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DIFFERENTIAL IMPACT OF JAPANESE AND U.S. FOREIGN DIRECT INVESTMENTS ON PRODUCTIVITY GROWTH: A FIRM LEVEL ANALYSIS

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Contents

Foreword i

1. Introduction..1

2. Trends in Japanese and U.S. FDI in India 3

3. Impact of FDI on Productivity Growth: Earlier Studies.......................................5

4. Is Source of FDI Important? 7

5. Data and Variables...10

6. Methodology 15

7. Empirical results using "Time-variant firm specific" Technical Efficiency Approach...19

8. Empirical Results using DEA 21

9. Conclusions...24

References 26

Foreword

Studies have found the impact of FDI on productivity growth to be firm-industry-host economy specific. However, the impact of FDI on productivity growth of the firm may differ with respect to the source of FDI since different source countries may come with different levels of technology; have different modes of transferring technology; follow different output and investment strategies; operate at different efficiency levels; and have different motives for undertaking investments.

The paper examines the impact of Japanese and U.S. foreign direct investments (FDI) on total factor productivity growth of the firms in Automobile, Electrical and Chemical industries in the post reforms period. It undertakes industry specific firm-level comparisons of total factor productivity growth, efficiency change and technological progress in Japanese-affiliated, U.S.-affiliated and domestic firms in this period. A "time-variant firm specific" technical efficiency approach is used to estimate total factor productivity growth (TFPG) of firms in the industries. Further, a deterministic production frontier is estimated using Data Envelopment Analysis (DEA). Malmquist indices are reported and TFPG of a firm is decomposed into total factor productivity change arising out of efficiency change and change in technology. Comparisons of these components are undertaken in each industry for the three groups of firms for the period 1993-94 to 1999-2000. The results show that most of the TFPG in Japanese firms is explained by efficiency growth while most of the TFPG in U.S.-affiliated firms is explained by technological progress. An important result arrived at by the study is that in the post reforms period, domestic firms have witnessed both efficiency growth and technological progress in electrical and chemical industries. This indicates "catching-up" with the higher productivity levels of the foreign firms in the same industry.

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Differential Impact of Japanese and U.S. Foreign Direct Investments on Productivity Growth: A Firm Level Analysis

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1. Introduction

The Indian government in the post-liberalisation period has slowly but steadily tried to facilitate the inflow of foreign direct investment (FDI) into different sectors of the economy. FDI is sought because it is expected not only to augment investible resources but, more importantly, to improve technological standards, efficiency, and competitiveness of domestic industry. FDI is also associated with bringing in of "relatively" later technology into the industry since markets for technology are imperfect. However, studies on the impact of FDI on productivity growth suggest that the exact nature of the impact of FDI depends on the firm-industry-host economy specific factors. These include the technological levels prevailing in the industry, the learning capabilities of the firms and the absorptive capacity of the host economy, which determines the rate of technical diffusion of the technology (Aitken and Harrison 1999, Kokko et al., 1996).

But, hardly any study has taken into account the source of FDI while examining the impact of FDI on the productivity growth of a firm[1]. Foreign direct investments come from different sources. These sources of FDI are likely to operate at different levels of technology, follow different modes of transferring technology, operate at different efficiency levels, have different managerial and entrepreneurial capabilities and have different motivations for undertaking investments, depending on the economic and

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[1] None is available for the Indian economy.

financial environment of their respective home countries. It is therefore possible that they have differential impact on the productivity growth of a firm.

For our comparative analysis, we select FDI from two source countries, namely, Japan and U.S. The reasons for selecting these two countries are twofold. Firstly, since mid 1980s till about mid 1990s the percentage share of both U.S. and Japan in the total stock of FDI in India has risen steadily. The second reason for selecting these two source countries of FDI is that the differences in the nature of FDI from Japan and U.S. have been studied extensively in the literature and therefore warrants a comparison in the context of the Indian economy. The paper thus attempts to analyse whether the source of foreign direct investment in a firm has an impact on its productivity growth.

The analysis is carried out for the Indian manufacturing sector and productivity growth of Japanese-affiliated, U.S.-affiliated and domestic firms is compared in three broad industrial categories, where both Japanese and U.S. firms are significantly present, namely, Automobile, Electrical and Chemicals for the period 1993-94 to 1999-2000. Estimations are undertaken at three levels. First, total factor productivity growth (TFPG) is estimated using “time-variant firm specific" technical efficiency approach (parametric approach) and average TFPG in Japanese-affiliated firms is compared to that in U.S.-affiliated and domestic firms. Second, the impact of source of affiliation on TFPG of a firm is estimated using least square regressions on seven year averages. Finally, to investigate to what extent inter-firm differences exist in explaining TFPG and to what extent is TFPG in a firm explained by technical progress and efficiency growth, Data Envelopment Analysis (non-parametric approach) is carried out and Malmquist indices are estimated using panel data in the three industries.

The rest of the paper is organised as follows: Section 2 briefly analysis trends in Japanese and U.S. FDI in India in the post reforms period. Section 3 examines the literature related to the impact of FDI. Section 4 discusses why the source of FDI matters? Section 5 describes the data and variables used. Section 6 discusses the different methodologies used to estimate production frontier. Sections 7 and 8 present empirical results with respect to the parametric and non-parametric approaches used respectively. Finally Section 9 summarises and concludes.

