EFFICIENCY SPILLOVERS FROM FDI IN THE INDIAN MACHINERY INDUSTRY: A FIRM-LEVEL STUDY USING PANEL DATA MODELS

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Abstract

Adopting a micro-level framework of impact of FDI in an industry, this study empirically examines the following three issues in the context of Indian machinery industry (IMI) - division 28 of National Industrial Classification, 2008. First of all, it compares the technical efficiency of foreign affiliates of multinational enterprises (FAs) against the domestic firms (DFs) to know if there are spillovers from MNEs to their affiliates. Secondly, it identifies the differences in the determinants of technical efficiency between FAs and DFs. Finally, it examines the presence (or absence) of efficiency spillovers from FAs to DFs in terms of its two major sources: competition effect and demonstration and imitation effect. To examine these issues, we first compute the firm- and year-specific technical efficiency by estimating a stochastic frontier production function with the help of an unbalanced panel of data on a sample of 177 firms for 7 years covering FY 2000/01 to FY 2006/07. Thereafter, we estimate random-effect panel data models of the determinants of firm-level technical efficiency.

One of the important finding of the study is that the FAs as a ownership group maintains higher level of technical efficiency than DFs even after controlling for the additional determinants (both observed and unobserved) of technical efficiency. Another significant aspect of the finding is that the competition effect generated by FAs does not play a positive role in enhancing the efficiency of DFs. Probably, the inefficient DFs have been ousted on account of competitive pressure from the efficient FAs. On the other hand, the demonstration and imitation effects generated by FAs through their R&D activities (i.e. knowledge spillover) act as the important channel in enhancing the efficiency of DFs. In sum, FDI is found to have efficiency enhancing effect in the IMI. This finding has considerable policy implication for the IMI, which suffers from the adverse impact of high level of imports of finished goods, limited technological capabilities and operational inefficiency. In the post-WTO era, restricting imports and implementation of trade related investment measures are not the feasible options. Beside, this study also indicates that the import of disembodied technology has no impact on technical efficiency despite the IMI entering into maximum number of foreign technological collaboration agreements during August 1991 to July 2007. Given the current policy of Indian Government for 100 per cent equity participation through FDI on an automatic basis in the manufacturing sector including IMI, the firms desiring to expand their base this industry may consider the option of attracting FDI for building additional capacity and for enhancing their efficiency levels (viz. from knowledge spillovers from MNEs) and thereby upgrading this industry for facing the challenges of the global competition.

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1. Introduction

Indian machinery industry (IMI) suffers from the deficient technological capabilities, management and operational inefficiencies and lack of global market orientation (CII 2007, EXIM Bank 2008). Thus, the firms based in the IMI are required to achieve international standards in terms of productivity, efficiency and customer services to meet the challenges of globalisation. In this regard, multinational enterprises (MNEs) may play a major role in enhancing the efficiency of IMI for the following reasons: a) foreign affiliates of MNEs (FAs) may have access to the superior efficiency enhancing *resources and capabilities*[1] of MNEs' network (Dunning 2000), b) FAs may identify, evaluate and harness *resources and capabilities* present in the host country and combine these with their internal resources and capabilities for maximizing the benefits of innovation, learning and accumulated knowledge and minimizing the transaction cost (Dunning 2000). c) a and b together may lead to higher level of efficiency in FAs in relation to the existing domestic firms (DFs) in the industry; d) the presence of FAs in adequate numbers may also raise the efficiency level of DFs on account of competition effect and knowledge spillovers[2] (e.g. demonstration and imitation effects created by FAs and migration of skilled employees from FAs to DFs). However, the recent firm-level empirical literature on benefits of FDI suggests that the superior efficiency of FAs over DFs and positive (or negative) efficiency spillovers from the former to the latter are industry, country, region and FDI specific (viz. the nature, type and quality of FDI received by FAs from the MNEs' network).[3]

In this background, the present study empirically examines the following issues in the context of IMI. First of all, whether the technical efficiency of FAs is greater than that of DFs. Secondly, whether the technical efficiency of FAs remains greater than that of DFs, even after controlling for other (observable and unobservable) firm-specific and industry-specific and year-specific determinants of TE. Thirdly, whether the determinants of technical efficiency differ between FAs and DFs. Fourthly, whether there are efficiency spillovers from FAs to DFs in terms of its two major sources- competition effect and demonstration and imitation effect.

Rest of the study is organised in six sections. Section-2 defines IMI and explains the reasons for focusing on IMI. Section-3 briefly discusses the literature on relative efficiency/productivity of FAs and DFs and efficiency spillovers, including its various channels, arising from the presence of FAs on DFs. Section-4 defines the variables of the study and formulates verifiable hypothesis regarding the relationship between dependent variables and various independent variables. Section-5 discusses the sample, data sources and period of the study. Section-6 explains the econometric models and procedures for deriving technical efficiency and panel data models of determinants of technical efficiency. Section-7 presents and discusses the findings of the empirical analysis. Section-8 offers conclusions.

2. Indian Non-electrical Machinery Industry-The Focus of Study

Keeping in view the contextual nature of the benefits of FDI, we selected only one industry that is the Indian Machinery Industry (IMI) - a medium/high technology industry of an emerging economy- for this study. Selection of only one industry enabled us to reduce heterogeneity across industries arising out of differing product profiles, levels of product differentiation, industry specific policies, tax and tariff rates, levels of backward and forward linkages, capital intensity, levels of technological capabilities, export orientations, etc. Focusing on only one industry also reduces heterogeneity in FDI, including the types and motives of FDI and types of FAs created through FDI.

IMI represents *manufacture of machinery and equipment n.e.c.* that is the division 28 in National Industrial Classification: All Economic Activities-2008 (NIC-2008). The division-28 comprises two types of machinery producing industries, namely, general-purpose machinery (or group 281) and special purpose machinery (or group 282) at three digit level of classification. We thus define IMI as the amalgamation of these two groups of industries. The major reasons for the selection of IMI *inter alia* are the following:

a) Machinery industry being a technology and skill intensive has potential to become important source of innovations and higher value addition with higher margins and growth prospects as compared to the mature low-technology industries, in which intense competition has shrunk margins and lowered growth prospects. It can also generate significant intra-industry and inter-industry externalities due to its linkages with other sectors of the economy. As the machinery industry supports the other sectors of economy and holds strategic importance, the Indian policy makers, who laid the foundation for the import substitution industrialization in the early 1950s, considered the growth of IMI as of paramount importance.

b) In terms of micro level impact of FDI in an industry, IMI is relatively under-studied. Besides, there exists no firm-level study to the best of my knowledge that employs common sample of panel data for the recent period and uses sophisticated econometric methods for simultaneous examination of several important aspects of comparative behaviour and performance of DFs and FAs in the IMI.

d) Along with the adoption of outward oriented growth strategy and economic reform measures implemented since the year 1991, IMI has been exhibiting certain problems including inadequate technological capability, lack of international competitiveness, global marketing and customer orientations, management and operational inefficiencies, higher propensity to import than the domestic production, etc. (CII 2007, EXIM Bank 2008).

e) IMI has received lower level of FDI compared to the other closely related medium/high-tech industries (viz. electrical machinery and transport equipment) in the post-reform period.[4] As a consequence, during the period of study, FAs as a group constituted only about 20 per cent in the aggregate sales of this industry whereas FAs' shares are quite high in the other closely related industries, for example, 41 per cent in the automobile and auto ancillaries and 42 per cent in the electrical machinery.[5]

f) Since IMI is categorized as the medium/ high technology industry, the MNEs could contribute in this industry in a better way either by setting up Greenfield ventures or by offering latest technology, management and marketing expertise, international business contacts and market intelligence.

g) Traditionally, USA, Germany and Japan have been the largest suppliers of IMI. Of late, Asian countries such as China, South Korea and Taiwan are also emerging as the important players in the production and export of IMI. Consumption of IMI has also increased substantially in the developing Asian countries due to their thrust on the value-added manufacturing. The shifting base of machinery and equipment production from the developed to developing countries is also providing major opportunities of production and exports from technologically advanced countries of the developing economies like China, India, South Korea, etc. In the year 2005, the countries like China and South Korea respectively shared 7 per cent and 4 per cent in the world's total production of IMI, while India's share was insignificant 1.4 per cent, indicating ample scope for expansion in its market share. (EXIM Bank 2008).

3. The Literature

3.1 Relative Efficiency of FAs and DFs

Bellak and Pfaffermayr (2002), Bellak (2004ab) and others identify the following *a priori* reasons for higher productivity/efficiency performance of FAs as compared to DFs: First and foremost, FAs, being part of MNE system, have access to firm-specific assets[6] (e.g. newer and superior technology, organisational and management practices) at marginal cost and to the internal market of the MNE systems. Therefore, FAs benefit from the productivity/efficiency spillovers of the system and multi-plant economies of scale. FAs may also develop their unique sets of productivity enhancing resources and capabilities while applying the resources and capabilities accessed from their respective MNE systems to the locational conditions of the host countries.

Second, FAs specialize in narrow spectrum of activities due to strategy of MNEs to fragment the production stages internationally according to the locational advantages of the host countries. FAs normally exist in higher end of an industry requiring intensive use of superior FSA, whereas DFs may exist in lower end of production involving standard technology and lower skill levels. For instances, on account of the availability of cheaper skilled workers in India, FAs may undertake highly technical or core activities with automated production facilities in a sub-industry of IMI requiring highly trained staff with above average efficiency. As most of the DFs in our sample do not have transnational presence, they are unable to fragment the production stages internationally.

Third, DFs may select and adopt inferior technology while FAs may use frontier technology. For example, import of second hand machinery has increased substantially in India after its liberalisation (CII 2007, EXIM Bank 2008). Compared to FAs, DFs may have higher propensity to use inferior machineries for the lack of adequate information about the frontier technology and lack of financial resources needed for acquiring the frontier technology, price sensitivity of their customer, inadequate market size or clientele for the quality products and unavailability of best practice technology due to strategies of the MNEs.

Fourth, MNEs would have formed FAs by acquiring more productive plants or firms possessing unique strategic FSA in IMI. Therefore, FAs may enjoy higher productivity than DFs.

Fifth, MNEs follow superior corporate governance practices as compared to DFs. Therefore, the top managements in FAs may be under higher pressure to perform and show better efficiency than the management of DFs, especially after MNE's takeover of a local firm through a strategic investment.

Sixth, FAs have access to financial capital of MNE system, which makes financing of the business of FAs easier and cheaper compared to that of DFs.

Seventh, as compared to DFs, FAs generally employ and retain highly skilled workers by paying them higher wages and by constantly upgrading their skills through regular trainings and exposure to best-practices in the industry.

Eighth, since the MNEs have global outlook, they are able to respond quickly to the changes in the policy environment, emerging opportunities and locational advantages of a country. For instances, they may invest and divest plants frequently, achieve better match between locational advantages and resources and capabilities, cherry pick plants/firms with above average productivity in an industry. This is almost impossible by uni national DFs and possible to a much lesser extent by newer MNEs headquartered in a developing country.

Ninth, the gap in the productivity/efficiency between the home country of a FA and the host country may be reflected in the gap in productivity/efficiency of FAs and DFs. Thus, the TE of FAs may also be higher than DFs because FAs are linked to MNEs headquartered in the developed home country and DFs are based in a developing host country like India. It may be noted that the average labour productivity of Indian manufacturing firms are lower compared to the other countries of emerging market economies (Lakshmanan, et al. 2007).

Three major surveys of the empirical literature, mainly based on the experience of the developed countries, conducted during the first decade of 2000s reached to the following conclusions (Jungnickel's 2002, Bellak 2004a and Lipsey 2007). First, the positive productivity gap between FAs and DFs does exist; however, the gap disappears when the factors other than foreign ownership are controlled for in the regression framework. Second, the real difference in productivity performance lies between FAs and uni-national DFs and not between FAs and multinational DFs. Third, the comparison between FAs and DFs is inherently context specific; hence there are divergent finding in different countries, industries, etc. Fourth, some of that higher productivity, but not all in most comparisons, can be attributed to higher capital intensity or larger scale of production in the FAs' plants. Fifth, when an econometric technique controls for the effect of observed and unobserved firm characteristics on productivity and also takes care of input simultaneously, measurement error and endogeneity problems associated with such studies, the productivity gaps between FAs and DFs disappears at least in the developed countries. Sixth, on account of the technological gap between the developed and developing countries, the positive gap in productivity between FAs and DFs is more likely to manifest in the industries of developing countries.

