Table 6: Comparison between Foreign firm and Domestic firm

Dependent Variable	In Output
In K	0.200***
In L	0.377***
In M	0.398***
OW	0.158***
Vertical	-28.504*
Time Dummy	0.066***
Constant	-38.637***
R-Squared	0.659
No. of Observations	1045
Time period	1990-91 to 2006-07
Breusch and Pagan Lagrangian multiplier value	3045.18

Note: (1) standard errors adjusted for heteroscedasticity

(2) *, ** and *** Statistically Significant at 10, 5 and 1 per cent level

From the above Table, it is clear that elasticity of capital 0.20 means that if capital is increased by one per cent, output will increase by 0.20 per cent. Correspondingly, the elasticity of labour and material is 0.377 and 0.398, respectively. The variable time dummy is found positive and significant, indicating a difference in sales before and after 1993-94.

2 . Vertical Integration Dimension

Vertical integration is a process where firms include more and more down-stream or upstream firms within their production systems. Therefore, this is a reverse process of vertical spillover. The phenomenon of vertical spillover can occur because of interactions across the industries. The inter industry spillovers arise mainly because of the consumer-supplier relationship between foreign and domestic firms. According to Dunning (1993, p456), "The presence of FDI has helped to raise the productivity of many domestic suppliers, and this has often had beneficial spillover effects on the rest of their operations." It is believed that spillovers are more likely in the case of inter-industry firms than within the same industry. The reason behind such a belief is that MNCs can prevent the leakage of technology to their competitors but there is no logic in preventing the diffusion of technology to their supplier or clients (Javorick, 2004). So, if there are more and more vertical integrations, one can expect fewer chances of spillover effects.

The estimated sign of vertical integration is negative and significant; that means more and more vertical integration can affect a firm's production process negatively. On the contrary, one can argue that spillover (consumer-supplier relationship) effects make firms better than integrations in the case of the Indian engineering industry. In other words, it is advantageous for a firm to buy its inputs from a competitive market rather than opt for vertical integrations.

3. Technical Efficiency Estimates

Table 7 shows the means of estimated technical efficiency for foreign and domestically owned firms for the period 1990-91 to 2006-07. The last column of the Table gives t-statistics for testing equality of means between foreign and domestic firms.

It is clear from Table7 that the mean technical efficiency score of foreign firms is higher than that of domestic firms across our study periods. From 1990-91 through 2006-07, the average technical efficiency score of foreign and domestic firms is 0.6433 and 05198, respectively. The difference between the mean technical efficiency score of foreign owned firms and the domestically owned firms are significant at ten (1992-93 at five per cent) per cent (one-tail test) for the first four years and at one per cent for the next three years. Thereafter the level of significance declines and between 2003-04 and 2005-06 it becomes insignificant. Again, in 2006-07, the difference is significant at ten per cent. It is clear from the Table 7 that the mean efficiency score of the foreign firms is higher than that of domestically owned firms in the Indian engineering sector. The advantages in terms of technical efficiency of foreign firms seem to have declined during the last four to five years of our study period. That the difference of the mean efficiency score became insignificant is not because of the improvement in the efficiency score of the domestic firms but because of the decline in the efficiency score of the foreign firms. One of these strange results may be due to the type of data used for the analysis. Here

the data type is balance panel, which means we are studying firms that are available from 1990-91 through to 2006-07. However, here we are not allowing our model to accommodate the entry and exit of firms. During the liberalisation process, it was expected that new and efficient firms would enter the market and the inefficient old firms either would improve due to the pressures of competition or exit from the market. Therefore, these results are meant for 62 firms and for the industry as a whole, we have to use the unbalance panel data where we could allow the model to capture the entry and exit of firms.