2. Trends in Japanese and U.S. FDI in India

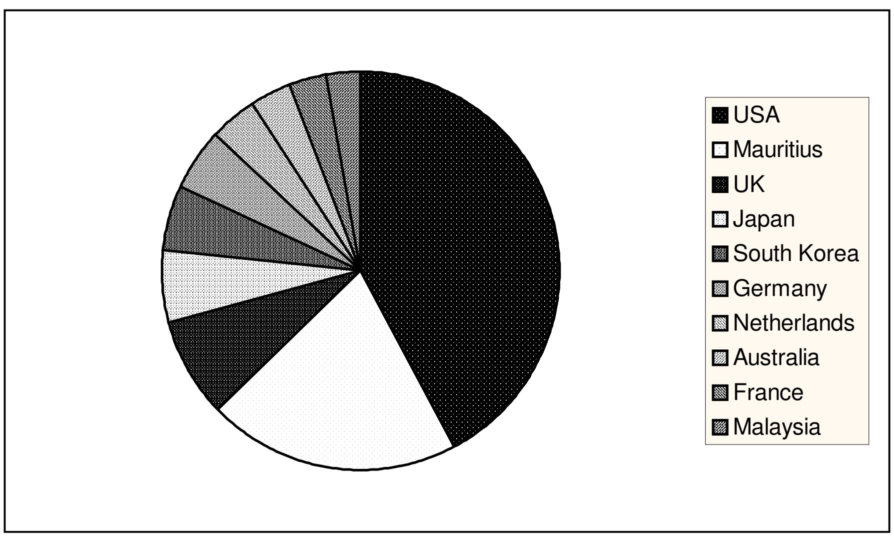
Foreign Direct Investment in India assumed critical importance in the context of the economic reforms process initiated in 1991. Raising the inflows of FDI substantially was taken as one of the key objectives of industrial and trade reforms. The reforms were accompanied by a rapid increase in inflow of foreign direct investment (FDI) into the Indian economy. FDI inflow rose from around USD 300 million in 1992-93 to more than USD 3 billion in 1997-98. However, it declined in 1998-1999 to around USD 2 billion, partly due to a decline in investment from the East Asian countries as they struggled with their economic downturn. But the ratio of FDI inflows to GDP increased from 0.5% in 1999 to 0.9% in 2001[2].

With respect to the source of FDI, since mid 1980s the relative importance of FDI from Japan and U.S. in India has risen steadily. In the period 1991 to 2001, we find

[2] UNCTAD 2003

that the share of U.S. increased to about 24% of total FDI, while the share of Japan increased to about 8% in mid 1990s. The share of countries like U.K. and Germany, however, declined over this period. It is worth noting that the U.S. multinationals increased their operations in India as early as the 1960s, while the Japanese multinationals entered India as late as the 1980s. However, in spite of their late entry, in the 1990s, Japan emerged as the third largest investor in India after U.S. and U.K. Comparing the shares of top ten investing countries in India during the period 1991 to 2001 (which is around 50.16% of total FDI inflows), we find that over 20% of FDI in this period has come from the U.S., followed by U.K. with a share of around 4% and then Japan with a share of around 3 %[3].

Figure 1. Share of Top Ten Countries in FDI Inflows (Actual) during 1991-2001



An examination of sector-wise distribution of outstanding FDI from different source countries in the year 1995 reveals that the industrial distribution of FDI differs significantly with respect to the source of FDI in the Indian manufacturing sector

[3] FDI from Mauritius can be ignored as many countries routed their FDI through Mauritius since it was considered as a tax haven. Source of the figures is Secretariat of Industrial Assistance Newsletter August 2001, Ministry of Industry, GOI.

(Table 1). Comparing the shares of foreign direct investments from U.S. and Japan we find that in 1995, 60% of Japanese FDI concentrated in the transport equipment industry, while the share of U.S. FDI in this industry was only 5% and around 30% of U.S. FDI concentrated in the chemical industry, while the share of Japanese FDI in this industry was only 8%. Regarding the electrical industry we find that around 15 per cent of U.S. and 14 per cent of Japanese FDI entered this industry.

Table 1: Sector-Wise Distribution of Outstanding FDI in March End 1995 in India by Source Country (%)

Industry	UK	U.S.	JAPAN	GERMANY	SWEDEN
Plantation	16.76	0.04	0.00	0.00	0.00
Mining	0.91	0.00	0.00	0.00	0.00
Petroleum	6.19	1.10	0.00	0.00	0.00
Manufacturing of which:	71.85	91.72	88.47	96.20	85.95
Food & beverages	17.29	4.61	3.34	0.25	0.96
Textiles	6.24	0.38	0.48	5.31	0.00
Transport equipment	9.84	5.28	60.57	22.22	0.00
Machinery & Tools	8.36	15.90	1.43	18.89	64.42
Metal & Metal products	5.18	1.78	0.95	3.46	5.77
Electrical goods	3.01	15.61	13.67	18.27	17.31
Chemicals & Allied	41.78	30.55	8.27	21.98	3.85
Others	7.88	25.89	11.29	9.63	7.69
Trading	1.86	0.93	2.81	1.19	0.00
Construction	0.72	0.53	0.70	0.36	0.00
Transport	0.04	0.00	0.00	0.00	0.00
Utilities	0.00	0.48	0.00	0.00	0.00
Financial	0.80	1.63	6.19	0.00	0.00
Others	1.18	3.57	1.83	2.26	14.05
Total	100	100	100	100	100

Source: RBI Bulletin 1999

Given the above industrial distribution it can be said that though both Japanese and U.S. FDI concentrate in manufacturing sector, but comparisons of the operations of these firms can be undertaken only in few industries, where they are both simultaneously present.

3. Impact of FDI on Productivity Growth: Earlier Studies

Literature related to the direct impact of FDI has emphasised that FDI, due to the resources associated with it and the attributes embedded in it is expected to provide a package of tangible and intangible wealth-creating assets. These assets become available directly for use in productive activities in the host countries and are further amplified by externalities and spillovers that strengthen the resource base and production capabilities in developing economies. The very presence of FDI in an industry is also expected to improve the average productivity and skill levels of the industry since MNCs are associated with higher efficiency levels due to their ownership and internalisational advantages (Caves 1974b, Dunning 1973).

