FDI spillovers and local productivity growth: evidence from Indian pharmaceutical industry

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Abstract: The study tests the FDI spillover hypothesis in the Indian Pharmaceutical industry using an unbalanced panel data for a sample of firms over the period 1989-90 to 2000-01. The study estimates firm-specific productive efficiency growth for domestic firms from frontier production function and relates the same to a set of firm-specific attributes along with the variables of foreign presence. The study found that the presence of foreign firms per se may not be important for productivity growth of domestic firms unless it is complemented by the latter's R&D activity or size. Therefore, the study concludes that policy efforts to encourage R&D and some concentration of size of the domestic firms in the industry may be more desirable than passively liberalizing the FDI policy from the point of view of increasing productive efficiency of local enterprises.

Key Words: *FDI; Productivity; Pharmaceutical Industry*
JEL Classification: *F23; D24; L65*

1. Introduction

Indian pharmaceutical industry provides a unique example of a late industrializing country successfully building domestic capabilities in a highly competitive knowledge-intensive industry. The industry which was not having any technological base to start local production during 1960s, has made significant technological transformation during 1970-1990 to achieve a near self-sufficiency in raw materials to start production from as basic stage as possible. It has also achieved a high degree of self-sufficiency with regard to its requirements of basic raw materials and intermediates. One important component of policy intervention that made this transformation possible is related to foreign investment in the industry.

To begin with, during the period 1948-1970 the industry was largely dominated by foreign direct investment (FDI) firms, accounting for about 80 percent of domestic production of formulations. They were mostly engaged in importing bulk drugs and processing them into formulations to sell in India (Kumar and Pradhan 2003). During this phase of FDI domination there was little international transfer of technology to the industry as most of the patent holding foreign companies were reluctant to translate their patent

enjoyed under the Patent Act of 1911 into local production. In few of the cases where domestic enterprises made attempts to start local production were denied access to technology through legal adjunction obtained by FDI firms under the Patents and Designs Act, 1911[1]. During this phase, drugs prices in India were one of the highest in the world and there used to be huge outflows of foreign exchange on account of large trade-deficits in pharmaceutical products.

Realizing that inward FDI under a strong patent regime has not been conducive to the indigenous technological development in the industry, India has shifted to a new patent regime in 1970. The Indian Patent Act, 1970 accorded process patent in place of product patent for pharmaceutical products and has reduced the patent duration to 5 years from the date of sealing or 7 years from the date of application, whichever is earlier. To ensure that FDI firms transfer technology several measures were also taken. Those FDI firms which are producing high technology drugs can retain foreign equity in excess of 40 percent and others producing low technology drugs or processing imported/ domestically purchased bulk drugs would have to reduce their foreign equity holding to 40 percent. FDI firms producing finished formulations from imported bulk drugs or from penultimate stage are required to start production from the basic stage within a specified time period. Further, licenses to FDI companies will only be given if the production involves high technology bulk drugs and formulations based thereon. As a result of these policy measures, during the period 1970-1990 Indian pharmaceutical industry has seen tremendous local innovation mainly in the form of adaptation, reverse engineering and new process developments and emergence of a strong domestic sector in the industry. By the end of 1991 about 70 percent of the domestic pharmaceutical market was accounted by the domestic firms in the case of bulk drugs and 80 percent in the case of formulations (Lanjouw 1998).

However, in the 1990s these policy measures have changed beyond recognition. Apart from the changes in industrial policies like abolishing licensing system, removing phased manufacturing and technology transfer requirements, the impending changes in the patent regime, FDI policy has been considerably liberalized. In 1994-95, almost all bulk drugs were de-licensed and the industry was provided with automatic approval of foreign

[1] Many such cases can be found in the literature. The case of Unichem Laboratories being prevented from producing tolbutamide and Excel Industries from producing aluminium phosphate are two famous cases where foreign patent owners had legally prevented domestic companies from producing the product locally (Desai 1980).

equity up to 51% in most drugs and formulations. The foreign equity limit through automatic route for drugs and pharmaceuticals has been further raised to 74% in 1999-2000 and then to 100% in 2001-2002.