Several studies appearing in the first decade of 2000s for the developing countries, mostly using sophisticated methodologies of investigation, report FAs to be more productive than DFs [e.g. Takii (2004), Takii and Ramstetter (2003) for Indonesia; Kokko et al. (2001) for Uruguay; Hallward-Driemeier et al. (2002) for various East Asian Countries[7]; Ngoc and Ramstetter (2004) for Vietnam; Kathuria (2001), Ray (2004), Goldar et al. (2004), Sasidharan and Ramnathan (2007) for Indian manufacturing sector]. On the contrary, some other studies [e.g. Patibandala and Sanyal (2005) for Indian manufacturing sector; Ito (2002) and Ramstetter (2003) for Thailand; Oguchi et al. (2002) for Malaysia; Konings (2001) for Bulgaria and Rumania] suggest that FAs are not more productive than DFs.

Indian Studies on Relative Productivity/Efficiency of FAs and DFs

As Indian studies are more relevant for our purpose, we explain the findings and the methodologies adopted in the major studies dealing with post-reform period. By employing Data Envelopment Approach (DEA), Ray (2004) first computes year-specific firm-level TE for 27 industry groups of Indian manufacturing sector. Thereafter, she examines the determinants of TE by using several explanatory variables for each year of his study during the period 1991 to 2001. Her analysis, *inter alia*, shows that: i) FAs (firms with at least 51 per cent foreign equity holding) enjoy significantly higher level of TE than DFs in all the years except 1992; ii) technology import payment intensity has favourable impact on TE during 1995-98; iii) capital intensity has significant positive influence on TE; iv) product differentiation has negative influence for three years but no effect on the remaining years. She concludes on the basis of these results that the liberalization policy of GoI has been successful in terms of efficiency enhancement effect of FDI and import of disembodied technology in the manufacturing sector.

A study by Goldar et al. (2004) analyses the effect of foreign ownership along with other factors on the TE of engineering firms in India during 1990s in which firm-specific TE is calculated by estimating a SFPF based on panel data model. This study reveals that the mean TE of FAs was greater than DFs but the latter group was in the process of catching up with the former with narrowing of efficiency gap during the second half of the 1990s. Using firm-level panel data across eleven industries, which received significant FDI over the period spanning 1989 to 1999, Patibandala and Sanyal (2005) reports in a study that the percentage of foreign equity holding in a firm had no significant impact on productivity.

Banga (2004) examines the impact of US and Japanese owned firms on total factor productivity growth (TFPG) of the firms in the Indian automobiles, electrical and chemical industries in post-reform period of 1993/94 to 1999/2000. The findings of the study show that the presence of Japanese affiliates has a significant positive impact on TFPG in an industry, while the US affiliation has no impact on TFPG.

Using a pooled sample of cross-section and time series data of over 2700 firms for the period 1994-2002, Sasidharan and Ramanathan (2007) found that FAs (firms with 10 per cent of foreign equity holding) are better performers than DFs (rest of the firms) in terms of total factor productivity. They control for industry and time effect in their regression analysis.

In sum, most of the studies pertaining to India show the evidence of higher productivity/efficiency of FAs relative to DFs or positive impact of FDI on firm level productivity, even after controlling for observed and unobserved firm-specific heterogeneity by employing more sophisticated panel data regression framework.

3.2 Productivity/Efficiency Spillovers

Productivity/efficiency spillovers is defined as the phenomenon by which DFs gain in terms of enhanced efficiency due to the presence of FAs in a host country or industry as the latter group is unable to take exclusive advantage of their superior resources and capabilities, primarily because of somewhat public goods' character of resources and capabilities (Blomström and Kokko 1998). There are two aspects of productivity/efficiency spillovers, namely, intra-industry (or horizontal) and inter-industry spillovers (or vertical spillovers through forward and backward linkages). As we deal with only one industry, we are concerned here with the intra-industry spillovers.

In the case of horizontal spillovers, when the FAs and DFs interact, transact and compete with each other for a considerable length of time in an industry, the resources and capabilities of the former group get transmitted to or acquired by the latter group. The main channels or sources of horizontal spillovers are the competition effects, demonstration and imitation effects and movement of employees (notably the skilled ones) from FAs to DFs (Görg and Strobl 2001; Smeets 2008). Some scholars (Caves 1974; Chung 2001) argue that competition effect should not be considered as a channel of spillover for it does not involve flow of resources and capabilities from FAs to DFs. Nevertheless, since the competition effect generated by FAs is a major source of improvement (or deterioration) in the DFs' technical efficiency/productivity, we also include this channel. We now explain competition effect, demonstration and imitation effects stemming from the presence of FAs in more detail in terms of their likely impact on TE of DFs.

The entry and operations of FAs with better resources and capabilities in an industry, particularly in an industry with high barriers to entry and oligopolistic market structure, may generate competitive pressure that disturbs its status quo and inertia. This competitive pressure would motivate (or force) at least some DFs to improve their efficiency, product quality and protect their market share and profits. This may happen on account of these DFs adopting advance technology of production and quality conscious management practices and enforcing stricter quality and most cost effective norms causing their employees to work harder and reduce slack in the use of inputs. However, the increased competition may also lead to the reduction in the productivity of DFs, if FAs draw demand from them and thereby DFs have to cut production and increase costs (Aitken and Harrison 1999). Thus, we cannot determine the direction of competition effect on TE of DFs on a priori basis.

Due to the demonstration effect generated by FAs, DFs may adopt similar FSA including technology of production and organizational, marketing and management practices (OMPs) as those prevailing in FAs. The DFs may accomplish this by imitating (or copying) OMPs and processes of production or reverse engineering the products and imparting better (than existing) or new skills set through retraining the workers.

Despite the clear potential of knowledge spillovers from FAs to DFs**,** the literature on knowledge spillovers suggests that it is context specific and depend more on quality rather than quantity of FDI. The context specific factors may include *competence and scope of FAs*, *strategies of MNEs*, *motives of FDI*, *nature of resources and capabilities transmitted to FAs by the MNEs*, *relative technological capabilities of home and host countries*[8], the absorptive capacity of DFs and the state of development of the economy in terms of infrastructure, industrialization and technological capabilities (Lall and Narula 2004) or the country's stage in terms of investment development path (Narula and Dunning 2000 & 2010).

There exists a vast amount of empirical literature examining the issue of productivity/efficiency spillovers from the presence of FDI in manufacturing sector of various developed and developing economies. The important literature surveys on the subject include those by Blomström and Kokko (1998), Görg and Strobl (2001), Görg and Greenaway (2004), Meyer (2004), Lipsey and Sjöholm (2005) and Smeets (2008). These surveys highlight the following points. First, there exists mixed evidence on magnitude, direction and presence of productivity/efficiency spillovers. The initial literature on productivity/efficiency spillovers employed cross-section multiple regression framework using OLS technique and found evidence of positive productive spillovers from FAs to DFs in most of the cases (Görg and Strobl 2001; Görg and Greenway 2004). Secondly, when the later empirical works on the efficiency/productivity spillovers employed the panel data models for controlling both the observable and unobservable characteristics, the evidence of positive spillovers was found only in a few cases [Görg and Strobl (2001); Görg and Greenway (2004); Lipsey and Sjöholm (2005) and Smeets (2008)]. The results of the studies using firm-level panel data models in case of the selected developing also corroborates the findings of the above mentioned literature surveys.

Second, the positive productivity spillovers from FAs to DFs may not always be possible due to the following context specific factors: a) there exists heterogeneity in characteristics of host economies[9], industries and firms in which FDI takes place. In particular, the countries, industries and DFs differ among each other in terms of their capacity to copy, reverse engineer, absorb and assimilate the firm-specific assets (resources and capabilities) possessed by FAs; b) there is heterogeneity in FDI arising out of various nationalities of parent companies, motives of FDI, competence and scope of individual FAs, and the nature of resources and capabilities (e.g. tacit or explicit) transferred to FAs from the MNEs (Lall and Narula 2004, Smeets 2008); c) the empirical studies adopt variety of definitions for FAs and different measures for capturing productivity/efficiency; d) the large number of studies employ single variable to capture the source of spillovers, whereas multiple channels of spillovers should ideally be captured by multiple variables (Smeets 2008); e) there could be reduction in the market share of and even the exit of the DFs from the market due to the customers opting more for the products of FAs than that of DFs.

Indian Studies on Productivity Spillovers from FDI

We now turn towards the detailed analysis of the major Indian studies on productivity/efficiency spillovers from FDI conducted during 2000s. Employing SFPF technique in the context of panel data model, Kathuria (2001) analysed whether the spillovers from the presence of foreign owned firms (with 25% of foreign equity) and disembodied technology imports lead to higher productivity growth for the domestically owned firms in the Indian manufacturing sector during the period of 1975/76-1988/99. The results of his study show the evidence of spillovers from the presence of foreign owned firms on the total factor productivity growth of domestic firms. However, the nature and type of spillovers vary between scientific group (viz. pharmaceuticals, chemicals, electrical machinery and electronics) and non-scientific group (metal products, non-electrical machinery and automobiles) of industries and R&D capabilities of the firms.

Using panel as well as cross section data for each year during 1993-2000, Siddharthan and Lal (2004) have analysed the effect of liberalization including the effect of foreign ownership on domestic firms in terms of (labour) productivity spillovers. The study also take care of heterogeneity in skill content of employees across firms by measuring productivity as a ratio of value added to wage cost. The study argues in favour of using the sample of unbalanced panel of firms so as to take care of entry and exit of firms in an industry. Further, it advocates the use of cross section data for each year to understand the pattern of spillover over time. The result of the study shows rapid increase in the size of spillover over the years. It is also reported that spillovers are more likely to occur in cases where the technology gap between FAs and DFs is small.

Using panel data for the period spanning over 1989 to 1999, Patibandala and Sanyal (2005) finds strong evidence of DFs benefitting in terms of productivity spillovers from the presence FAs in the Indian manufacturing sector. Besides, their results show that larger firms are able to absorb the spillovers more than the smaller ones.

A study by Sasidharan and Ramanathan (2007) empirically examines the spillover effects from the entry of foreign firms in the Indian manufacturing industries. They use a firm-level panel data for the period 1993/94 to 2001/2002 and consider both the horizontal and vertical spillover effects of FDI. The study finds no evidence of horizontal spillover and negative vertical spillover effects. Thus the Indian studies also report mixed evidence on productivity spillovers from FDI.

4. Variables and Hypotheses

To fulfill the objectives of the study, we require a measure of TE in the first place. We derive firm- and year-specific measure of TE by estimating a stochastic frontier production function (SFPF).[10] Method of estimating SFPF and thereby computation of TE are described in detail in Section-5. In terms of this method, TE of a given firm (in a given year) is defined as the ratio of its mean output (conditional on its level of factor inputs and firm effects) to the corresponding mean output if the firm utilizes its levels of inputs most efficiently (Battese and Coelli1992).

In the second step, we examine the effect of foreign ownership on TE. Since TE is not only affected by the foreign ownership but also by many additional factors, the observable explanatory variables of the model are divided into two categories, namely the key variables and control variables. The key variables used in the model are foreign control dummy variable (FCD) and variables related to the sources of efficiency spillovers from FDI. The control variables are further categorised into firm-level, sub-industry level and year-specific dummy variables. The observable explanatory variables and their expected relationship with TE are discussed in the following sub-section. Measurements of individual variables are explained in the Appendix-2.

Key Variables

***Foreign Control Dummy* (FCD)**

In view of the discussions in section-3, we expect FAs to be more technically efficient than DFs even after controlling for other possible observed and unobserved determinants of TE in a panel data regression model. In the empirical literature, a FA is normally defined on the basis of minimum proportion of foreign share holding that could provide a foreign entity control over the management of the firm. However, there is no consensus in the literature about the minimum proportion of share capital for the purpose of exercising control or sharing of resources. The reason being that the foreign entity may control a local company even with less than majority share holding, if the pattern of share holdings of a company is fragmented or local partner is highly dependent on technology provided by foreign entity. Besides, the sharing of resources and cross-border value adding activities can take place in a firm with MNE affiliation involving minority ownership or even without equity holding (Narula and Dunning 2010).

In this study, we select a threshold of 26 percent of foreign equity as a representative of MNE. We thus define a sample firm as FA if a foreign promoter holds at least 26 per cent share in the paid-up capital of the company. Accordingly, DF is referred as a company having less than 26 per cent equity by a foreign promoter. The adoption of this criterion can also be justified on the basis of Indian Company Act 1957 by which a single entity or a group of shareholders with 26 per cent equity holdings in the paid up capital of a public limited company can block special resolution (Majumdar 2007). FCD assumes value 1 for a FA and 0 for a DF.

Foreign Presence

We capture the effect of FAs on efficiency of DFs by two main channels, notably the *competition effect* generated by FAs (CEF) and *demonstration/imitation effect* created by the FAs (DEF). In view of the discussions in Section-3 on the findings of Indian studies, we predict positive impacts of each variable of foreign presence, CEF and DEF, on the technical efficiency of DFs.