Another direct impact of FDI, which goes far in promoting productivity growth in a firm is that foreign affiliates give an access to technology particularly through imports of capital goods. Such technology is exported through FDI to wholly owned foreign affiliates and joint ventures. This way the foreign firms maintain their competitive advantage by transferring their most recent technology to their affiliates, while selling or licensing older technology to others. For developing countries, therefore, FDI may be the only way to gain access to latest or "relatively" later technology.

The empirical evidence on the impact of FDI is however, mixed. Some studies e.g., Caves (1996), Globerman (1979), Blomstrom and Wolf (1994), Djankov and Hoekman (2000) find that FDI has a positive or weak positive effect on the productivity levels. On the other hand, there are others e.g., Kokko (1994), Kokko, et al., (1996), Aitken, and Harrison (1999) and Haddad and Harrison, (1993), who find that foreign firms have negative effects on the productivity performance of the domestically owned firms. But, these studies together establish the fact that the impact of FDI is industry-firm-host economy specific.

For the Indian economy, Goldar (1995) and Kathuria (2000, 2001) have studied the impact of FDI on productivity growth of Indian firms. The study by Goldar examines the impact of technology acquisition via FDI on TFPG for the period 1987-88 to 1989-90. His results do not reveal any strong positive effect of the technology acquisition accompanying FDI on productivity growth. The study of Kathuria indicates that there exists positive spillovers from the presence of foreign-owned firms, but the nature and type of spillovers vary depending upon the industries to which the firms belong and also on the R&D capabilities of the firms. However, as mentioned earlier, hardly any of the studies in the literature have tried to disaggregate the impact of FDI from different sources and compare them. The paper is an attempt in this direction. It tries to bring out differences in the productivity growth of foreign affiliates from different source countries and their impact on the TFPG of the firms.

4. Is Source of FDI Important?

The inherent differences in the foreign direct investment originating from different source-countries i.e., Japan and the U.S. were first discussed by Kojima (1973). Though Kojima's approach is criticised on various grounds, it has nevertheless led to a vast theoretical and empirical literature comparing various aspects of the nature and the impact of Japanese and U.S. multinational corporations. Of this vast literature, some of the important empirical studies that have compared operations and impact of these firms in the same host country are Kojima (1991), Schroath, Hu and Chen (1993), Dunning (1994), Encarnation (1999), Ravenhill (1999), Banga (2003b). and These studies have together brought out some important differences in the ownership advantages, organizational structures, motives, technology levels and management practices of Japanese and U.S. firms, which we discuss now.

It is generally argued that Japanese firms behave differently from other firms, either because of their protected domestic base or because they have different financial and institutional structures. (Graham and Krugman 1995). A much established fact discussed in the literature is that in terms of their industrial distribution, U.S. FDI in manufacturing is usually undertaken in most technologically sophisticated industries with not yet standardised products that are more capital-intensive in nature while Japanese FDI generally enter industries that are less capital-intensive producing standardised products that are less technology-intensive. Schroath, Hu and Chen (1993) also find that U.S. has a higher proportion of its joint ventures in the high technology category as compared to Japan and these results are supported by the study of Balassa, and Marcus (1990).

As a result, it is found that US FDI is largely undertaken by large firms while Japanese FDI is largely undertaken by small and medium sized firms. This implies that the level of technology at which they operate may differ. Further, the mode of transfer of technology by the Japanese firms which is termed as “orderly transfer” of standardised production and it differs significantly from the American "reverse-order" transfer of technology (Kojima 1978). Along with their size and mode of technology transfers, firms from these two source countries are also found to differ with respect to their corporate governance, financial structures and output & investment strategies in Indian manufacturing industries[4]. With respect to their management objectives, it is pointed out that while short-term profits are important for U.S. firms, it is the long-term profits that the Japanese firms aim at.

[4] See Banga (2002).

Dunning (1994) finds that the ownership advantages of Japanese and U.S. firms also differ. In the 1970s and 1980s the ownership advantages of Japanese essentially comprised of their capability to co-ordinate and manage the resources and capabilities within their jurisdiction so as to minimise their transaction costs whereas the ownership advantages of US firms, when they started their operation in 1950s and 1960s, were primarily based on their ability to innovate new products and production processes.

Comparing the impact of Japanese and U.S. FDI, Kojima (1991) finds that in most cases Japanese FDI contribute to the development of the host country with greater efficiency than American FDI. The impact of Japanese FDI as compared to U.S. FDI is also found to be higher in terms of productivity spillovers in the Indian manufacturing sector by Banga (2003a). Doyle, Saunders and Wong (1992) compare the goals and strategies of American, Japanese and British multinational corporations (MNCs) and find that American subsidiaries are more oriented towards delivering short-term profits and less adapted to local market conditions than their Japanese competitors. Some of the recent studies have also found differences in the operations of Japanese-affiliated and U.S.-affiliated firms operating in the same host country. In a study by Encarnation (1999) that compares American MNCs, Japanese and other Asian MNCs, it is found that as compared to other MNCs, Japanese MNCs still sell more of their output in the markets at home or in third country.

Ravenhill (1999) identifies four areas, namely, localization of management, sourcing of components and capital goods, replication of production networks, and distribution of research and development activities, in which Japanese multinational corporations subsidiaries frequently differ in their practices from their U.S. counterparts. This is expected to affect the prospects of technology transfer to the host economy. The study concludes that the subsidiaries of U.S. corporations are more likely than their Japanese counterparts to interact with the host economy in a manner that facilitates local acquisition of technology. Given the results of the above studies, it can be concluded that the source of FDI is important in determining its nature of operations and impact in the host country and therefore should not be ignored.