This change in the attitude of Indian government towards FDI firms stems from the realization that the foreign investments not only provide financial resources but also are a source of technical, managerial and organizational knowledge which are largely not available in the economy. The knowledge brought in by FDI firms ultimately spilled to the rest of the economy contributing to the productivity growth in the domestic sector. Against this background the present study examines the nature of relationship between the presence of foreign firms and local productivity growth in Indian pharmaceutical industry. It focuses on two sets of issues: (i) Are the productivity levels of local firms improved by the presence of foreign firms? (ii) What policy options can be resorted to facilitate increase in the productivity of local firms? Understanding of these questions is of crucial importance to the policy makers for improving the productivity of domestic sector and managing FDI policy effectively concerning the industry.

This paper has been structured as follows. Section 2 conceptualizes the link between FDI spillovers and local productivity growth. The model and hypotheses to be tested has been developed in the section 3. Section 4 describes the data source and presents results from empirical analysis. Section 5 concludes the paper.

2. FDI and Productivity Spillovers

There is now considerable evidence from the past research on the role of FDI in the host countries that FDI firms may involve significant elements of externalities and spillovers to their domestic counterparts (see Blomström and Kokko 1998; Görg and Greenaway 2001 for surveys). Whenever the externalities from foreign firms affect the objective functions of domestic firms like profit, productivity or costs functions in the same industry, it is known as 'horizontal spillovers' and if in the other industry situated at the forward or backward stages of production it is known as 'vertical spillovers'. In the literature, the existence of spillovers from FDI is by now well established. However, what is still debated is the nature and magnitude of spillovers.

Table-1 provides a summary of empirical studies on FDI spillovers. Out of a total of 31 empirical studies at firm or industry level with a cross-sectional or panel data analysis, 14 reported that the presence of foreign firms proxies by the share of FDI firms in total industry employment or sales have benefited labour productivity or total factor productivity of domestic enterprises in the host countries. There are 4 studies that evidenced that spillovers from FDI firms are significantly negative to the productivity of domestic firms. Another 13 studies reported that some domestic firms may have benefited from FDI while others may not, thus on an average, the spillovers from FDI is not significant to the domestic sector as a whole. Therefore results from these numerous studies on this issue are mixed.

Table-1
A summary of findings on the relationship between FDI spillovers and Local Productivity growth

Region	*Coefficient of Spillover Variable*					
	Significantly (+ve)		*Significantly (-ve)*		*Insignificant/Mixed*	
	Author(s)	*No.*	*Author(s)*	*No.*	*Author(s)*	*No.*
Developed Countries	Caves (1974) on Australia; Globerman (1979) on Canada; Liu et al. (2000), Driffield (2001) on UK; Dimelis and Louri (2001) on Greece.	5	Barry et al. (2001) on Ireland.	1	Girma et al. (2001), Girma and Wakelin (2001a, 2001b), Harris and Robinson (2001) on UK; Barrios and Strobl (2001) on Spain	5
Developing Countries	Blomström & Persson (1983), Blomström (1986), Blomström & Wolff (1994), Kokko (1994, 1996) on Mexico; Blomström & Sjöholm (1999), Sjöholm (1999a, 1999b) on Indonesia; Chuang & Lin (1999) on Taiwan.	9	Aitken & Harrison (1999) on Venezuela.	1	Haddad & Harrison (1993) on Morocco; Kokko et al. (1996), Kokko et al (2001) on Uruguay; Kugler (2001) on Colombia; Kathuria (2000) on India.	5
Transition Countries			Djankov & Hoekman (2000) on Czech Republic; Konings (2001) on Bulgaria and Romania;	2	Kinoshita (2001) on Czech Republic; Bosco (2001) on Hungary; Konings (2001) on Poland	3
All Region		14		4		13

Source: Author's adaptation from Görg and Greenaway (2001), Table-2, pp.10-11.

FDI spillovers may be positive or negative. Net result therefore depends upon the relative strength of these two effects. Further, the impact of FDI firms on the productivity growth of domestic firms is not only sector specific but also firm specific as postulated by the

technology gap hypothesis. As the knowledge brought in by foreign firms involves tacit elements difficult for imitation, domestic firms need to incur R&D to apprehend FDI spillovers. The domestic firms with a lower technology-gap vis-à-vis foreign firms are relatively better placed to benefit from spillovers than those with a wider technology-gap. Hence, the spillover impact of FDI is ambiguous in nature.

The positive spillovers that FDI firms may generate in the development process can occur through many channels but important are the followings:

- *Competitive effect*: This is the most important indirect benefit that FDI firms may generate in the host economy. Entry of FDI firms leads to competitive structure of an industry. This increased competition forces domestic firms to improve their productivity by using more efficiently existing resources, shifting to sophisticated and advanced technology, providing training to workers, and undertaking R&D expenditure to develop indigenous technologies. Therefore, FDI may result in the improved productivity levels of domestic firms (Caves, 1974).