Table 7: Mean Technical efficiency across Indian Engineering Firms, 1990-91 to 2006-07, by Foreign and Domestic Category

Year	Mean Technical Efficiency		t-ratio for testing equality of means
	Foreign owned firms (17 firms)	Domestically owned firms (45 firms)	
1990-91	0.6945	0.6018	2.059**
1991-92	0.6492	0.5130	2.191**
1992-93	0.6658	0.5379	1.931*
1993-94	0.6521	0.5219	2.047**
1994-95	0.6767	0.5002	2.642***
1995-96	0.6908	0.5007	3.020***
1996-97	0.6432	0.4908	2.691***
1997-98	0.6338	0.4975	2.229**
1998-99	0.6484	0.5308	1.873*
1999-00	0.6664	0.5323	2.056**
2000-01	0.6506	0.5213	2.074**
2001-02	0.6294	0.5181	1.855*
2002-03	0.5812	0.5093	1.262
2003-04	0.5769	0.4959	1.295
2004-05	0.6107	0.5165	1.455
2005-06	0.6130	0.5226	1.334
2006-07	0.6542	0.5253	1.891*
1990-91 to 2006-07	0.6433	0.5198	

Note: *, ** and *** Statistically Significant at 10, 5 and 1 per cent level

One can see from Table 7 that the efficiency of domestic as well as foreign firms decreases over the study period. This means that mainly old foreign firms are not able to develop to the level where they can increase or at least maintain their efficiency in view of the increasing competition. The picture is almost the same for domestic firms.

4. Inter-firm variations in technical efficiency

Table 8 presents variations in the technical efficiency among the engineering firms over the study period. Here, the result presented for foreign and domestic firms separately.

Table 8: Inter-Firm Variations in Technical Efficiency across foreign and domestic firms

Explanatory variables	Foreign Firms (17)	Domestic Firms (45)
Capital Labour Ratio	-0.1042**	0.1286*
Export Intensity	0.2051***	0.7323***
Technology Imports	-0.4010*	-0.4745*
Intermediate Inputs Import Intensity	0.9835**	0.1249
Capital Goods Import Intensity	0.3247*	0.6761
Vertical Integration	0.3919	0.3406**
Central Excise Duty Rate	-0.7650	-0.7441

Note: *, ** and *** Statistically Significant at 10, 5 and 1 per cent level respectively

Turning to the coefficients of various explanatory variables, the coefficients of capital labour ratio are negative for foreign firms and positive for domestic firms. In the case of foreign firms, the results are contrary to expectations even though the companies with a higher capital labour ratio are assumed to be more efficient. The reason behind such an expectation is that with a higher capital labour ratio companies can have better access to technology and greater scope for learning-by-doing. However, here it may be inferred that due to liberalisation, in the initial stages foreign companies managed to install more capacities, which were not appropriately utilised. This is consistent with the findings of Ahluwalia (1991) for the Indian Manufacturing Industry. Ahluwalia provides two explanations for this negative relation: first, there must have been some other factors highly correlated to the Capital-Labour ratio for a negative relation with efficiency and, second, the policy of that regime encouraged firms for over-capitalisation.

As expected, export intensity is positive for foreign and domestic firms. This signifies that grater export orientation is favorable for attaining efficiency, that is, companies with more export intensity are more efficient. The coefficient of export intensity is higher for domestic firms compared to foreign firms, i.e., more export orientation makes the domestic firms more efficient. One of the reasons behind it may be that foreign firms come to India with the main objective of capturing the domestic markets and not for exports.

Among the technology acquisition variables, the coefficient of technology imports variable is negative for foreign and domestic firms. The possible explanation for this negative result is that the imported technologies are not properly utilised. The sign of the variable, Intermediate Inputs Import Intensity is positive for all the firms, as expected. This means that those firms using more imported intermediate to their total intermediate input are performing comparatively better. The capital goods import intensity is also positive, as excepted.

As explained earlier, vertical integration shows the contribution value companies have for their own products. The positive coefficient can be explained in the sense that companies incorporate more supplies within their production system and, hence, are more efficient. In other words, as explained earlier, the positive coefficient means less vertical spillovers.

The relation between the central excise duty rate and efficiency is expected to be negative. The results also prove this relationship for all domestic and foreign firms. The results identify that a

higher excise duty rate by the government can have a negative impact on the performance of the companies.