Control Variables

***Capital Intensity* (CAPI)**

The use of firm-level capital intensity (CAPI) as an independent variable is employed to control for the effect of intra-IMI heterogeneity in capital intensity on TE. Differences in capital intensity among the firms may partly reflect firm-specific capital intensity and partly reflect the average capital intensity of the main sub-industries or industry segments in which the firms operate. Depending on the interpretations, capital intensity may have favourable or unfavourable impact on TE. The high capital intensity can be interpreted as the capital expenditure on plant and machinery not yet productive and it thereby proxies for unused plant capacity. This interpretation would imply a negative relationship between the capital intensity and TE. On the other hand, the higher capital intensity reflects the greater employment of machinery and equipment (embodied technology), information and communication technology and automatic processes in comparison to the use of manual labour. This explanation would then suggest a positive relationship between TE and CAPI. As IMI is relatively capital intensive industry requiring precision and quality, the efficiency enhancing efforts of a firm may require capital deepening in the form of higher use ICT, automation and frequent modernisation of the plant and machinery.

A study by Banga (2004) for the period 1993/94 to 1999/2000 shows that capital intensity has no impact on TFPG in the case of a pooled sample of firms in the Indian automobile, chemical and electrical industries. Driffield and Kambhampati (2003) find capital intensity to be positively related to technical efficiency in the chemicals, metal products and transport equipment industry but negatively related in the food and beverages and machine tools.

We expect CAPI to be positively related to TE in the IMI.

***Firm Size* (SZ)**

Firm size (SZ) is a complex variable reflecting the influence of several characteristics. The major factors differentiating a large size firm from a small size firm are the latter's command over a large amount of resources and its diverse capability (e.g. risk bearing and innovatory capability), economies of scale and scope in production, bargaining power in accessing resources and factors of production from the market, ability to exert pressure through lobbying and win favours from the government and bend rigid rule-based systems and procedures.

Depending upon the interpretation given to firm size, the economic literature offers contrasting viewpoints on relationship between size and efficiency. Some scholars suggest a positive relationship between firm-size and efficiency. Hirsch and Adler (1974) point out that a positive correlation between size and efficiency exists at least up to a point. Reasons for the positive relationship are that the larger firms are better equipped than smaller ones to: a) take advantage of economies of scale in production, marketing and finance, and b) assume risk involved in business including new product development and exports. The proponents of the efficient structure doctrine suggests that the large size results from the higher efficiency in utilization and allocation of resources or/and efficient scale of operation of a firm (Demsetz 1973, Peltzman 1977 and Brozen 1982). In this framework, however, efficiency becomes an independent variable in the explanation of size rather than the size explaining the efficiency.

Another group of scholars posits a negative relationship between firm size and efficiency. Leibenstein (1966) considers competitive pressure and motivation as the two important factors in improving the efficiency of a firm. Since the larger firms are generally afflicted by complex bureaucratic rules causing lack of human relationship and motivation to work, the larger firms suffer more X-inefficiency than the smaller ones (van den Broeck 1988). Further, the large size may confer higher degree of market power to a firm (Shepherd 1972, Boardman and Vining 1989). As a consequence, the bigger firms may feel the reduced necessity for gaining competitiveness through efficient utilization and allocation of their resources. Furthermore, firm size may also reflect the degree of diversification achieved by a firm, which by and large has been found to affect the performance negatively (Wernerfelt and Montgomery 1988). Thus, any significant relationship between SZ and TE will depend on the net outcome of the positive and negative factors as discussed above.

A study by Banga (2004) for the period 1993/94 to 1999/2000 shows that firm size has no impact on TFPG in the case of a pooled sample of firms in the Indian automobile, chemical and electrical industries.

Firm's Age **(AGE)**

It is possible to interpret the firm’s age (AGE) in two alternative manners and accordingly its effect on TE can be positive or negative. If the firm’s age acts as a proxy measure for its maturity, accumulated experience or learning, AGE is expected to have a favourable impact on TE. On the contrary, if a firm’s age reflects the plant vintage and/or rigidity in outlook or inflexibility towards the changing market conditions, AGE is expected to have negative influence on TE. Thus, the relationship between AGE with TE cannot be predicted on *a priori* basis.

In a study on the determinants of technical efficiency, Ray (2006) did not find any impact of capital vintage on technical efficiency. A study by Banga (2004) for the period 1993/94 to 1999/2000 shows that age of a firm has no influence on TFPG in the pooled sample of Indian automobile, chemical and electrical industries.

***Export Behaviour* (XD)**

As summarised in Wagner (2007) and Greenaway and Kneller (2005), there are three major explanations regarding exporters being more efficient than non-exporters. First of all, the export activity links a firm operating in less competitive domestic market to a more competitive international market. Therefore, the export oriented firms may face more competitive pressure than domestic oriented firms. The higher competitive pressure faced by exporting firms may lead to the reengineering of their business processes in such a way that their efficiency in utilization of inputs of production may improve or/and they may decide to operate on a more efficient scales, moving down on average cost curve. Secondly, exporting may increase a firm's exposure to other technologically advanced firms (e.g. those based in developed countries) that in turn may lead to higher learnings and skill formation and adoption of better methods of productions, technology and marketing.

Thirdly, a firm has to incur additional costs (notably sunk and transaction costs) for selling in the international market. These costs may include the cost of market research for acquiring information about the requirements of overseas customers and modifying domestic products as per the needs of foreign customers, cost of transportation, establishing distribution and logistics channels, cost of deploying personnel with skills to manage overseas networks and delivery of after-sales-services at foreign locations, etc. (Wagner 2007). To cover the sunk cost the exporting firms must have productivity/efficiency advantages as compared to the export ones (Greenaway and Kneller 2005).

There is now a large and rich empirical research based on micro-level data pertaining to manufacturing sector of developed as well as developing countries suggesting exporters to be more productive than the non-exporters (Wagner 2007 and Greenaway and Kneller 2005). Hence, we expect exporter firms to be more technically efficient than the non-exporter ones.

I have not come across any Indian study, examining the effect of propensity to export on technical efficiency. However, there are some studies linking export intensity with technical efficiency [Driffield and Kambhampati (2003), Goldar et al. (2004), Ray (2006)]. The findings of these studies are mixed and industry-specific even during the post-reform period. In view of the above discussions, we test the hypotheses that the exporting firms would be more technically efficient than non-exporting ones.

***Intensity of Import of Intermediate Goods* (MI)**

The opportunity to import better quality raw material and advance technologies, both in embodied and disembodied forms, is seen as the major benefits of import liberalisation (Tybout 2000; Chand and Sen 2002). Imported intermediate goods, particularly the capital goods, equipments and spare parts, generally embody latest technology. Besides, the imported raw material or spare parts may be superior in quality and less expensive than the domestically available raw materials, spare parts, etc. Further, certain types of machinery and equipment may be unavailable domestically. Thus, the import of intermediate goods may add to the technological strength of a firm and fulfill the special quality or production requirements of the final goods that cannot be met through the domestically available inputs. Therefore, higher intensity of import of intermediate goods (MI) may lead to greater TE.

The studies pertaining to the post-reform phase of Indian economy report mixed findings regarding the impact of intensity of imported inputs on the technical efficiency/productivity in the manufacturing sector. Using a pooled dataset on medium and large firms for the period 1987-94, Driffield and Kambhampati (2003) find impact of intensity of import of intermediate goods on technical efficiency to be negative in the machine tools, transport equipment and chemical industry but positive in the case of textile industry. Ray's (2006) study for the year 2001 reports a positive impact of intensity of import of raw material on the technical efficiency but did not find any impact of intensity of import of capital goods. Goldar et al. (2004) find import intensity to have a positive impact on technical efficiency in the engineering industry during 1993/94 to 1996/97 as well as during 1997/98 to 1999/2000.

We hypothesize a positive relationship between TE and MI.

***Financial Leverage* (LEV)**

Firm-specific choices related to financial risk and efficiency in asset management may lead to the creation of heterogeneity within the industry and may help to explain firm level performance. In theory, a highly leveraged company, because it has large debt for its size, is subjected to greater monitoring by its board of directors and lenders so that the company makes regular payments of interest and installments of principal. The greater monitoring puts pressure on the company to perform better. Thus, the financial leverage (LEV) may have positive influence on TE. However, in the Indian context, the lending banks and financial institutions, mostly being government owned, are unable to exercise much pressure on the companies to perform. Instead, the higher equity participation may lead to greater involvement of promoters in the company' affairs and better management of the company. Additionally, availability of higher amount of retained earnings with a company acts as a cushion for undertaking expansion or modernisation of its plants or undertakes exports. Thus, variable LEV is expected to have negative impact on TE.

Intensity of Import of Disembodied Technology **(MTI)**

A firm acquires explicit disembodied technology through license under foreign technological collaboration agreements. Disembodied technology imports cover many aspects of intellectual property rights such as right to use patented products and processes, basic (or/and detailed) designs and drawings, brand names, trademarks, provision of engineering services, etc. The disembodied technology is generally imported against the payment of royalty and/or technical know-how fees made to the foreign technological collaborator. The royalty is paid on recurring basis as a certain percentage of domestic sales and/or of exports. The technical know-how fees are paid either in a lump-sum amount or in installments for import of drawings and designs, the use of patents, brand names, trademarks and engineering services provided by the foreign licensee. Thus sum of royalty (net of tax) and lump sum payments as a ratio of sales would capture that part of technological capability of a firm, which is acquired through the import of disembodied technology.

In a firm-level study on the Indian automobile, chemical and electrical industries, Banga (2004) reports that the intensity of import of disembodied technology has a positive impact on TFPG during the period 1993/94 to 1999/2000. In a study on the determinants of technical efficiency for the year 2001, Ray (2006) finds favourable impact of intensity of import of disembodied technology on the technical efficiency in the Indian manufacturing sector.

Research and Development Intensity **(RDI)**

The *technological capabilities* approach emphasizes that the firm-level technological capabilities in developing countries are created through *minor innovations* which include incremental modifications in the plants and machineries, efficiently using technologies, imitation, absorption and adaptation of imported technology, reverse engineering of products, etc. Besides, these *minor innovations* are largely generated by firms' in-house R&D efforts and the development of human resources and skills, notably on the job training. (Lall 2000a).

The most of the existing firms in IMI lack (basic as well as detailed) designing capabilities and invest in R&D mainly to develop *in-house technological capabilities* in the form of production engineering, which include operating existing plants and machineries more efficiently; assimilating, absorbing and adapting (to local conditions) the imported disembodied technology; shop-floor based problem solving related to running, maintaining and repairing of plants (CII 2007, EXIM Bank 2008). The important implication of this message is that the higher R&D expenditures by firms in IMI may lead to higher technical efficiency even without producing new products and processes.

According to Torri (1992), R&D intensity can also have negative impact on technical efficiency in the following cases: a) if R&D activities give rise to dynamic effects so that present expenditure on R&D is sure to result in future innovations. For this reason it is possible that a firm that spends on these activities may appear to be obtaining low output at present, although it will obtain higher output in the future; b) if some firms have incurred more R&D expenses compared to their competitors but such R&D does not lead to the expected innovation, RDI will not improve the firm's degree of efficiency; c) the relatively high R&D expenditure by some firms could move upward the frontier production function of an industry, making non-innovative firms appear inefficient.

Driffield and Kambhampati (2003) find impact of R&D intensity on technical efficiency to be negative in machine tools industry and to be positive in the case of transport equipment, metal products and chemical industries. In a study on the determinants of technical efficiency for the year 2001, Ray (2006) did not find any impact of R&D intensity on technical efficiency in the Indian manufacturing sector. The R&D activity being inadequate in IMI, the coefficient of RDI may not be statistically significant in equations. In a study on the determinants of technical efficiency in the Indian engineering industry during the decade 1990s, Goldar et al. (2004) find R&D intensity to have no influence on technical efficiency. We therefore expect the effect of RDI on TE to be insignificant.

***Product Differentiation through Advertising and Marketing* (AMI)**

Advertising- a phenomenon associated with imperfectly competitive market- is used as a means to reduce the scope and effectiveness of price competition by creating product differentiation and strong goodwill for the firm. Advertising and marketing is widely accepted as the most effective method of product differentiation among firms in consumer goods industry. In a producer goods industry like IMI, advertising and marketing expenses may be less important in creating product differentiation and giving a degree of market power to a firm. Nevertheless, the market power may lead to complacency and inefficiency in utilization of inputs in a firm.