5. Data and Variables

Data and sample

In order to estimate the productivity growth rates at the firm level, we have collected data from corporate data base Capitaline, produced by Capital Markets Ltd, an Indian information services firm. The database provides panel data for about 10,000 companies that are listed on an Indian stock exchange as well as some unlisted companies. This is the only data source that provides the source of foreign equity ownership in the Indian firms. This data has also been used for comparing the market values of Japanese and non-Japanese firms by Nagaishi (2003). This is supplemented with data taken from various issues of Annual of Survey of Industries (ASI), National Accounts Statistics and some publications of Ministry of Industry.

The analysis is based on data of 276 firms for the year 1993-94 to 1999-2000 in three broad industries i.e., Automobiles, Electrical and Chemical. The criteria used for selecting industries is that only those industries are selected where both Japanese and U.S. foreign direct investments are simultaneously present. Table 2 shows the industrial distribution of Japanese and U.S. FDI in these three industries as found in the Capitaline dataset. FDI inflow is estimated as a proportion foreign equity to total equity invested in the industry. We find that a major share of total equity invested by Japanese and U.S. firms goes to these three industries (65 and 76 per cent respectively). We also find that U.S. FDI concentrates heavily in chemical industry while Japanese FDI concentrates in automobile industry. We therefore control for industry specific effects.

Table 2: Distribution of Japanese Equity and U.S. Equity as a Proportion of Total Equity Invested in Indian Manufacturing Industries in the Period 1993-94 to 1999-2000

Industry	US Equity	Japanese Equity
Automobile	17.74	52.11
Chemical	30.92	4.68
Electrical	16.79	20.17
total	65.45	76.96
others	34.55	23.04
total	100	100

Source: Author's estimations based on Capitaline dataset.
Notes: 1. Proportion of foreign equity to total equity invested in an industry represents FDI.
2. Automobile industry includes auto and auto ancillary; electrical industry includes electrical and electronic equipment; chemical industry includes chemicals (organic and inorganic), personal care and pharmaceuticals.

Variables

The study explains the impact of Japanese and U.S. FDI on TFPG of a firm. As mentioned earlier, the proportion of actual equity invested by the foreign firm to total equity invested in the industry is taken as a measure of FDI. The data on foreign equity is estimated from Capitaline. However, the data on foreign equity invested for the years 1993-94 to 1995-96 is not available. This has been constructed using the ratio of the dividends paid in foreign exchange by the firms to total dividends paid. One of the limitation of this measure is that it may also include the dividends paid to foreign institutional investors. However, this is not expected to be large for this period. All the variables used in the panel data estimation of productivity are measured at constant prices of 1993-94. Deflation of output and inputs has been done with help of suitably constructed deflators.

A major improvement in the construction of input and output variables made by the study is that the earlier studies estimating production function for the Indian manufacturing have used the wholesale price indices to deflate the series on output and inputs of the firms to arrive at the constant prices. However, we have used the actual prices of the major outputs and inputs of the firms to arrive at the indices for deflating output and input series of the firms.

There are two sets of variables used for the analysis: (a) variables for the estimation of production function for deriving productivity estimates and (b) variables used in the regression analysis explaining variations in productivity growth. These are discussed in that order.

(A) *Variables for production function estimates:*

Output: The Capitaline dataset provides data on the major outputs of the firms along with their prices. Weighted output indices are constructed using the prices of two major outputs of the firms. The value (price*quantity) of the output is used as the weights in the series.

Intermediate inputs: Capitaline dataset also provides data on the major inputs used by the firms along with their prices. The total raw-materials consumed by the firms is deflated by the weighted input price series, which is constructed using the actual prices of the inputs. The total cost of the inputs is used as the weights.

Labour: The data on total employee cost of the firms is collected from the Capitaline and the series on number of employees is constructed using the wage-rate in corresponding industries estimated from ASI.

Capital series: The methodology used to estimate capital is that used by Srivastava (1996). However, the deflators used for deflating different series of capital are further disaggregated. Capital stock is taken to consist of Plants and Machinery, Land & Building and other Fixed Assets. Two separate series of capital are constructed i.e., one for Plants and Machinery along with other fixed assets and the other for Land & Building. These are deflated separately to arrive at estimates of capital stock in the base year i.e., 1993-94 for each firm. Data on Gross capital formation in plants & machinery and construction at current and constant prices are collected from NAS and an implicit deflator is arrived at. Applying this implicit deflator, capital stock in the year 1993-94 is estimated. However, since in the base year the firm' s asset mix is valued at historic cost, the value of capital at replacement cost for the current year is arrived at by revaluating the base year of capital. Implicit deflators are constructed for last 15 years in case of plants and machinery of the firms and for last 25 years or the date of incorporation of the firm for construction in the firms.

A revaluation factor (as used by Srivastava) is then applied to each series to obtain capital stock at replacement costs at current prices. Deflating these values we arrive at capital stock in real terms for the base year. Subsequent years investment is then added i.e., Gross fixed assets $_t$ - Gross fixed assets $_{t-1}$ to the capital stock existing at every time period using the perpetual inventory method. The capital stock series is hence arrived at for the firms.

Fuel and power: Energy is an important input in firms' output. Capitaline provides data on expenditure on fuel and power. Weighted price indices are constructed to deflate the expenditure on fuel and power. Wholesale price indices for electricity for industrial purposes and furnace oil from CMIE publications are used. Weights used are the firms' expenditure on oil and power.

(B) Variables used in regression analysis:

The productivity growth of the industry is found to be related to some industry-specific variables like capital intensity in the industry; R&D intensity of the industry, outward-orientation of the industry and policy regulations controlling the industry. To analyse the impact of FDI on the productivity growth of the firms it becomes important to control for these variables. Industry dummies are therefore introduced to control for these industry-specific effects.