- *Human capital effect*: An educated, well-trained and skilled workforce generally characterizes FDI firms. When these well-trained workers migrate to domestic firms or start their own enterprises, it results in local productivity growth (Blomström and Persson, 1983; UNCTAD, 1999)

- *Demonstration effect*: The presence of FDI firms in the host economy may also lead to diffusion of information on new technology, production process, quality control techniques and marketing strategy to the local firms and latter may emulate the same so as to improve their productivity levels.

- *Linkage effect*: Efficiency spillovers can further operate through subcontracting relationship between foreign and local firms. These vertical inter-firm linkages are beneficial for both the FDI and non-FDI firms. For FDI firms, subcontracting certain production activities to specialized local firms and concentrating on their core lines of production is a means of achieving cost reduction and efficiency improvement. Subcontracting is also beneficial for local subcontractors as it provides these firms new markets along with exposure to new forms of production and management organization,

and further access to technical assistance and training support to upgrade their technological capabilities (World Bank, 1997).

While FDI is associated with these positive externalities, this does not rule out negative externalities from it. This aspect of spillovers is often discussed in the context of crowding out from FDI, which can occur through one or both of the following two channels:

- *Product market*: FDI firms with ownership specific advantages such as superior technological capabilities, skill, new management techniques, marketing networks, and others, not only overcome entry barriers but also have an edge over domestic enterprises. Further, due to their large entry size and trans-border operation they enjoy scale and scope economies. All these factors contribute to the increased market power of FDI firms and consequent market concentration. On the contrary, domestic firms characterized by low technological capabilities, high cost, and inefficiency face negative scale effect as a result of their declining market share. Negative scale, in turn, raises cost of production of domestic firms and as a result of which these firm face further decline in their market share. This cumulative impact of the entry of FDI firms on the market position of domestic firms may lead to crowding out of many small sized domestic firms. Therefore, entry of FDI firms may adversely affect learning and growth of local firms in competing activities (Markusen and Venables, 1997; UNCTAD, 1999).

- *Financial market*: FDI firms, given their size and other advantages of being a part of a global system of production, usually have a preferential access to local capital through financial institutions in the host country. This may lead to credit rationing for small sized local firms by reducing their access to capital or raising costs of borrowing (UNCTAD, 1999).

3. Hypotheses

The productivity of domestic enterprises depends on several firm-specific factors besides the spillover effects from the presence of FDI firms. Firm-level productivity growth is a composite measure of the efficiency improvements in the firm including technical progress, learning-by-doing, improved skills, and enhanced utilization of capacities, etc. The

study has considered the following possible factors to explain the firm-level productivity growth:

3.1 Technology: The importance of technology factor in explaining inter-firm variation in the productivity performance within an industry can hardly be exaggerated. Technology in the form of improved techniques of production could be important for accounting that growing part of output which cannot be wholly explained by the growth of traditional inputs like labour and capital. As technological capability of a firm includes its ability to operate, to absorb, and to create innovations encompassing entrepreneurial, managerial and technical components, it not only pushes the firm nearer to the production frontier but also shifts the frontier itself. Many empirical studies such as Griliches (1975, 1986) and Griliches and Mairesse (1984) have found that R&D significantly affects the productivity growth at the firm level. In the present study, the technological capability of a firm has been measured by a group of three variables: the in-house R&D expenditure (RDINT), the technological payments made overseas (DISTECH) and the imports of capital goods (EMTECH), all expressed as a percentage share of sales. RDINT measures the firm's own efforts to create and strengthen indigenous innovative capacity. DISTECH and EMTECH respectively measures embodied and disembodied channels of technology imports like know-how licenses and import of plant and machinery. All these three measures of firm-specific technical capability are predicted to affect positively the productivity growth of domestic firms. However, as the relationship between productivity and technology is likely to exhibit bi-way causation, the study has introduced measures of technology in one period lagged form.

3.2 Firm Age: A firm's efficiency is also dependent upon the age of the firm. Start-up firms with new equipments are likely to be more efficient than their older counterparts, as the scope for productivity growth from learning by doing effects is greater for them. Older firms with older equipment and machinery have relatively less scope for benefiting from learning process. Further, younger firms operate with greater organizational flexibility to respond to the changing nature of a firm's environment than older firms. Hence, other things being equal the efficiency of the firm is predicted to depend negatively upon its age (AGE).