5. Convergence in technical efficiency

The results of the model estimated to examine convergence in the technical efficiency among foreign and domestic firms are presented as follows:

$$\text{Growth of the difference in } TE_i = -0.04 - 0.064 \ln (\text{initial difference in } TE)_i$$

The coefficient of initial difference in TE is found to be negative and significant at one per cent over the entire study period. Thus, the negative coefficient clearly indicates that there is a process of divergence in the technical efficiency of the Indian engineering industry. Across the domestically owned firms, those closer to the efficiency level are the ones that grow faster. These results signify that the benefit of the spillover effect from foreign firms happens only when domestic firms are close to the foreign firms' efficiency level. If we compare this convergence result with Table 9, it is clear that there is a convergence between foreign and domestic firms across the Indian engineering industry, but in the process of convergence, the poor firms are lagging behind.

Conclusion

In this paper, the efficiency scores of 62 (45 domestically owned and 17 foreign owned) companies at the firm level across Indian engineering industry over the period 1990-91 to 2006-07 are analysed. In addition, the factors affecting inter-company variations in efficiency are also considered. It is found that there is a significant difference between domestic and foreign firms in terms of production. The results show that there is a shift in the production process before and after 1993-94, i.e., post liberalisation.

It was observed that the variable vertical integrations positively influenced all the domestic and foreign firms. Moreover, the value of the coefficient of vertical integration was higher in the case of the foreign firms. This would mean that in the case of foreign firms, vertical integration tends to have more impact on the efficiency scores compared to domestic firms.

The analysis of technical efficiency presented above clearly indicates that foreign firms in the Indian engineering sector are technically more efficient than the domestic firms. The difference between the mean efficiency of foreign firms and domestic firms is significant in the initial periods but decreases over time. It is important to note that on an average, the efficiency of foreign and domestic firms decreases (at least after comparing the first and the last point), which is not expected. Although the Government of India provides much importance to boosting the efficiency of the industry, in the light of the above analysis it is quite clear that the results are to the contrary. Hence, one of the important tasks is to find out the causes behind this. Nevertheless, it has very serious policy implications and one can even question many of the existing policies.

There are indications in the convergence process, i.e., the domestic firms are rapidly catching up with the production processes of the foreign firms in terms of technical efficiency. The convergence is found more pronounced in the later stages of globalisation (2002-03) when the mean differences between foreign and domestic firms are more insignificant. Here also some questions arise, as

mentioned above, the efficiency of foreign firms is decreasing while there is no improvement in the efficiency of the domestic firms and, hence, we look for a better methodology to analyse the convergence.

Based on the results, it appears that a positive relationship exists between the international trade of firms and its technical efficiency. The imported input intensity is positive for firms, which mean that imported input helps firms improve themselves, and simultaneously other variables like capital goods import, technology imports etc. The above analysis supports the liberalisation of imports also.

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Appendix 1

Author	Sectors	Average Technical Efficiency (Max=1)	
Mitra (1999)	Industrial Sector	**1976-770 to 84-85** 0.47	**1985-86 to 93-94** 0.46
Agarwal (2001)	**Public Sector firms** Infrastructure, Petroleum/ Oil Engineering	**1990-91** 0.56 0.40 0.56	**1998-99** 0.66 0.22 0.18
Driffield and Kambhampati (2003)	 Chemicals Food Metals Textiles Transport Machine Tools	**1987-90** 0.92 0.86 0.93 0.92 0.95 0.96	**1991-94** 0.94 0.88 0.95 0.94 0.95 0.96
Kambhampati (2003)	 Cotton Textiles	**1986-90** 0.81	**1991-94** 0.90
Golder, Ranganathan and Banga (2004)	**Engineering Industries** Foreign owned Private owned Public owned	**1990-91 to 1999-00** 0.79 0.73 0.63	
Kathuria (2002)	**Industrial Sector** All firms FDI firms , Non-FDI firms	**Growth in TE between 1990-96** 0.0119 0.0067 0.0297	

Source: Mahambare & Balasubramanyam

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INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: lekha@isec.ac.in; Web: www.isec.ac.in