The productivity growth of the firms is dependent on firm-specific variables like size of the firms, age of the firms, R&D intensity of the firms, etc. To control for firms-specific variables the following variables are considered:

Firm-specific variables

a) Size of the firm i.e., log of sales of the firm (SIZE)
b) Age of the firm, i.e., date of inception of the firm (AGE)
c) R&D Intensity of the firm i.e., R&D expenditure/sales (R&D)
d) Export Intensity of the firm (XI)
e) Capital-Labour ratio of the firm (K/L)
f) Import of disembodied technology by the firm, i.e., Royalty and Technical fees paid by the firm (IMPDIS)
g) Import of embodied technology, i.e., capital goods by the firm (IMPEMB)
h) Japanese Equity as a proportion of total equity invested in the firm (JE)
i) U.S. Equity as a proportion of total equity invested in the firm (USE)

Among the external factors, competitive pressure is the most important factor that may lead to higher efficiency in the firms. Competitive pressures force the firms to improve their technology and/or make efficient use of the factors of production. This may lead to higher imports of embodied technology, higher imports of disembodied technology and higher research and development expenditures. All these variables are expected to have a positive impact on the technical efficiency of the firms and therefore we control for these variables. Apart from these variables other firm-specific variables that may affect technical efficiency are the size of the firm, age of the firm, export-intensity of the firm and extent of foreign equity in the firm. Size of the firm and its impact on technical efficiency is ambiguous in nature. Large firms may have higher technical efficiency due to economies of scale but labour market imperfections and organisational complexities might be a source of disadvantage to large firms in realising optimal technical efficiency.

Higher capital intensity in the firms may also contribute to a firm' s productive process and so it' s productivity growth over time. We use proportion of capital labour ratio as a measure of capital accumulation in the firms. Not controlling for these firm specific internal and external variables may bias the results. Thus, we control for these variables.

6. Methodology

The estimates are undertaken at three levels, using both parametric and non-parametric approaches. In the first stage, total factor productivity growth is estimated using "time-variant firm specific" technical efficiency approach, first introduced by Cornwell, Schmidt and Sickles (1990). This methodology for estimating TFPG has also been used by Srivastava (1996) and Kathuria (2000) for estimating TFPG. Four inputs based Cobb-Douglas production function is estimated for the three industries. Average TFPG is compared in Japanese-affiliated, U.S.-affiliated and domestic firms.

These estimates are then used in the second stage, where the impact of Japanese affiliation and U.S. affiliation on the TFPG of the firm is examined using seven year averages for 276 firms. Averages are taken so as to smoothen out the impact of the year-to-year fluctuations in demand. Finally, Data Envelopment Analysis (DEA) is undertaken to examine the source of TFPG in a firm.

"Time-variant firm specific" Technical Efficiency Approach:

We estimate a four input production function i.e., with output Y and inputs as material inputs M, labour L, capital K and Energy E. The production function can be written as

$Y_{it} = F_t(L_{it}, K_{it}, M_{it},, E_{it})$

Typically the model to be estimated is Cobb-Douglas representation of technology relating factor inputs and output for a given industry, i.e.,

$Y_{it} = A\, e^{h(i,t)} f_t(L^{\alpha}_{it}, K^{\beta}_{it}, M^{\gamma}_{it}, E_{it})$

Where i index firm and t index time periods. The Hicks-neutral productivity factor, $A\, e^{h(i,t)}$ is allowed to be different across firms and over time. It is further assumed that h(.) can be parametrised as,

$h(i,t) = u(i) + \lambda(t) + v_{it}$

Where $u(i) = u_i$ depends on unobservable differences across firms. $\lambda(t)$ represents productivity and policy shocks common to all industries during any time period and v_{it} represents all other omitted variables and random shocks. A very general parametrisation for $\lambda(t)$ is to impose no structure on it. Alternatively, some structure could be imposed on productivity growth and it can assumed to be linear or quadratic function of time.

Assuming $\lambda(t)$ to be a quadratic function of time it can be written as

$\lambda_{it} = \theta_{i1} + \theta_{i2}t + \theta_{i3}t^2$

$\lambda_{it} = \gamma'_t \theta_{ij}$ where $\gamma_t = (1,t,t^2)$ and $\theta_{ij} = (\theta_{i1}, \theta_{i2}, \theta_{i3})'$.

In discrete time framework, annual productivity growth is measured as $\Delta\ \lambda(t)$. The regression of the residuals on time and time squared is first done and then the predicted values of the residuals in the period t-1 are subtracted from those of period t to get the estimates of productivity growth of the firms.

After arriving at the TFPG of firms we estimate the following model:

$$TFPG_{it} = constant + \beta_1 JE_{it} + \beta_2 USE_{it} + \underset{(+)}{\beta_3 SIZE_{it}} + \underset{(+)}{\beta_4 EXP_{it}} + \underset{(+)}{\beta_5 K/L_{it}} + \underset{(+)}{\beta_6 R\&D_{it}}$$

$$\underset{(+)}{\beta_7 AGE_{it}} + \underset{(+)}{\beta_8 IMPDIS_{it}} + \underset{(+)}{\beta_9 IMPEMB_{it}} + \beta_{10}\ DUMMY_{(AUTO)} + \beta_{11} DUMMY_{(Electrical)}$$

Where i index firm and t index time.

Data Envelopment Analysis (DEA)

To compare TFPG and its components in Japanese-affiliated, U.S.-affiliated and domestic firms in each industry we use non-parametric approach. We construct a deterministic production frontier using linear programming technique. The method used for this is the Data Envelopment Analysis (DEA), which evaluates the performance of a set of peer entities called decision-making units (DMUs).

Using panel data, DEA is used to arrive at input-or-output based Malmquist indices to measure productivity change for each firm over time and decompose this into technological change and technical efficiency change. Fare et al (1994) specifies an output-based Malmquist productivity index as:

$$m_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d^t_0(x_{t+1}, y_{t+1})}{d^t_0(x_t, y_t)} \times \frac{d^{t+1}_o(x_{t+1}, y_{t+1})}{d^t_0(x_t, y_t)} \right]^{1/2}$$

This represents the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t). A value greater than one will indicate positive TFP growth from period t to period t+1. This index is the geometric mean of two output based Malmquist TFP indices. One index uses period t teschnology and the other period t+1 technology.