In a study on the determinants of technical efficiency, Ray (2006) did not find any impact of product differentiation on technical efficiency in the Indian manufacturing sector. However, a study on the Indian engineering industry, Goldar et al. (2004) find positive relationship between advertisement intensity and technical efficiency during 1993/94 to 1996/97 and during 1997/98 to 1999/2000. Since IMI is a producer goods industry, we expect AMI to have no impact on TE.

***Index of Market Concentration* (IMC)**

The four-firm seller concentration ratio may differ across various product groups of the IMI. Therefore, we need to control the impact of product group wise market concentration on the firm-specific TE. For this purpose, we use the firm-specific index of market concentration (IMC) which is expected to follow a negative relationship with the efficiency for the following reasons. First, the concentrated market structure may prevent diffusion of information, technical knowledge and experience-sharing, therefore, it may reduce the efficiency of the firms participating in the industry (Caves and Barton 1990).

Second, the existence of monopoly generally allows slack or lack of efforts on the part of stakeholders, notably the managers and workers of the company. Thus, the firms with least market power will be more stimulated to develop strategies (differentiating, innovating, etc.) to modify their market conditions, whereas firms with greater market power will not feel threatened by the potential competition. Third, the existence of a larger number of firms in an industry leads to sharpening of effort incentive since the unobserved productivity shocks are likely to be correlated across firms operating in the same industry. Besides, the competition makes profit more responsive to managerial efforts. Therefore, the firms operating in the competitive market conditions have greater incentive to ensure that managerial efforts are kept at a high level. These may not happen in the concentrated market and thereby inefficiency could result (Nickel 1996). Fourth, the competition raises the probability of bankruptcy and thereby the companies try to avoid this fate by increasing efficiency in utilisation of human and physical resources (ibid). Fifth, the market leaders may spend additional resources for preventing new entry or deterring rivals in the oligopolistic industries and this can lead to production inefficiency.

There have been some comprehensive cross-section data based studies of technical efficiency using frontier production function techniques to estimate technical efficiency indices and relate them to concentration or competition [see e.g. Caves and Barton (1990) and Caves (1992)]. These studies suggest that an increase in market concentration above a certain threshold lowers the technical efficiency (Nickell 1996). There are not many studies linking industrial concentration with technical efficiency in the case of Indian manufacturing sector. Driffield and Kambhampati (2003) find Herfindal index of market concentration to be negatively related to the technical efficiency in the Indian machine tools, chemicals, transport equipment and metal products industries. In view of the above, we hypothesise a negative relationship between IMC and TE in the IMI.

Segment-Specific Dummy Variable **(NICD)**

We use panel data model to control the effect of any systematic variation in sub-industry-specific characteristics or any unobserved firm-specific characteristics on technical efficiency. Hence, we do not use sub-industry specific dummy variables as the control variables. Instead, we use a dummy variable NICD that assumes the value 0 for a firm producing general-purpose machinery and 1 for the firms based in the special-purpose machinery segment. NICD is expected to control the differential impact of these two major segments of IMI on the firm-level TE.

Year-specific Dummy **(YD)**

TE of the firms are expected to be influenced by year to year changes in external factors such as changes in industrial policy, competitive conditions, supply and demand conditions, industrial growth, etc. To account for these affects we employ 6 additive year-specific dichotomous dummy variables (YD), corresponding to the each year of the period covering the 2001/02 to 2006/7.

5. <u>Sample, Data and Period</u>

Empirical analysis in this study utilises the unbalanced panel data on a sample of 177 firms, with 936 observations spread over 7 years period (2000/01 to 2006/07), drawn from the IMI. We obtained basic data on a number of financial and non-financial parameters for each year of the study for designing various indicators for carrying out the empirical exercise. The major portion of this data and information was sourced from the PROWESS database - an electronic database on information about the financial statements and various other aspects of Indian firms designed by the Centre for Monitoring the Indian Economy (CMIE). Data sourced from the PROWESS was supplemented and sometimes cross checked by obtaining relevant information from additional sources and publications, namely *Bombay Stock Exchange Directory, Annual Reports* of some companies, *Capital Line Ole* (another electronic database) or even by personally contacting the company's representatives in the case of some doubt on data. We also acquired data from CMIE's *Industry Market Size and Share* chiefly for constructing a variable on the index of market concentration. We also used some price deflators for which data was collected from various publications of the Government of India (GoI). For each year of analysis, we compiled relevant product/industry-wise data on *Wholesale Price Index* (base year 1993-94) from the WPI series published by the Office of Economic Advisor (OEA), GoI. Similarly, we accessed year-wise data on the *All India Consumer Price Index Numbers (General) for Industrial Worker* (base year 1982) from the Labour Bureau, GoI. With the help of compiled data, we designed appropriate firm-level and sub-industry level indicators.

We extracted a list of all firms belonging to the IMI available in PROWESS database. We included all those firms in the sample for which data on each of the relevant variables were available for at least 2 years of the 7 financial years of the study. Further, we deleted sick companies, i.e., the companies with negative networth in a financial year, mainly with a view to remove outlier effect from the analysis. These exclusions left us with a usable sample of unbalanced panel of 177 firms with 936 observations. The size of overall sample (as well as the size of each sub-sample of DFs and FAs) varies from year to year during the period 2000/01 to 2006/07 of the study. Despite the sample size being smaller than that of the PROWESS database, share of sample firms in respect of some aspects of corporate financial indicators (say sales turnover or net worth) of the IMI during the period of the study ranges from 66 per cent to 90 per cent depending on the individual aspects of financial indicators. In particular, sample firms in aggregate over 2000/01 to 2006/07 covered 68 per cent of sales turnover, 90 per cent of gross profit, 85 per cent of net worth, 74 per cent of gross fixed assets, 69 per cent of total assets, 66 per cent of foreign exchange earnings and 74 per cent of foreign exchange outgo of all the firms belonging to the IMI as classified in the PROWESS database. Considering the fact that PROWESS covers almost entire corporate sector, our sample with such shares on the individual aspects of financial indicators can be considered as the good representative of the corporate sector of IMI.

The period of study was characterised by the following events: First, the Indian companies have adopted better accounting standards since 2000/01, which has made the presentations and descriptions of financial statements more detailed, transparent, accurate and uniform across the firms. As our study uses firm-level data originally sourced from the annual reports of the companies, these developments add additional feature to our study over the studies that have used data pertaining to the period prior to the year 2000. Second, India has become one of the most attractive destinations for FDI during the period of the study. Third, there has been no major change in policies affecting the IMI. Yet, the first 4 years of this period were characterized by slow growth in the IMI and the remaining period was marked by a significantly higher growth compared to the first period. Empirically, this suggests that we should control for time effect in the proposed econometric analysis.

The descriptive statistics of individual variables used in the study shows that the statistics on standard deviation of FCD reveal no within group variation in data (Table-1). Matrices of correlation coefficients of variables and information on variance inflation factor and tolerance factor in respect of full sample, sub-sample of DFs and FAs reveal no serious multicolinearity problem either in terms of the rule of thumb for the pair-wise correlation coefficients between two regressors (> 0.80) or the rule of thumb for the variance inflation factor (>10) for the individual regressors.

Table-2 compares the major characteristics of FAs and DFs. It indicates that FAs, as compared to DFs, on an average achieve greater technical efficiency (TE), gross profit margin (GPM) and export intensity. As compared to DFs, FAs spend higher portion of their revenue on research and development as well as on import of intermediate goods and disembodied technology. As the R&D activity and use of imported technology require higher level of skill, we may assume that skill intensity of FAs are greater than that of DFs. These results probably suggest that FAs do have firm-specific ownership advantage over DFs in terms of technology. In relation to DFs, FAs on an average spend less portion of their revenue on advertising and marketing. In other words, DFs spend more towards creation of product differentiation advantage. In comparison to DFs, FAs are also bigger in terms of their size of their operation. Results on relative AGE and CAPI indicate that FAs and DFs do not significantly differ in terms of years of operations and choice of technique. As compared to DFs, FAs are also found less financially leveraged, implying that the latter finance their operations more from owned fund than from the borrowed.

6. Econometric Models and Procedure

6.1 Deriving Technical Efficiency

To derive firm and year specific TE, we estimate a SFPF model by adopting Battese and Coelli's (1992) specification involving the use of unbalanced panel data. General formulation of this model is expressed by the following equations:

$$Y_{jt} = f(X_{jt}; \beta) \exp(V_{jt} - U_{jt}) \quad (1)$$

or

$$Y_{jt} = \beta \mathbf{X_{jt}} + V_{jt} - U_{jt} \quad (2)$$

$$U_{jt} = [\exp\{-\eta(t-T)\}] U_j, t \in |(j); j = 1, 2, \ldots\ldots, N; \quad (3)$$

where Y_{jt} is the natural logarithm of production of the j^{th} firm in the t^{th} year; $\mathbf{X_{jt}}$ is the vector of logarithm of quantities of each input of production of the j^{th} firm in the t^{th} year of observation; β is a vector of unknown parameters; random error V_{jt}'s are assumed to be independently and identically distributed (iid) as $N(0, \sigma_v^2)$ reflecting two-side "statistical noise" component that accounts for the effect of all random factors such as the measurement error, luck, machine performance, etc.; V_{jt} are also assumed to be independent of U_{jt} and the input vector X_{jt}; U_j's are non-negative random components assumed to be iid as non-negative truncations of the $N(\mu,\sigma_u^2)$ distribution; U_j's are assumed to capture technical inefficiency in production, since the non-negative assumption of U ensures that the firm's actual production point lies beneath the stochastic frontier and the gap between the point frontier and actual point thus measures technical inefficiency; Eta (η) is an unknown scalar parameter to be estimated, reflecting the time trend of the efficiency of individual firms; $|(j)$ represents the set of T_i time periods among the T periods involved for which observations for the i^{th} firm are obtained. Given the assumptions on the statistical distribution of U_{jt} and V_{jt}, we first obtain maximum likelihood (ML) estimates of the SFPF represented by equation (2).

Thereafter, we obtain the technical efficiency of firm j at the time period t (i.e. TE_{jt}) as the minimum-mean-squared-error predictor of the technical efficiency of the i^{th} firm at the t^{th} time period with help of help of equation (4):

$$E[\exp(-U_{jt})| E_j] = \frac{1 - f[\eta_{jt} \sigma_j^{*} - (\mu_j^{*}/\sigma_j^{*})]}{1 - f(-\mu_j^{*}/\sigma_j^{*})\}} \exp[-\eta_{jt} \mu_j^{*} + (1/2) \eta^2_{jt} \sigma_j^{*2}] \quad (4)$$

where E_j represents the $(T_j \Delta 1)$ vector of η_{jt}'s associated with the time period observed for the j^{th} firm, where $E_{jt} \therefore V_{jt} - U_{jt}$;

$$\mu^{*} = [\mu \sigma_v - \eta_j' E_j \sigma^2] / [\sigma_v^2 + \eta_j' \eta_j \sigma^2] \quad (5)$$

$$\sigma^{*2} = [\sigma_v^2 \sigma^2] / [\sigma_v^2 + \eta_j' \eta_j \sigma^2] \quad (6)$$

The function f (.) denotes the probability distribution function (pdf) for the standard normal variable. In the case Cobb-Douglas SFPF, E_{jt} is a linear function of the vector, ®. The operational predictor for equation 4 is obtained by substituting the relevant parameters by their maximum-likelihood estimates. In this framework, TE of a given firm (in a given year) is defined as the ratio of its mean output (conditional on its level of factor inputs and firm effects) to the corresponding mean output if the firm utilizes its levels of inputs most efficiently (Battese and Coelli1992).

Our empirical model consists of a single equation production function with natural logarithm of output as the dependent variable, and material input, labour input, capital input as three independent variables. The Cobb-Douglas form of production function is chosen, because of its well-known advantages and simplicity. In principal, confining the analysis to this one functional form can be somewhat restrictive. However, a few studies [e.g. Kopp and Smith (1980) and Krishna and Sahota (1991)] suggest that the functional specifications have small impact on measured efficiency. In a relatively recent study, Driffield and Kambhampati (2003) do not find significant differences in the estimation results obtained either from trans-log or Cobb-Douglas specification. The log linear form of Cobb-Douglas production function to be estimated in accordance with the estimation methods described above is expressed as follows:

$$\ln Y_{jit} = b_0 + b_1 \ln M_{jit} + b_2 \ln L_{jit} + b_3 \ln K_{jit} + V_{jit} - U_{jit} \qquad (6)$$

where Y, M, L, K represent output, material input, labour input and capital input respectively. The subscript j (j = 1,…,177) refers to the j-th sample firm; i (i = 1,…,936) denotes i^{th} observation and t (t = 1,…,7) represent year of operation. The ln symbolises natural logarithm. V_{jt} and U_{jt} are the random variables whose distributional properties are described in the previous section. We use Coelli's (1996) "FRONTIER 4.1" software for estimating the above equation by MLE method and obtaining the parameters of the model and predictors for deriving the year-specific and firm-specific TE.