3.3 Capital intensity: As the capital goods incorporate latest knowledge and innovations it plays a central role in technical change and productivity growth at the firm level. Higher firm

efficiency is expected to be associated with higher capital intensity (KINT) of operations. The KINT is measured as the ratio of capital stock to labour.

3.4 Import: The import intensity (IMINT) of a firm can be expected to determine its productivity performance. The continuing process of economic reforms initiated in India since 1991 has infused radical changes in the trade regime of the country marked by phasing-out of many quantitative and qualitative restrictions on imports. This has provided easy access to imports of capital goods, raw materials and components, and to the extent that these new imports are technologically and qualitatively better than local alternatives, they can be expected to improve productivity performance of domestic enterprises. The cheap imports may also force domestic enterprises to increase their productivity to survive in the business by utilizing resources efficiently and improving technological capability.

3.5 Exporting: The efficiency of domestic firms can also be argued to be positively associated with their export activity. Export provides them with the access to the endowment of foreign knowledge. By exporting, they can obtain crucial information about foreign markets, technologies, skills and products and this may even be accompanied by technical and organizational assistance from global buyers. Evidence from many empirical studies suggests that firms with export linkages are more productive than firms exclusively serving domestic markets (e.g. Girma et al, 2002; Kraay 1999). Further the discipline of export market compels firms to be constantly productive and innovative to maintain its competitive edge in the world market. Thus, the export intensity of a firm (EXPOINT) is hypothesized to have a positive impact on its productivity growth. As the relationship between exporting and productivity may be subject to bi-way causality, EXPOINT has been introduced as one period lagged variable.

3.6 Foreign Presence. As already mentioned, entry of FDI firms into under-developed industries of developing countries have both positive and negative spillovers to the growth and learning of the local enterprises. On one hand, FDI results in productivity and technology spillovers to the domestic firms by information diffusions, induced competition, local linkages, and skilled labor migration to local firms. On the other hand, it may also result in crowding out of local capabilities through blocking information flows, less local linkages, market and credit rationing for domestic firms. Hence, the impact of spillover variable on the

productivity growth of local firms is theoretically ambiguous. The study has used two proxy variables for the presence of FDI firms in the industry: (1) the share of sales of FDI firms to total industry sales (SPIL1) and (2) the share of R&D expenditure of FDI firms to total industry R&D expenditure (SPIL2). The first and second measures respectively capture foreign participation in the product market and technological efforts in the industry.

However, not all domestic firms get equally affected by the presence of foreign firms in an industry. As far as the efficiency caused by competitive pressures from the foreign share of an industry's sales is concerned, the effect can be expected to depend upon the relative variation in inter-firm market power. A domestic firm with higher market power proxied by the size of its sales may be more sensitive to the presence of foreign firms than a domestic firm with a fringe status. To capture this phenomenon the study has constructed an interaction variable by interacting SPIL1 and size of the firm (SPIL1*SIZE). Likewise the spillovers benefits from foreign firm's innovative activity require a degree of technological capability on the part of the domestic firm. The fact that foreign firms bring in new technologies doesn't automatically guarantee that domestic firms may benefit as technology by definition is firm-specific, local, often tacit and partly appropriable knowledge. Domestic firms with higher innovative capability may benefit relatively more from knowledge spillovers from FDI than those with low level of technological capability. An interaction term between SPIL2 and R&D intensity (SPIL2*RDINT) of domestic firms has been included in the study to capture the inter-firm differences in the ability to de-codify and absorb the FDI spillovers.

The Determinants of firm-level efficiency growth is thus specified by the following model:

$$EFF_{it} = \beta_{0i} + \beta_1 AGE_{it} + \beta_2 RDINT_{it-1} + \beta_3 DISTECH_{it-1} + \beta_4 EMTECH_{it-1} + \beta_5 KINT_{it} + \beta_6 IMINT_{it} + \beta_7 EXPOINT_{it-1} + \beta_8 SPIL1_t\,(SPIL2_t) + \beta_9 SPIL1_t * SIZE_{it}\,(SPIL2_t * RDINT_{it}) + \varepsilon_{it} \quad (1)$$

Where:

EFF_{it}: The change in the technical efficiency of ith domestic firm from t-1 to tth year.
AGE_{it}: The age of ith firm in number of years.
$RDINT_{it-1}$: Total R&D expenditure as a percentage of total sales of ith firm in t-1 year.
$TECHIM_{it-1}$: Royalties, technical and other professional fees remitted abroad by ith firm as a percentage of sales in the year t-1.
$EMTECH_{it-1}$: Imports of capital goods as a percentage of total sales of ith firm in t-1 year.
$KINT_{it}$: The ratio of capital stock to labour.