One of the disadvantages of using a stochastic approach is that the stochastic estimations incorporate a measure of random error. This involves the estimation of a stochastic production frontier, where the output of a firm is a function of a set of inputs, inefficiency and random error. As a result it imposes an explicit functional form and distribution assumption on the data. In contrast, the linear programming technique of DEA does not impose any assumptions about functional form, hence it is less prone to mis-specification and therefore it is not subsequently subject to the problems of assuming an underlying distribution about the error term. However, since DEA does not take into account statistical noise, the efficiency estimates may be biased if the production process is largely characterised by stochastic elements.

Using panel data for 276 firms for the years 1993-94 to 1999-2000, DEA is used to further explain the components of TFP growth, i.e., it shows to what extent of TFP growth can be explained due to change in technology (that is caused by the frontier shift) and change in technical efficiency (defined as the distance from the efficiency frontier which is derived from some efficient units for each firm and for each year). The average over the years is also reported. The decomposition of TFP change into these two components makes it possible to understand whether the firms have improved their productivity levels through a more efficient use of existing technology or has technical progress occured.

7. Empirical results using "Time-variant firm specific" Technical Efficiency Approach

Table 3 compares average annual total factor productivity growth rates of Japanese-affiliated, U.S.-affiliated and domestic firms, arrived at by the "time-variant firm specific" technical efficiency approach. Along with these averages of some other industrial characteristics of these firms in the selected industries during the period 1993-94 to 1999-2000 are also compared. The total number of the firms considered are 276; out of which around 153 firms are domestic firms, 78 firms are U.S.-affiliated firms and 45 are Japanese-affiliated firms. The results show that the average annual TFPG in the firms has been very low, in fact it is less than one percent in this period. TFPG has been highest for the Japanese firms. However, interestingly, the average TFPG of domestic firms is found to be higher than that of the U.S. firms. This shows that all foreign firms may not be alike in their operations even if they operate in the same industry of the host country.

The R&D intensities are higher for the Japanese firms as compared to the U.S. firms. The imports of disembodied technology is highest for domestic firms, while the import of embodied technology is highest for the U.S.-affiliated firms though it is higher for domestic firms as compared to Japanese-affiliated firms. This can be taken as indicative of the efforts made by the Indian firms to "catch-up" with the foreign firms in the same industry.

Table 3: Comparison of Average TFPG and some Industrial Characteristics of Japanese, U.S. and Domestic firms: 1993-94 to 1999-2000

	Domestic firms		U.S. Firms		Japanese Firms	
	Mean	σ	Mean	σ	Mean	σ
1. TFPG	0.70	0.04	0.40	0.04	0.90	0.03
2. R&D intensity	0.40	0.001	0.10	0.003	0.30	0.004
3. Import of disembodied technology/ total sales	0.90	0.004	0.40	0.001	0.70	0.002
4.Import of embodied technology/ total sales	0.60	0.01	0.70	0.04	0.50	0.01
No.of firms	153		78		45	

The figures reported are in percentages

To examine the impact of foreign equity from different sources on TFPG of a firm least square estimations are undertaken and the following results are arrived at:

$$\underset{}{TFPG} = \underset{(0.83)}{0.03} + \underset{(2.23)}{0.09\ JE^{***}} + \underset{(0.67)}{0.03\ USE} + \underset{(1.00)}{0.02\ SIZE} - \underset{(-1.51)}{0.61\ EXP} + \underset{(1.27)}{0.09\ K/L} + \underset{(2.46)}{0.009\ R\&D^{***}}$$

$$\underset{(-1.52)}{-0.02\ AGE} + \underset{(2.90)}{2.74\ IMPDIS^{***}} + \underset{(1.00)}{5.10\ IMPEMB} + \underset{(1.84)}{0.10\ DUMMY^{**}_{(AUTO)}} + \underset{(0.87)}{0.04\ DUMMY_{(ELECT)}}$$

*indicates significant at 10%;** indicates significant at 5%;*** indicates significant at 1%.
Figures in the parenthesis are the t-ratios.
Adj R Squared = 0.23, N = 276, White Statistic = 1.98

The results show that foreign equity, when disaggregated by its source, has differential impact on productivity growth of a firm. We find that Japanese equity in the firm leads to higher productivity growth, after controlling for other firm-specific and industry-specific effects. U.S. equity, on the other hand, does not have a significant impact. The other characteristics of the firms that lead to higher productivity growth are the R&D intensity of the firms and import of disembodied technology by the firm. These variables are also found to be important determinants of productivity growth in Indian firms by Basant and Fikkert (1996). The age and export-intensity of the firm appear with negative signs but they are not significant.The industry specific dummy with respect to the automobile industry is found to be the automobile industry. This industry also has higher presence of Japanese affiliated firms as compared to U.S. affiliated firms. The results thus show that affiliation with foreign firms of different country-of-origin may lead to differential impact on TFPG of a firm.

8. Empirical Results using DEA

The TFPG in a firm can however occur either due to technological progress, i.e., due to shift in the production function or due to efficiency improvements in the firm. In an attempt to analyse the reasons for differential productivity growth with respect to the source of FDI in these firms, we first examine the extent of efficiency growth and technological progress in these firms in each industry. DEA analysis using panel data set is undertaken and output-oriented Malmquist indices are estimated which are further disaggregated into technical efficiency change indices and technological change indices.

However, one of the limitations of DEA approach is that it gives “relative” efficiencies of DMU, i.e., a firm is compared to its peers but not compared to a “theoretical maximum”. This makes DEA results sample specific. Comparisons of firms across industries are therefore avoided. But within an industry we compare the average efficiency change, technical change and total factor productivity change in Japanese-affiliated, U.S.-affiliated and domestic firms in this period. The results are reported in Table 4.