6.2 Econometric Models for Comparing TE of FAs and DFs and Efficiency Spillovers from FAs to DFs

Earlier studies on difference in productivity or productivity spillovers used econometric techniques (viz. OLS) based on cross-section data and reported higher productivity of FAs over DFs and evidence of productivity spillovers from the presence of the former to the latter (Görg and Strobl 2001, Görg and Greenaway 2004). However, the cross-section method has one major limitation in this regard. The cross-sectional studies may overstate the productivity advantage of FAs over DFs and spillover effects of FAs on the productivity of DFs. The reason is that cross-section techniques (e.g. the OLS) do not allow for other time-invariant firm or industry (or sub-industry) specific factors that may affect the relationship between the foreign presence and productivity, but for which the researcher do not have any knowledge (Görg and Strobl 2001, Görg and

Greenaway 2004). For example, if FAs are predominantly located in the more productive/efficient segments within an industry, FAs will be seen as more productive (than DFs) even without spillovers having taken place from the MNEs. Since the panel data models (e.g. with use of fixed effect or random effect techniques) can purge such time invariant effects, their applications are strongly recommended for examining the benefits of spillovers from FDI (Görg and Strobl 2001).

Hence, we employ and estimate panel data models of the determinants of technical efficiency to accomplish the objectives set out in the Section-1. Being a pooled data set of cross-section and time-series observations, the use of panel data also improves the efficiency of econometric estimates on account of larger number of observation compared to the individual data set of cross-section or time series. Besides improving the efficiency the application of panel data model in this study shall enable us to control for time invariant firm-specific heterogeneity in TE arising from the sample firms' sub-industry specific characteristics, business practices and culture, routine, trade secrets, preferences, etc. Panel data models are mostly estimated either by fixed effect (FE) or random effect (RE) techniques. We employ RE panel data linear regression model. The reasons for the preference of RE over FE model are the following: First of all, researchers have no option but to use the RE model if a explanatory variables has time invariant observations. In such cases, if one uses FE model, he cannot estimate the coefficients of time invariant variables, because u_i captures the effect of all the time-invariant variables. In the case of the dataset used for this study, since FCD and NICD do not have time variant observations, we are constrained to use RE technique. (Greene 2005, Chapter 13)

Secondly, our data set is characterized by a large number of cross-section units (N=177), each unit with a few years of data (T = 2 to 7 years). Therefore, the use of FE model would involve the estimation of firm-specific unobserved fixed effect (u_i) to be constant over time by including N intercept dummy variables or by differencing out the u_i's. On the other hand, we estimate only the mean and variance in the case of RE model. This latter method thus saves us a lot of degrees of freedom. (Greene 2005, Chapter-13).

Thirdly, the u_i measures firm-specific effects that we are ignorant about just the same way as v_{it} measures effects for the i^{th} cross-section unit in the t^{th} period that we are ignorant about. Hence, if we treat v_{it} as a random variable, there is no reason why we should not treat u_i as also a random variable. Finally, since we want to make inferences about the population from which cross-section data came, we should treat u_i as random not fixed (u_i should be considered fixed if we want to make inferences about the set of cross section units). (Greene 2005, Chapter-13).

In accordance with our objectives set out in Section-1 and with regard to the discussions in the previous sections, we use three alternative empirical specifications of the determinants of technical efficiency. Model-1 is estimated primarily for comparing the technical efficiency of FAs and DFs while controlling for other observed determinants of TE and unobserved heterogeneity possibly having influence on TE. Thus, Model-1 has the additive dummy variable FCD as the key variable of interest. To estimate this model we use data on full sample of firms with 177 groups and 936 observations.

Model-2 including a set of 3 equations is estimated for analysing the observable differences in the determinants of TE between DFs and FAs. Second equation examines the influence of foreign ownership on TE indirectly through the interactions between FCD and other observable variables meant for explaining TE, while controlling for unobservable factors. (For instance, we may like to examine if the firms' size get larger, the TE of FAs may improve more rapidly than that of DFs. This implies that the regression line for FAs has a steeper slope than that for the DFs. Thus in this procedure, the slopes of FAs are allowed to be different from those of DFs in addition to the differing intercepts).

As a result, equation (2) has additional set of variables, each one with letter F suffixed at the end of the variable name. Each one of these variables has been created by multiplying FCD with corresponding independent variable (except FCD) in equation 1. For example, SZF is created by multiplying FCD with SZ. When both SZ and SZF are in the equation, the coefficient of SZ takes on the slope value of the sample of DFs and the coefficient of SZF represents the deviation of the FAs slope from the DFs slope. Furthermore, we estimate equations (3) and (4) for analysing the determinants of TE for each ownership group (i.e. for DFs and FAs) separately. In order to estimate the equations (2), (3) and (4), we respectively utilise the unbalanced panel of data on full sample of 177 firms with 936 observations, data on sub sample of 134 DFs with 675 observations and data on sub sample of 43 FAs with 261 observations.

Model-3 is estimated for investigating the effect of the presence of FAs on the technical efficiency of DFs. The equation (5) of this model explains TE of DFs with the help of CEF and DEF as the key variables of interest along with many observable control variables. We symbolically present all the three empirical models of TE as follows:

Model-1

$TE_{it} = b_0 + b_1\ FCD_{it} + b_2\ SZ_{it} + b_3\ AGE_{it} + b_4\ CAPI_{it} + b_5\ AMI_{it} + b_6\ MTI_{it} + b_7\ RDI_{it} + b_8\ LEV + b_9\ XD + b_{10}\ MI_{it} + b_{11}\ IMC_{it} + b_{12}\ NICD_{it} + b_{13} YD02 + \ldots + b_{18}\ YD07 + u_i + v_{it};$

$i = 1, 2, \ldots., 177; t = 1, 2, \ldots\ldots.7$ (1)

Model-2

$TE_{it} = b_0 + b_1 FCD_{it} + b_2\ SZ_{it} + b_3\ AGE_{it} + b_4\ CAPI_{it} + b_5\ AMI_{it} + b_6\ MTI_{it} + b_7\ RDI_{it} + b_8\ LEV + b_9\ XD + b_{10}\ MI_{it} + b_{11}\ IMC_{it} + b_{12}\ NICD_{it} + b_{13} YD02 + \ldots + b_{18}\ YD07 + b_{19}\ SZF_{it} + b_{20}\ AGEF_{it} + b_{21}\ CAPIF_{it} + b_{22}\ AMIF_{it} + b_{23}\ MTIF_{it} + b_{24}\ RDIF_{it} + b_{25}\ LEVF + b_{26}\ XDF + b_{27}\ MIF_{it} + b_{28}\ IMCF_{it} + b_{29}\ NICDF_{it} + b_{30}\ YDF02 + \ldots + b_{35}\ YDF07 + u_i + v_{it};$

$i = 1, 2, \ldots., 177; t = 1, 2, \ldots\ldots.7$ (2)

$TE_{it} = b_0 + b_1\ SZ_{it} + b_2\ AGE_{it} + b_3\ CAPI_{it} + b_4\ AMI_{it} + b_5\ MTI_{it} + b_6\ RDI_{it} + b_7\ LEV + b_8\ XD + b_9\ MI_{it} + b_{10} IMC_{it} + b_{11}\ NICD_{it} + b_{12} YD02 + \ldots + b_{17}\ YD07 + u_i + v_{it};$

$i = 1, 2, \ldots., 134; t = 1, 2, \ldots\ldots.7$ (3)

$TE_{it} = b_0 + b_1\ SZ_{it} + b_2\ AGE_{it} + b_3\ CAPI_{it} + b_4\ AMI_{it} + b_5\ MTI_{it} + b_6\ RDI_{it} + b_7\ LEV + b_8\ XD + b_9\ MI_{it} + b_{10} IMC_{it} + b_{11}\ NICD_{it} + b_{12} YD02 + \ldots + b_{17}\ YD07 + u_i + v_{it};$

$i = 1, 2, \ldots, 43; t = 1, 2, \ldots\ldots.7$ (4)

Model-3

$TE_{it} = b_0 + b_1\ CEF_{it} + b_2\ DEF_{it} + b_3\ SZ_{it} + b_4 AGE_{it} + b_5\ CAPI_{it} + b_6\ AMI_{it} + b_7\ MTI_{it} + b_8\ RDI_{it} + b_9\ LEV + b_{10}\ XD + b_{11}\ MI_{it} + b_{12} IMC_{it} + b_{13}\ NICD_{it} + b_{14} YD02 + \ldots + b_{19}\ YD07 + u_i + v_{it}$ $\quad i = 1, 2, \ldots.,134; t = 1, 2, \ldots,7$ (5)

The random error term u_i refers to the unobserved heterogeneity specific to the observations relating to the i^{th} firm (or group). The important assumptions on u_i and v_{it} are already discussed in section.

We estimate equations of each model with the assumption that there is no autocorrelation but panels are heteroskedastic. We employ STATA software package for estimating each of the five equations by the FGLS technique. To examine the effectiveness of RE panel data model as against pooled classical regression model with no group-specific effect, we conduct Breusch and Pagan's Lagrange multiplier (LM) test in respect of each of the five equations. In this test, LM statistics is calculated with the help of OLS residuals, and the same is utilized for testing the null hypothesis that variances of groups are zero (H_0: $\sigma_u = 0$). If null hypothesis is rejected, the use of RE model is considered appropriate.

7. Results and Discussions

7.1 Results from the Estimation of SFPF and Technical Efficiency

Before estimating SFPF, we obtained summary statistics of each variable used in the production function for studying sample characteristics. Summary statistics for each variable used in the estimation of SFPF suggests that there is enough variability in data around mean and the variability is almost similar for all the variables. For each variable, the variability within the group is much lower than between the groups. To detect multicolinearity in among the independent variable, we first computed matrix of correlation coefficients which indicated that the correlation between the pair of independent variables, ln M and ln L, is the highest, followed by the correlation between ln L and ln K and between ln M and ln K. Besides we also calculated the values of VIF and TOL. The results from both the exercises indicated the absence of multicolinearity problem.

Results of the maximum likelihood estimates of parameters of SFPF are given in Table-3. The results show that the coefficients of each of the three inputs explaining production behaviour of sample firms are statistically significant. In our model, ML estimates of coefficients also signify elasticity of output with respect to material, labour and capital input. The comparison of these elasticity show that elasticity of output with respect to material input (0.71) is the highest and substantial, followed by elasticity of output with respect to labour (0.14) and capital input (0.10) respectively. Although the value of the coefficient associated with material input is substantial, it is much less than the unity. Notably, when we use two input production function, ignoring raw material, we implicitly assume that the coefficient associated with material input is close to unity. Further, return to scale, measured as a sum total of these elasticities (0.95), is quite close to unity, indicating that the production technology is characterised by constant returns to scale.

The software also gave the firm specific and year-specific TE_{jt}. The analysis of data mean value of TE (over sample period) suggests that: a) the most technically efficient firm with mean TE of 99.3 per cent belongs to the group of FAs whereas the least technically efficient firm with mean TE of 55.5 per cent belongs to the group of DFs; b) the five most technically efficient firms in the sample includes two FAs, each one with mean TE of 99.3 per cent and 97.0 per cent, and three DFs, each one with mean TE of 96.3 per cent, 96.1 per cent and 95.9 per cent; c) the five least efficient firms, with mean percentage TE of 57.9, 57.9, 55.8, 55.1 and 54.5, belong to the group of DFs. The summary statistics of TE indicates the mean value of TE to be 0.71 per cent with higher between variation than the within variation measured by standard deviation.

7.2 <u>Estimation Results from the Models of the Determinants of Technical Efficiency</u>

FGLS estimates of the coefficients and corresponding heteroskedasticity (panel) corrected standard error for each of the equations included in Model-1, Model-2 and Model-3 are presented in Table-4, Table-5 and Table-6 respectively. It is evident from the results that Wald chi^2 statistics corresponding to each of five equations are quite high and significant, suggesting that the each equation enjoy significant explanatory power in terms of the independent variables used for explaining TE. Z-value corresponding to the coefficient of each variable presented in the tables is obtained from dividing the value of an estimated coefficient of each independent variable by corresponding heteroskedastic panel corrected standard error. We now discuss the results on each determinants of TE.

Relative TE of FAs and DFs

It is evident from the Table-4 that the coefficient of FCD is statistically significant and positive, implying that the FAs on the average are more technically efficient than the DFs even after controlling for observed and unobserved factors including firm-specific heterogeneity, industry segment effect and year wise effect in data. This result is in line with our hypothesis and the findings of several studies reviewed in Section 3, notably the one comparable study on Indian engineering firms by Goldar et al. (2004).

TE & RDI

In every equations of Table-4 & 5, we find that the estimated coefficients of RDI turn out to be significant and positive. Thus, the results on RDI indicate that the in-house R&D contributes significantly in achieving higher efficiency, irrespective of the ownership of the firms in the IMI. Firms in the IMI conduct R&D mainly for improving existing processes, plant efficiency and for developing productionising capabilities by adapting imported capital goods, raw material and components, disembodies technology to the indigenous requirements. All these activities lead to higher production per unit of inputs or less input cost per unit of output. Besides, as shown by the estimated equation (4) in Table-5, the difference in slopes of RDI is also positive and significant between FAs and DFs. This result suggests that expenditure on R&D helps more in improving the efficiency of FAs than the efficiency of DFs. In other words, efforts to adapt the technology, factor of production or customise the products yield better result in terms of efficiency enhancement in FAs than in DFs. Our results on RDI are contrary to those of Driffield and Kambhampati (2003) for machine tools industry and the findings of Goldar et al. (2004) and Ray (2006).

TE & MTI

Contrary to the results on RDI, the coefficients of MTI are insignificant in all the equations. These results suggest that the import of disembodied technologies is not effective in enhancing the efficiency of the plant in the IMI. It seems that the firms in IMI purchase foreign disembodied technologies only for creating production capabilities or they are getting older technologies which are incapable of enhancing their efficiency in resource use or even providing value added items. As the IMI imports maximum amount of foreign technology in the manufacturing sector, this issue needs further investigation.

TE & AMI

Contrary to our expectations, the results show that, irrespective of ownership category, the firms spending more on advertising and marketing as a ratio of sales enjoy greater TE. Moreover, the AMI equally favours FAs and DFs in their efforts to enhance TE. It seems the product differentiation advantages created through expenditure on advertising and marketing is helping the firms in realizing higher value for their products for a given combination of inputs. This result is in line with the finding of Goldar et al. (2004) for the Indian engineering firms.

TE & CAPI

As expected, estimated coefficients of CAPI show that the use of more capital intensive technology leads to higher TE, irrespective of firms' ownership status. At the same time, CAPI affects TE of FAs and DFs in the same manner. This result suggests that the higher use of capital in its various forms is providing greater efficiency in utilisation of resources and value addition to the firms in the IMI.

TE & SZ, AGE

The results pertaining to SZ indicate that the larger size DFs are more efficient but SZ has no impact on the TE of FAs. This result shows that the DFs need to augment their scale of operation to achieve higher efficiency. Age of the firm has no impact on TE in case of full sample as well as in the case of sub-sample of FAs (or DFs). This finding is in accordance with the findings of Banga (2004) and Ray (2006).

TE & LEV

Irrespective of the category of ownership higher leveraged firms are found to be less technically efficient. Thus, the greater use of borrowed fund in comparison to owned fund penalizes the efficiency in the IMI. At the same time, the difference in slope coefficients of LEV between DFs and FAs shows that LEV affects more adversely the TE of FAs than that of DFs.

TE & XD

Insignificant coefficients of XD in each equation suggest that exporting and non-exporting firms do not differ in terms of efficiency in the use of inputs of production. This may be because firms in IMI are mostly oriented towards domestic market and consider exporting as the residual activity.

TE & MI

The relationship between TE and MI is found significantly positive in case of overall sample. This result implies that the greater use of imported input improves the TE in general. Slopes of MI do not differ significantly between DFs and FAs equations. Thus our results along with the findings of Goldar et al. (2004) and Ray (2006) suggests that the import liberalisation aimed at providing easy access to imported raw material and capital goods has efficiency enhancing effect on the IMI.

TE & IMC

As expected, IMC has negative impact on TE of overall sample and TE of DFs. However, IMC has no impact on TE of FAs. The slopes of IMC also differ significantly between DFs and FAs equations. In line with the findings of Driffield and Kambhampati (2003), these results suggest that higher industrial concentration leads to lower level of efficiency.

TE & NICD, YD

Coefficients of NICD are positive and statistically significant in the case of full sample and sub-sample of DFs respectively. This suggests that the special purpose machinery segment is nearer to the efficiency frontier than the general purpose machinery. The results on coefficient of YD variables indicate no year-wise differences in TE.

Efficiency Spillovers from FAs to DFs

The value of estimated coefficient of CEF in Table-5 shows that it has no influence on TE, when CEF is used exclusively. This suggests the absence of efficiency spillovers from the competitive pressure exercised by FAs in the IMI. However, coefficient of CEF turns out to be significantly negative when it is used in conjunction with DEF. These results indicate a negative efficiency spillover from FAs to DFs on account of competition effect generated by the former. This finding is in line with oft-quoted finding of Aitken and Harrison (1999) for Venezuela and findings of the other studies conducted in the context of some developing countries and transition economies [e.g. Kathuria (2001, 2002), Sasidharan and Ramanathan (2007) for India; Konings (2001), Djakov and Hoekman (2000) for transition economies]. It seems that the competition effect by FAs have caused less efficient DFs losing business in the favour of FAs in the IMI. As pointed out by some scholars (e.g. Aitken and Harrison 1999 and Konings 2001), this might have happened because FAs, due to their superior production technology, produce goods at lower marginal cost than that by the DFs which, in turn, allows FAs to sell cheaper than DFs and take away demand away from the latter.

The coefficients of the variable DEF employed to capture the effect of externalities occurring from the demonstration and imitation effect generated by the R&D activities FAs in IMI turn out to be significant positive, whether DEF is used exclusively or jointly with CEF. This implies that the demonstration and imitation effect generated by FAs is the important channel of positive efficiency spillover to DFs in the IMI. This is an important result, showing that the DFs have capability to absorb the knowledge spillovers generated by FAs in the IMI. Hence, increase in the population of FAs, particularly those with higher technology capabilities may lead to beneficial knowledge spillovers to DFs.

The coefficients of control variables are in line with the results discussed in the previous paragraphs.

8. Concluding Remarks

Adopting a micro-level framework of impact of FDI in an industry, this study empirically examined the following three issues in the context of Indian machinery industry (IMI). First of all, it compared the technical efficiency of foreign affiliates of multinational enterprises (FAs) against the domestic firms (DFs). Secondly, it identified the differences in the determinants of technical efficiency between FAs and DFs. Finally, it examined the presence (or absence) of efficiency spillovers from FAs to DFs in terms of its two major sources: competition effect and demonstration and imitation effect. To examine these issues, we first computed the firm- and year-specific technical efficiency by estimating a stochastic frontier production function with the help of an unbalanced panel of data on a sample of 177 firms for 7 years covering FY 2000/01 to FY 2006/07. Thereafter, we estimated random-effect panel data models of the determinants of firm-level technical efficiency.

One of the important finding of the study is that the FAs as a group maintains higher level of technical efficiency than DFs even after controlling for the additional determinants (both observed and unobserved) of technical efficiency. Another significant aspect of the finding is that the competition effect generated by FAs does not play a positive role in enhancing the efficiency of DFs. Probably, the inefficient DFs have been ousted on account of competitive pressure from the efficient FAs. On the other hand, the demonstration and imitation effects generated by FAs through their R&D activities (i.e.

knowledge spillover) act as the important channel in enhancing the efficiency of DFs. In sum, FDI is found to have efficiency enhancing effect in the IMI. This finding has considerable policy implication for the IMI, which suffers from the adverse impact of high level of imports of finished goods, limited technological capabilities and operational inefficiency. In the post-WTO era, restricting imports and implementation of trade related investment measures are not the feasible options. Beside, this study also indicates that the import of disembodied technology has no impact on technical efficiency despite the IMI entering into maximum number of foreign technological collaboration agreements during August 1991 to July 2007. Given the current policy of Indian Government for 100 per cent equity participation through FDI on an automatic basis in IMI, the firms desiring to expand their base in this industry may consider the option of attracting FDI for building additional capacity and for enhancing their efficiency levels (viz. from knowledge spillovers from MNEs) and thereby upgrading this industry for facing the challenges of the global competition.

Table-1: Descriptive Statistics of Variables for full Sample, 2000/01-2006/07

Variable		Mean	Std. Dev.	Min	Max	Observations
FCD	overall	0.2788	0.4487	0.0000	1.0000	N = 936
	between		0.4301	0.0000	1.0000	n = 177
	within		0.0000	0.2788	0.2788	T-bar = 5.28814
TE	overall	0.7096	0.0816	0.5377	0.9934	N = 936
	between		0.0838	0.5447	0.9932	n = 177
	within		0.0028	0.7025	0.7156	T-bar = 5.28814
GPM	overall	0.1904	0.1173	-0.4871	0.7081	N = 936
	between		0.0979	-0.1754	0.4736	n = 177
	within		0.0683	-0.2759	0.6389	T-bar = 5.28814
SZ	overall	3.4278	1.6245	-0.1372	8.8828	N = 936
	between		1.5575	0.2772	8.5254	n = 177
	within		0.2773	2.1015	4.9944	T-bar = 5.28814
AGE	overall	3.1944	0.7298	0.0000	4.6250	N = 936
	between		0.7373	0.8959	4.6000	n = 177
	within		0.1266	2.0978	3.8896	T-bar = 5.28814
CAPI	overall	4.7216	5.0334	0.2844	50.0000	N = 936
	between		5.0590	0.3259	39.5469	n = 177
	within		1.2665	-4.5606	15.1747	T-bar = 5.28814
AMI	overall	0.0309	0.0333	0.0000	0.2506	N = 936
	between		0.0314	0.0000	0.2197	n = 177
	within		0.0127	-0.0548	0.1597	T-bar = 5.28814
MTI	overall	0.0031	0.0074	0.0000	0.0743	N = 936
	between		0.0060	0.0000	0.0372	n = 177
	within		0.0040	-0.0215	0.0547	T-bar = 5.28814
RDI	overall	0.0035	0.0060	0.0000	0.0398	N = 936
	between		0.0053	0.0000	0.0284	n = 177
	within		0.0027	-0.0093	0.0260	T-bar = 5.28814
LEV	overall	0.3338	0.2526	0.0000	0.9863	N = 936
	between		0.2432	0.0000	0.9577	n = 177
	within		0.1070	-0.1947	0.7288	T-bar = 5.28814
XI	overall	0.1247	0.1736	0.0000	0.9922	N = 936
	between		0.1523	0.0000	0.7551	n = 177
	within		0.0886	-0.3857	0.6732	T-bar = 5.28814
MI	overall	0.0930	0.1027	0.0000	0.5823	N = 936
	between		0.0918	0.0000	0.4633	n = 177
	within		0.0455	-0.1904	0.4421	T-bar = 5.28814
IMC	overall	0.4038	0.1596	0.1256	0.8955	N = 936
	between		0.1523	0.1580	0.7762	n = 177
	within		0.0568	-0.0171	0.6845	T-bar = 5.28814

Table-2: Comparing Characteristics of FAs and DFs-Univariate Method

(Tests of Equality of Group Means)

Variable	Domestic Firms			Foreign Affiliates of MNEs			Tests of Equality of Group Means	
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Welch's d. o. f.	T-stat
TE	675	0.6976	0.0777	261	0.7405	0.0835	445.23	7.176*
GPM	675	0.1800	0.1187	261	0.2175	0.1094	511.39	4.600*
SZ	675	3.1821	1.6779	261	4.0633	1.2766	619.45	8.630*
AGE	675	3.1911	0.7251	261	3.2028	0.7431	463.90	0.218
CAPI	675	4.7699	5.5087	261	4.5967	3.5243	713.20	-0.569
AMI	675	0.0331	0.0347	261	0.0254	0.0287	568.06	-3.455*
MTI	675	0.0016	0.0052	261	0.0070	0.0104	312.36	8.070*
RDI	675	0.0032	0.0058	261	0.0043	0.0065	427.06	2.376**
LEV	675	0.3655	0.2498	261	0.2516	0.2415	489.15	-6.409*
XI	675	0.1131	0.1744	261	0.1548	0.1683	489.91	3.369*
MI	675	0.0705	0.0873	261	0.1513	0.1159	380.61	10.197*

Note: * and ** denote significance levels at 1% and 5% respectively

Table-3: Maximum Likelihood Estimates of Parameters of SFPF

Variable/Parameters	Coefficient	t-ratio
Ln M	0.7059	85.68*
Ln W	0.1399	8.13*
Ln C	0.1004	6.83*
Constant	1.2017	29.17*
Sigma-squared (σ_s^2) $\therefore$ $\sigma_v^2 + \sigma^2$	0.0315	5.62*
Gama (©) = σ^2 / σ_s^2	0.7765	32.13*
Mu (μ)	0.3127	9.44*
Eta (η)	0.0064	0.8357
Log likelihood function	705.57	
LR test of the one-sided error	462.36	
Number of iterations	10	
Number of cross-section	177	
Number of Years	7	
Number of Observations	936	
Number of Observations not in the panel	303	

Note: * shows that the coefficient is significant at one per cent level.