The results show that domestic firms in all the three industries have experienced an average positive total factor productivity change in the post reforms period and this has been very impressive in the electrical and chemical industry but very miniscule in the automobile industry. The comparative result of Japanese-affiliated, U.S.-affiliated and domestic firms in Automobile industry show that average TFP change is higher in Japanese firms as compared to domestic firms. However, US-affiliated firms have witnessed, on an average, a slight decline in TFP index. Most of the TFP change in domestic firms can be explained by the change in technology (technical progress) but most of the TFP change in Japanese firms is explained by improved efficiency levels. But results for US-affiliated firms are similar to those of domestic firms in this industry. These firms have witnessed technical progress accompanied by an average decline in their efficiency.

Table 4: Average Total Factor Productivity Change, Efficiency Change and Technological Change in Japanese-affiliated, U.S.-affiliated and Domestic Firms over the period 1993-94 to 1999-2000.

IND	Number of Firms	FIRMS	EFFCH	TECHCH	TFPCH
Automobile	37	DOM	0.996	1.022	1.007
			(0.05)	(0.04)	(0.05)
	17	JAP	1.039	0.960	1.028
			(1.37)	(0.25)	(1.58)
	13	US	0.977	1.029	0.995
			(0.12)	(0.11)	(0.07)
Electrical	51	DOM	1.014	1.029	1.033
			(0.15)	(0.15)	(0.15)
	17	JAP	1.027	0.990	1.008
			(0.10)	(0.11)	(0.07)
	28	US	0.998	1.019	1.008
			(0.13)	(.010)	(0.09)
Chemicals	67	DOM	1.074	1.039	1.049
			(0.81)	(0.24)	(0.33)
	11	JAP	0.993	1.023	1.010
			(0.10)	(0.09)	(0.09)
	35	US	0.999	1.021	1.013
			(0.11)	(0.10)	(0.09)

Figures in parenthesis are the standard deviations. TFP change is decomposed into efficiency change, technology change, scale efficiency change and pure efficiency change. Scale efficiency change and pure efficiency change figures are not reported.

With respect to the electrical industry, we find that the domestic firms in this industry have experienced a high average TFP growth of 3.3 per cent but Japanese and U.S. affiliated firms have witnesses almost similar TFP growth. However, an important difference between the two is that much of the productivity growth in Japanese-affiliated firms is explained by their efficiency growth while change in technology explains most of the change in TFP in the U.S. affiliated firms.

Interestingly, in the chemical industry we find that the domestic firms have experienced both positive efficiency change and technological progress. The average change in TFP experienced by them is 4.9 per cent with a higher proportion of it explained by efficiency changes. Japanese firms, however, witness a fall in their average efficiency growth though there is technological progress witnessed by these firms. U.S.-affiliated firms experience a marginal decline in their average efficiency growth but technological progress leads to a positive change in their TFP, which is higher than that achieved by the Japanese firms. The results thus suggest that the major source of TFPG in all the three industries for Japanese-affiliated firms is increase in efficiency while for the U.S.-affiliated firms it is mostly technological progress.

There can be many reasons associated with higher productivity growth of Japanese-affiliated firms. The role played by the organisation and management practices in improving productivity has now been recognised in the literature. In recent decades, the sustained competitive strength of Japanese manufacturing firms has been credited to the distinct management system of Japanese firms (Womack, et al. 1990, Ozawa 1994). Japanese firms have also been found to enjoy the highest level of productivity and competitiveness in the component-intensive, assembly-based industries from where the lean production system originated (Ozawa 1994).

It is also often quoted that Japanese production model draws its strength from the human related dimensions of engineering technologies, workplace practices and corporate culture more than in-house R&D or embodied technology imports as in the case of U.S. firms. Given these differences in the parent firms of Japanese and U.S. affiliates, it can be expected that Japanese affiliation will lead to higher efficiency levels while U.S. affiliation will lead to higher technology levels within the same industry. Thus, affiliation with foreign firms from different countries of origin may lead to differential impact on productivity growth and its components in a firm.

9. Conclusions

The paper analyses the impact of FDI from Japan and U.S. on total factor productivity growth of a firm in the Indian manufacturing sector. It also examines the reasons as to why firms affiliated with different source countries may have differential productivity growth. A firm level analysis has been undertaken for the period 1993-94 to 1999-2000 for three industries, i.e., automobile, electrical and chemicals. The study estimates both non-deterministic and deterministic production frontiers to arrive at conclusions with respect to impact of FDI from different sources on TFPG. The results of the 'time varying firm specific" technical efficiency approach show that Japanese-affiliated firms have higher average productivity growth as compared to domestic firms and U.S.-affiliated firms. Interestingly, domestic firms in these industries are found to have higher productivity growth as compared to U.S.-affiliated firms.

The study further uses deterministic production frontier to decompose TFP change into efficiency change and technology change within each industry. This analysis is used as a complement rather than a substitute of the first analysis. Using DEA approach Malmquist indices are estimated and differences in the efficiency growth and technological progress achieved by Japanese-affiliated, U.S.-affiliated and domestic firms in an industry. The analysis show that U.S.-affiliated firms rely mainly on technological improvements to achieve productivity growth while the major thrust to productivity growth in Japanese-affiliated firms comes from efficiency improvements.

One of the important findings of the study is that in the post-reforms period, domestic firms have experienced both technological progress and efficiency growth in some industries like electrical and chemical industries. This is indicative of the fact that domestic firms are "catching-up" with higher productivity levels of foreign firms in the same industry.

References

Aitken, B., and Harrison A. (1999), Do domestic firms benefit from FDI? Evidence from Venezuela, American Economic Review, 89 (3), 605--618.