Table-4: Relative Technical Efficiency of FAs and DFs

(Model-1)

Explanatory Variable		Coefficient	Std. Err. (Het Corrected)	Z-stat
FCD		0.0293	0.0060	4.84*
SZ		0.0036	0.0016	2.22**
AGE		-0.0046	0.0037	-1.27
CAPI		0.0024	0.0009	2.69*
AMI		0.5711	0.0738	7.74*
MTI		0.0423	0.2903	0.15
RDI		2.1197	0.4634	4.57*
LEV		-0.0566	0.0093	-6.07*
XD		0.0055	0.0052	1.06
MI		0.0675	0.0279	2.42**
IMC		-0.0472	0.0194	-2.43**
NICD		0.0142	0.0055	2.57*
YD02		0.0028	0.0086	0.32
YD03		0.0047	0.0088	0.54
YD04		0.0078	0.0088	0.89
YD05		0.0076	0.0088	0.87
YD06		0.0063	0.0092	0.68
YD07		0.0100	0.0093	1.07
Constant		0.6805	0.0165	41.34*
Number of obs.				936
Number of groups				177
Obs. per group:	min			2
	avg			5.29
	max			7
Panels		heteroskedastic (unbalanced)		
Auto correlation		no autocorrelation		
R^2				0.24
Wald chi^2 (18)				404.59
Prob > chi^2				0.00

Note: *, ** denote level of significance at 1 per cent and 5 per cent per cent respectively.

Table-5: Differences in Determinants of Technical Efficiency between FAs and DFs (Model-2)

Explanatory Variables	All Firms			DFs			FAs		
	Coef.	Std. Err. (Het-corr.)	Z-stat	Coef.	Std. Err. (Het-corr.)	Z-stat	Coef.	Std. Err. (Het-corr.)	Z-stat
FCD	0.0176	0.0215	0.82	-	-	-	-	-	-
SZ	0.0066	0.0018	3.55*	0.0063	0.0018	3.54*	-0.0037	0.0047	-0.78
AGE	-0.0075	0.0043	-1.76***	-0.0052	0.0045	-1.17	-0.0034	0.0060	-0.57
CAPI	0.0022	0.0010	2.13**	0.0022	0.0010	2.16**	0.0050	0.0016	3.07*
AMI	0.4914	0.0763	6.44*	0.5188	0.0761	6.82*	0.8423	0.2046	4.12*
MTI	0.2175	0.4547	0.48	0.4252	0.4490	0.95	-0.5121	0.3725	-1.37
RDI	1.2048	0.4953	2.43**	1.2674	0.4959	2.56*	3.1826	0.9527	3.34*
LEV	-0.0439	0.0111	-3.96*	-0.0455	0.0109	-4.17*	-0.1063	0.0196	-5.41*
XD	0.0025	0.0059	0.43	0.0041	0.0059	0.69	0.0147	0.0112	1.32
MI	0.0671	0.0374	1.80***	0.0497	0.0346	1.44	0.0123	0.0430	0.29
IMC	-0.0824	0.0207	-3.98***	-0.0794	0.0206	-3.86*	0.0374	0.0440	0.85
NICD	0.0129	0.0063	2.04**	0.0147	0.0063	2.35**	0.0001	0.0119	0.01
YD02	0.0043	0.0100	0.43	0.0032	0.0100	0.33	0.0012	0.0166	0.07
YD03	0.0077	0.0102	0.76	0.0069	0.0102	0.68	-0.0037	0.0165	-0.22
YD04	0.0117	0.0101	1.16	0.0107	0.0101	1.05	-0.0008	0.0165	-0.05
YD05	0.0121	0.0102	1.19	0.0098	0.0102	0.96	-0.0001	0.0162	0.00
YD06	0.0099	0.0109	0.91	0.0094	0.0109	0.86	-0.0015	0.0162	-0.09
YD07	0.0114	0.0111	1.02	0.0135	0.0110	1.22	0.0027	0.0164	0.16
SZF	-0.0120	0.0040	-3.00*	-	-	-	-	-	-
AGEF	0.0067	0.0066	1.01	-	-	-	-	-	-
CAPIF	0.0028	0.0020	1.37	-	-	-	-	-	-
AMIF	0.2709	0.1919	1.41	-	-	-	-	-	-
MTIF	-0.6222	0.5760	-1.08	-	-	-	-	-	-
RDIF	1.9806	0.9863	2.01**	-	-	-	-	-	-
LEVF	-0.0491	0.0194	-2.54*	-	-	-	-	-	-
XDF	0.0117	0.0124	0.94	-	-	-	-	-	-
MIF	-0.0588	0.0562	-1.05	-	-	-	-	-	-
IMCF	0.1199	0.0357	3.36*	-	-	-	-	-	-
NICDF	-0.0118	0.0122	-0.97	-	-	-	-	-	-
YD02F	-0.0057	0.0190	-0.3	-	-	-	-	-	-
YD03F	-0.0114	0.0190	-0.6	-	-	-	-	-	-
YD04F	-0.0126	0.0188	-0.67	-	-	-	-	-	-
YD05F	-0.0137	0.0187	-0.73	-	-	-	-	-	-
YD06F	-0.0128	0.0192	-0.67	-	-	-	-	-	-
YD07F	-0.0099	0.0194	-0.51	-	-	-	-	-	-
CONS	0.6948	0.0170	40.99*	0.6874	0.0182	37.73*	0.7124	0.0375	19.00*
Obs.	936			675			261		
Groups	177			134			43		
R^2	0.24			0.18			0.31		
Wald chi^2	404.59			231.19			143.8		

Note: *, ** denote level of significance at 1 per cent and 5 per cent per cent respectively.

Table-6: Efficiency Spillovers
(Model-3)

Expl. Variable	Coef.	Std. Err. (Het-corr.)	Z-stat	Coef.	Std. Err. (Het-corr.)	Z-stat	Coef.	Std. Err. (Het-corr.)	Z-stat
CEF	-0.0685	0.0346	-1.98**	-	-	-	0.0209	0.0305	0.69
DEF	0.0577	0.0140	4.13*	0.0398	0.0123	3.23*	-	-	-
SZ	0.0076	0.0017	4.49*	0.0083	0.0017	4.90*	0.0068	0.0017	3.89*
LA	-0.0046	0.0044	-1.04	-0.0049	0.0045	-1.09	-0.0053	0.0045	-1.18
CAPI	0.0024	0.0010	2.36**	0.0023	0.0010	2.25**	0.0022	0.0010	2.12*
AMI	0.5179	0.0761	6.81*	0.4791	0.0760	6.30*	0.5015	0.0750	6.69*
MTI	0.5724	0.4538	1.26	0.4983	0.4509	1.11	0.4126	0.4463	0.92
RDI	1.1192	0.4679	2.39**	1.2296	0.4566	2.69*	1.2959	0.4995	2.59*
LEV	-0.0428	0.0112	-3.83*	-0.0453	0.0110	-4.13*	-0.0462	0.0111	-4.16*
XD	0.0040	0.0059	0.69	0.0040	0.0059	0.68	0.0041	0.0059	0.69
MI	0.0353	0.0341	1.04	0.0359	0.0341	1.05	0.0480	0.0346	1.39
IMC	-0.0504	0.0213	-2.37**	-0.0542	0.0215	-2.52*	-0.0771	0.0208	-3.71*
NICD	0.0052	0.0075	0.69	0.0131	0.0061	2.15**	0.0169	0.0075	2.25**
YD02	0.0066	0.0098	0.68	0.0059	0.0098	0.60	0.0034	0.0099	0.34
YD03	0.0057	0.0100	0.57	0.0061	0.0100	0.61	0.0069	0.0102	0.68
YD04	0.0119	0.0100	1.19	0.0114	0.0100	1.14	0.0106	0.0101	1.05
YD05	0.0128	0.0101	1.27	0.0118	0.0101	1.17	0.0098	0.0102	0.96
YD06	0.0102	0.0108	0.94	0.0093	0.0108	0.85	0.0091	0.0109	0.83
YD07	0.0138	0.0110	1.26	0.0124	0.0110	1.13	0.0129	0.0111	1.17
CONST	0.6697	0.0213	31.42*	0.6585	0.0202	32.53*	0.6800	0.0219	31.01*
Obs.	675			675			675		
Group	134			134			134		
R^2	0.20			0.18			0.18		
Wald Chi^2	250.30			234.12			234.12		
Panels	Heteroskedastic			Heteroskedastic			Heteroskedastic		
Autocorrelation	No autocorrelation			No autocorrelation			No autocorrelation		

Note: *, ** denote level of significance at 1 per cent and 5 per cent per cent respectively.

Appendix-1

Productivity Spillovers from FDI in Selected Economies:
Results of the Studies using Firm Level Panel Data Models

No	Authors	Countries	Years	Results
1	Liu (2008)	China	1995-99	−/+
2	Patibandala and Sanyal (2005)	India	1989-999	+
3	Siddharthan and Lal (2004)	India	1993-000	+
4	Kathuria (2001, 2002)	India	1976-89	?
5	Sasidharan and Ramanathan (2007)	India	1994-02	?, −
7	Haddad and Harrison (1993)	Morocco	1985-89	?
8	Aitken and Harrison (1999)	Venezuela	1976-89	−
9	Takii (2005)	Indonesia	1990-1995	Mixed results based on technological gap between FAs and DFs and majority and minority owned plants
10	Djankov and Hoekman (2000)	Czech Rep.	1993-96	−
12	Konings (2001)	Bulgaria, Poland, Romania	1993-97	Rumania and Poland (−); Bulgaria (?)
13	Marcin (2008)	Poland	1996-2003	+
14	Damijan et al. (2003)	Bulgaria, Czech Rep, Estonia, Hungary, Romania, Slovak Rep., Slovenia	1994-98	Rumania (+); others (?, −)
15	Yudaeva, et al (2003)	Russia	1993-97	−/+
16	Sinani and Meyer (2004)	Estonia	1994-99	+
17	Ruane and Ugur (2004)	Ireland	1991-98	?
18	Barry et al. (2005)	Ireland	1990-98	−
19	Piscitello and Rabbiosi (2005)	Italy	1994-97	+
20	Barrios and Strobl (2002)	Spain	1990-94	?

Notes: + or − correspondingly refers to the positive or negative statistically significant coefficient of the spillover (or foreign presence) variable. ? means that the coefficient is statistically insignificant.

Appendix-2

Construction and Measurement of Variables

Construction of Variables used for Estimating Stochastic Frontier Production Function

The data on nominal value of each of the variables employed to represent output and inputs of a firm is collected from the Prowess database for each year of the study. These data include: a) value of production (VoP) that is rupee value of net sales plus net increase or decrease in stock of finished goods, b) aggregate annual expenses incurred by a firm on the purchase of raw materials, components, stores, spare parts, etc. It also includes expenses incidental to the purchase of materials, c) wage bill i.e. a firm's annual staff expenses on payment of wages and salaries, bonus, contribution to and provision for provident, pension, gratuity funds, etc. and d) the original cost of plant and machinery as at the end of a financial year. Since we use many years of data on a firm, we need to compute real values of the same by deflating the value of each input and VoP by the appropriate annual price indices. Hence, we obtained relevant product-wise data on Wholesale Price Index (WPI) for each year of the study from the WPI series published by Office of Economic Advisor (OEA), Government of India. To deflate data on wage bill, we collected data All India Consumer Price Index Numbers (General) for Industrial Worker (CPI) from Labour Bureau, Government of India. In the following paragraphs, we discuss the method of constructing each variable employed for estimation of stochastic frontier production function. In addition, we also explain the justification for and limitation of data utilized for measuring output and input variables.

Output (Y): WPI deflated VoP represents the output (Y) of a firm in our study. To deflate VoP, we have used year-wise data on WPI for a firm's major product group. In this regard, the major product group of each company was matched with the WPI classification, and the matching price series was chosen for the deflation. If the appropriate deflator was not available, the deflator corresponding to the nearest product group is utilized for the purpose. For a few diversified companies operating in various segments of IMI, we have used WPI of IMI as the deflator. The value of production, instead of value added, is employed to measure the output because: (i) the use of the former facilitates the inclusion of material input as another important input of production, that can also be used efficiently (or inefficiently) along with the labour and capital, (ii) the use of value added as a measure of output can yield misleading results if there is imperfect competition or increasing returns to scale (Basu and Fernald 1995). Moreover, the option to employ value added or value of production depends upon whether there are substantial gains in the management and procurement of raw material to firms, and thereby it is essentially an empirical question (Patibandala 1998 and Driffield and Kambhampati 2003). Many Indian studies in recent years have estimated production function with material input as an important independent variable (see e.g. Driffield and Kambhampati 2003 and Banga 2004).

Material Inputs (M): Materials inputs (M) constitute one of the important constituents of production in the business. To remove the effect of year-to-year change in prices, M in this study is deflated by WPI corresponding to the main product group to which M belonged. For this purpose, M of each company was divided into various categories and matched with the WPI classification, and the best available price series was chosen for deflation.

Labour Input (L): Labour input is measured by "*man hours*", "*workers*", "*number of employees*". Indian firms rarely report this information in their annual reports, since the Indian Company Law does not make it mandatory. In view of this, we employ total wage bill, which also reflects the skill composition of employees at firm level (Bhavani and

Tendulkar 2001), as a proxy measure for the labour input in our study. Some scholars in India have preferred to use wage bill as the measure for labour input in their respective studies (see for example Siddharthan and Lal 2004, Ray 2006). Besides, it is normal practice among Indian firms, particularly in the recent years, to outsource a number of manual works to labour contractors. The payments made to labour contractors are included in the wage bill of the firm but the workers employed through the contractors are not included in the payroll of the firm. This makes number of workers as inappropriate measure of labour input. As we use panel data, we deflate total wage bill of a firm in year by the corresponding consumer price index of industrial workers to mitigate the effect of inflation on the wage bill of a firm.
Capital Input (K): Ideally, capital input (K) should be measured by the current replacement cost of the fixed assets of a firm. Nevertheless, the absence of relevant information/data has compelled the researchers to follow alternative methods for measuring capital input in their empirical studies. One such widely used method captures K by the gross (or net) fixed assets of a firm either in nominal term as given in the annual report of a firm or more satisfactorily in real term, which is calculated as gross (or net) fixed assets deflated by an appropriate price index. We also follow the similar method. To capture K, however, we utilise data only on the original cost of plant and machinery (or gross fixed stock of capital), rather than the gross fixed assets that includes the original cost of land and building as well. We exclude land and building from the gross fixed assets as many companies use rented premises and the value of land can be significantly under (or over) estimated in the Indian conditions. We do not use data on net fixed cost of plant and machinery because many Indian companies manipulate data on depreciation and machineries are used even beyond their life span. The above method has a drawback for it does not take into account the fact that the fixed assets of a firm involve assets of different vintages bought at different points of time and thereby proves inconsistent with the ideal current replacement cost 'measure'. To eliminate the vintage effect, some scholars (e.g. Goldar et al. 2004 and Kathuria 2000, 2001) have used *perpetual inventory* method, which requires detailed information on the age structure of capital assets, a long time series of data on gross fixed capital stock, the benchmark capital value, etc. In the absence of such data, the researchers make number of assumptions, which are sometimes unrealistic. Hence, we do not use perpetual inventory method, despite the limitation of the method selected for this study.

Measurements of Variables used for Explaining Technical Efficiency

***FAs, DFs and FCD*:** We adopted an appropriate and objective criterion for segregating sample firms into two ownership groups, FAs and DFs. This criterion was mainly based on certain provisions of the Indian Company Act 1957, which states that an investor can block special resolution in a company by holding a minimum of 26 per cent of equity in the paid-up share capital of a public limited company. Following this criterion, we defined a sample company as FA if a foreign promoter holds at least 26 per cent share in the paid-up capital of the company. Accordingly, DF is referred as a company having less than 26 per cent equity by a foreign promoter. A further checking on the FAs revealed that each one of them had affiliation with a reputed MNE. FCD assumes value 1 for a FA and 0 for a DF.
Capital Structure (LEV): In the empirical research, two ratios are normally utilised to measure leverage: (i) long-term debt to total debt plus market value of equity and (ii) long-term debt to long-term debt plus market value of equity. In this study, we specifically measure the leverage of a firm by the ratio between the medium and long-term debts and net worth. The medium and long term debts of a company include the debt of over one year maturity. Net worth is the summation of equity capital and reserves

and surplus. In the reserve and surplus, we do not include revaluation reserves. We represent this ratio by LEV, higher LEV of a firm (relative to other firms) means that it is financing greater proportion of its assets by debt than by owned fund (i.e. net worth).

Firm Size (SZ): Sales turnover is a most commonly used measure of firm size in empirical studies on manufacturing sector. We approximate sales turnover by net sales (NS), which equals gross sales minus indirect taxes. NS does not include other income from non-recurring transactions, income of extra-ordinary nature and prior period income. We follow this concept but measure firm size (SZ) by natural logarithmic value of net sales of a firm in a year. This measure of firm size has advantage over measuring size by absolute value of net sales as the former reduces degree of variability in size across firms, and thereby avoids the problem of heteroskedasticity in the estimation of the regression equations.

Age of a Firm (AGE)**:** Age of a firm is measured by the number of years of operation of a firm which is the difference between the year of presence in the sample and the firm's year of incorporation to. As every year of operation may not add significantly to the experience or oldness, we use natural logarithm of age (AGE) to represent the age of a firm.

Capital intensity (CAPI): Capital intensity (CAPI) is measured by the ratio of the original cost of plant and machinery to wage bill of a firm in a year.

Product Differentiation **(AMI):** We measure product differentiation advantage of a firm by its advertising and marketing intensity (AMI), which the ratio of sum of a firm's expenditure on advertising and marketing to net sales in financial year. The advertising expenses include expenses on launching, promotion and publicity of goods, etc. and marketing expenses comprises commission paid to selling agents, discounts, rebates, etc.

Export Intensity (XD): XD is a dummy variable assuming value 1 for exporting firm and 0 for non-exporting firms in a year. We define a firm as exporting, if its mean export intensity equals at least one per cent during the various years of its presence in the entire period of study.

Intensity of Imported Intermediate Goods (MI): MI is a ratio between c.i.f values of imported inputs to net sales of a firm in a FY. The imported inputs include raw material, stores, spare parts, capital goods, etc. We use combined value of imported inputs as some firms do not report reliable data on import of capital goods and raw materials separately and also both the components of imports provide benefits of foreign networks for exports.

Intensity of Imported Disembodied Technology (MTI): Indian firms import disembodied technology from a foreign technological collaborator against the payment of royalty and technical fee and /or lump-sum payments for obtaining technical know-how, use of patents, engineering services, drawings and designs, brand names, trademarks and the like, etc. The royalty is normally paid on the recurring basis as a certain percentage of domestic sales and/or of exports while technical fee may be paid on lump-sum basis as one-time payments. The sum of royalty (net of tax) and lump sum payments may approximate that part of technological capability of a firm, which is acquired by the import of disembodied technology. We measure intensity of imported disembodied technology of a firm by the ratio of sum of royalty and lump sum payment to net sales.

Index of Market Concentration (IMC): In order to construct IMC, we first categorise the IMI into 8 sub-industries (SI1,….,SI8) with the help of facilities provided in PROWESS. A minimum 51 per cent of gross sales made up from a sub-industry in a particular financial year is used as the norm for this reclassification. IMC is calculated as the sales weighted average of an index of a four-firm seller concentration ratio (SCR4) of each of the sub-industries of IMI in which a firm operates. The SCR4 is defined as the share of sales of four largest firms taken together in gross sales of a sub-industry of IMI.

Since a sample firm may operate in one or multiple sub-industries belonging to IMI, we calculate a weighted average of SCR4 to obtain firm-specific IMC. The weight is calculated as ratio of a firm's sales revenue generated from an individual sub-industry to gross sales of the firm in a year. The procedure of calculating IMC can be more clearly illustrated by the following example. If a firm's gross sales of Rs.15 crore generated from sale of Rs.10 crore worth of bearings (SCR4 = 0.90) and Rs. 5 crore worth of pumps (SCR4 = 0.30), IMC applicable to the firm would be 0.70 (10/15*0.90 + 5/15*0.30).

Foreign Presence: To measure foreign presence in a sub-industry of IMI, we employ three variables competition effect (CEF), demonstration and imitation effect (DEF) and information effect (IEF). We measure CEF by the weighted average of FAs' share in gross sales of each of the sub-industries of IMI in which the firm operates. The procedure of obtaining the measure of CEF can be illustrated by following example. Suppose a firm operates in two sub-industries, namely, bearing and pumps and its gross sales of Rs.15 crore constitutes Rs.10 crore worth of bearings (FS = 0.30) and Rs. 5 crore worth of pumps (FS = 0.15). Hence, the CEF applicable to the firm would be 0.25 = {10/(15*0.30)} + {5/(15*0.15)}. We approximate DEF by the FAs' share of R&D in total R&D expenditure of a sub-industry scaled by share of FAs in R&D expenditure of all firms in the sample. IEF is measured by the FAs' share of exports in the total export of a sub-industry scaled by share of FAs in exports of all the firms in the sample.

***Year-specific Dummy Variables*:** To account for developments over the period of study, we employ six year-specific additive dummy variables, YD02, YD03, YD04, YD05, YD06 and YD07 corresponding to the years 2001/02, 2002/03, 2003/04, 2004/05, 2005/06, 2006/07. The dummy variable YD02 takes value 1 for the year 2001/02 and 0 for other five years; YD03 assumes value 1 for the year 2002/03 and 0 for other five years; YD04 takes value 1 for the year 2003/04 and 0 for other five years; YD05 takes value 1 for the year 2004/05 and 0 for the other five years; YD06 takes value 1 for the year 2005/06 and 0 for other five years; YD07 takes value 1 for the year 2006/07 and 0 for other five years. We do not use any dummy variable for the reference year 2000/01 to avoid dummy variable trap.

Notes

[1] The Resources Based View (RBV) divides resources into two major heads, namely *tangible resources* and *intangible resources* or *assets*. The tangible resources include financial, physical and human capital. Intangible resources (or assets) consist of intellectual property rights (e.g. trademarks, patents, copyrights, registered designs, and brands), contracts (viz. agency agreements, license agreements, property lease), organizational and marketing expertise, trade secrets, reputation or goodwill and networks with customers, suppliers, government organizations, research institutes, etc. The *capability* is defined as a capacity to perform some task or activity by effective cooperation and coordination of team of resources for maximizing efficiency. Thus, RBV considers *resources and capabilities* to have efficiency enhancing impact on a firm (Peteraf and Barney 2003).

[2] Knowledge externalities or spillovers at firm level is defined as the diffusion of knowledge created by one firm or a group of firms (e.g. MNEs) to the other firm or group of firms (e.g. DFs in our case) without the latter (fully) compensating to the former (Javorcik 2008 and Smeets 2008). The knowledge spillovers differ from knowledge transfer or technology transfer in the sense that the latter involves voluntary diffusion or transfer of knowledge creating no externality (Smeets 2008).

[3] Refer to Jungnickel (2002), Bellak (2004) and Lipsey (2007) for literature on comparative performance of FAs and DFs and Lall and Narula (2004) ans Smeet (2008) on knowledge spillovers.

[4] Data on cumulative inflow of FDI in India during August 1991 to July 2007 show that: i) the share of manufacturing sector constituted about 56 per cent of cumulative inflow of FDI of about Rs. 2150 million (or USD 50.4 billion) in the country; ii) within the manufacturing sector electrical and electronic equipments (including computer software) received the highest amount with the share of 32.5 per cent, followed by transport equipment industry with the share of 13.6 per cent, chemicals and fertilizers industry with the share of 8.6 per cent and IMI with the share of only 5.1 per cent (GoI, 2008).

[5] These shares are calculated from the data obtained from PROWESS on mean of net sales of each firm for the maximum 7 years and minimum 2 years period between 2000/01 to 2006/07.

[6] Expenses on generation and development of FSA and auxiliary services like training, controlling, etc are counted as expenses of the headquarters of MNEs but the FAs derives the benefits of the same without incurring any cost or by incurring minimal cost. DFs, on the contrary, have to bear the full cost of such assets or services.

[7] Hallward-Driemeier et al (2002) used questionnaire survey covering 2700 manufacturing firms from the five East Asian countries Indonesia, Korea, Malaysia, the Philippines and Thailand. Their regression analysis revealed that, even after controlling for sector, size and export orientation, FAs have higher productivity than DFs in all countries except Korea.

[8] The higher gap in technological capabilities leads to lower domestic linkages for sourcing raw material and intermediate goods.

[9] Lipsey and Sjöholm (2005) consider heterogeneity in characteristics of host economies to be the most likely source of inconclusiveness of empirical research.

10 The frontier production function techniques yield maximum output as against the conventional production function techniques, which give an estimate of the mean output.

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