Balassa, B. and N. Marcus (1990), The Changing Comparative Advantage of Japan and the United States, in H.W. Singer, N. Hatti and R. Tandon, editors, North-South Trades in Manufactures, Indus Publishing Company, New Delhi, India, chp. 3.

Banga, R. (2003a), Do Productivity Spillovers Differ from Japanese and U.S. FDI Differ?", editors, R. Jha, "Ten Years of Indian Reforms, Macmillan Palgrave.

Banga, R. (2003b), Differential Impact of Japanese and U.S. Foreign Direct Investment on Exports of Indian Manufacturing, Working Paper, ICRIER, No. 106.

Banga. R. (2002), Corporate Financial Structures and Financial Performance of Japanese, US and Indian Firms in the Indian Manufacturing, Journal of International Economic Studies, No. 16.

Basant, R., and Fikkert, B., (1996), The Effects of R&D, Foreign Technology Purchase and Technology Spillovers on Productivity in Indian Firms, The Review of Economics and Statistics 78 (2), 187--99.

Blomstrom,M., and Wolf, E., (1994), Multinational Corporations and Productivity Convergence in Mexico, in: W. Bahmol, R. Nelson,and E. Wolff (Eds.), Convergence of Productivity: Cross National Studies and Historical Evidence, New York, Oxford University Press, p. 243--259.

Caves, Richard E.(1974) Causes of Direct Investment : Foreign Firms Shares in Canadian and United Kingdom Manufacturing Industries, Review of Economics and Statistics, 56 August: 207-293.

Caves, R.E., (1996), Multinational Enterprise and Economic Analysis, Cambridge University Press, Cambridge.

Cornwell, C., Schmidt , P., and Sickles, R.C. (1990), Production Frontier with Cross-Section and Time-Series Variation in Efficiency Level, Journal of Econometrics 46 (1-2), 317--32

Djankov, S., and Hoekman, B. (2000), Foreign Investment and Productivity Growth in Czech Enterprises. The World Bank Economic Review Vol.14, No. 1, 49--64.

Doyle, P., J. Saunders and V. Wong (1992), Competition in Global Markets: A Case Study of American and Japanese Competition in the British Markets, Journal of International Business Studies, Third Quarter.

Dunning John H. (1973) The Determinants of International Production. Oxford Economic Papers, 25, November: 289-336.

___, (1994), The Governance of Japanese and US Manufacturing Affiliates in the UK: Some Country-Specific Differences, in Kogut, B., editors, Country Competitiveness, Oxford: Oxford University Press.

Encarnation, D. J (1999), Japanese Multinationals in Asia: Regional Operations in Comparative Perspective, Oxford University Press, New York.

Fare, R.S., S. Grosskopf and C.A.K. Lovell (1994), Production Frontiers, Cambridge University Press.

Globerman,S., (1979), Foreign Direct Investment and Spillover Efficiency Benefits in Canadian Manufacturing Industries. Canadian Journal of Economics 12, 42--56.

Goldar, B.N., (1995), Technology Acquisition and Productivity Growth: A study of Industrial Firms in India, Working Paper Series, Institute of Economic Growth, Delhi University Enclave, September.

Graham, Edward M., and. Krugman P.R., (1995), Foreign Direct Investment in the United States. Washington, D.C.

Haddad, M., and Harrison, A., (1993), Are there Positive Spillovers From Foreign Direct Investment? Evidence from Panel Data for Morocco. Journal of Development Economics, October.

Kathuria, V., (2000), Productivity Spillovers from Technology Transfer to Indian Manufacturing Firms. Journal of International Development 12(3), 343--69.

Kathuria, V., (2001) Foreign Firms, Technology Transfer and Knowledge Spillovers to Indian Manufacturing firms: a Stochastic Frontier Analysis., Applied Economics, 33, 625-642.

Kojima, K., (1978), Direct Foreign Investment: A Japanese Model of Multinational Business Operations. London: Croom Helm.

___, (1986) Japanese-Style Direct Foreign Investment. Japanese Economic Studies 14,3 (Spring): 52--82.

___, (1991), Japanese and American Direct Investment in Asia: A Comparative Analysis, in H. W. Singer, N. Hatti and R. Tandon, editors, Foreign Direct Investments. New Delhi: Indus Publishing Company.

Kokko, A., (1994), Technology, Market Characteristics and Spillovers. Journal of Development Economics 43, 279--293.

Kokko, A., Tansini, R., and Zejan, M.C., (1996), Local Technological Capability and Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector. Journal of Development Studies 32 (4), April, 602--11.

Nagaishi, M. and Tomoya Matsumoto, (2003), "Market Values of Japanese Affiliates in India: An Industry-specific Analysis", Paper presented in Seventh International Conference on Global Business and Economic Development, Bangkok, January 8-11.

Ozawa, T., (1994), Japanese MNCs as Potential Partners in Eastern Europe' s Economic Reconstruction, in P.J. Buckley & P.N. Ghauri, editors, The Economics of Change in East and Central Europe, London, San Diego, Tokyo: Academic Press, Harcourt Brace & Company: 203-219.

Ravenhill, J (1999), Japanese and US Subsidiaries in East Asia: Host Economy Effects, in D. J. Encarnation, editors, Japanese Multinationals in Asia: Regional Operations in Comparative Perspective, Oxford University Press, New York.

Schroath, F. W., M. Y. Hu and H. Chen (1993), Country-Of-Origin Effects of Foreign Investments in the People's Republic of China, Journal of International Business Studies, Second quarter: 277-290.

Srivastava, V. (1996) Liberalisation, Productivity and Competition: A Panel Study of Indian Manufacturing, Delhi: Oxford University Press.

Womack, James P., Daniel T. Jones, and Daniel Roos, (1991), The Machine That Changed the World: The Story of Lean Production--How Japan' s Secret Weapon in the Global Auto Wars Will Revolutionize Western Industry. New York: Harper Collins.