$IMINT_{it}$: Total imports as a percentage of total sales of *i*th firm in *t*th year.
$EXPOINT_{it-1}$: Total exports as a percentage of total sales of *i*th firm in *t-1* year.
$SPIL1_t$: The percentage share of foreign firms in industry sales in *t*th year.. A firm with foreign ownership of 25%≥ of the equity capital of the firm is classified as a foreign entity.
$SPIL2_t$: The percentage share of foreign firms in industry R&D expenses in *t*th year.
$SIZE_{it}$: Total sales of *i*th firm in *t*th year.
ε_{it} : denote usual random error term.

The firm-specific efficiency growth (EFF) has been obtained by employing a frontier production approach as outlined in Cornwell, Schmidt and Sickles (1990). The model estimated in the study takes the following form:

$$\log VAD_{it} = \chi_{it} + \alpha \log K_{it} + \beta \log L_{it} + \varepsilon_{it} \qquad (2)$$

Where VAD, K and L respectively denote value added, capital and labor. ε_{it} is the usual normally distributed two-sided noise term permitting random variation of the frontier across firms. χ_{it} which is equal to $(\chi - u_{it})$ represents the time-variant productivity level of a firm. The non-positive disturbance term u_{it} suggests that the output of the firm must lie on or below the frontier $\chi+\alpha\log K_{it}+\beta\log L_{it}+\varepsilon_{it}$ and capture the shortfall of observed output from the maximum feasible output.

There are two stages of estimation involves in arriving at the firm-specific time-variant productive efficiency indexes. In the first stage, the production function (2) is estimated with fixed effects techniques of panel data and the residuals giving the joint estimate of the productive efficiency and the error term are obtained. In the second stage, the residual for each firm are regressed on time t and t^2 to obtain the fitted values which give estimates of firm-specific efficiency denoted as χ_{it}. The change in the productive efficiency level (EFF) is given by $\Delta\chi_{it} = (\chi_{it} - \chi_{it-1})$.

4. Empirical Analysis

4.1 Sample, Variable Construction and Methodology

The empirical analysis has been conducted with the help of a sample of Indian pharmaceutical firms drawn from the Prowess Data Base of the Centre for Monitoring Indian economy (CMIE). The database contains unbalanced panel data of 268 firms with 1781 observations spreading over 1989-90 to 2000-01. Of the 268 firms, 247 are domestic firms

with 1565 observations. The variables for production function are constructed as follows: (1) the net value added (NVA) deflated by the wholesale price index for chemical industry (base 1981-82=100) is used as the measure of output; (2) the net fixed asset (NFA) deflated by the wholesale price index for machinery and machine tools (base 1981-82=100) is taken as the measure of capital input; (3) labour input has been obtained by dividing total wage bill of a firm by the average industry wage rate obtained from the Annual Survey of Industries (ASI). As the wage rates for the last three years were not available, extrapolated figures based on the past trend during 1980-81 to 1997-98 have been used. The measurement of capital input by NFA is admittedly problematic but traditionally constructed capital stock based on the perpetual inventory method is not free from problems as well. Unreliable measures of depreciation forcing researchers to arbitrarily assume that capital is discarded at a uniform rate, lack of information on correct stock of the benchmark capital, aggregation problems of capital assets over time on account of technological advancement (i.e. new capital goods may be materially different from old capital goods), and changes in the prices of capital goods rendering valuation of new capital goods at base year prices untenable[2] etc., marked the estimate of capital stock obtained from the perpetual inventory method.

4.2 Empirical Findings

The first step in our analysis is the firm level estimation of frontier production function to derive firm-specific productive efficiency growth for domestic firms. The two factor Cobb-Douglas production function specified in model (2) has been estimated with the panel data techniques of fixed and random effects estimation with White heteroscedasticity corrected t-statistics. The statistical package used for this purpose is W.H. Green's LIMDEP version 7.0. Table-2 summarizes the results obtained from the estimation of the production function for 247 domestic firms. The high value of Hausman test strongly favours fixed effects over random effects estimation.

The estimated elasticity of output with respect to capital and labor are 0.10 and 0.76 percent respectively. Both these partial elasticity coefficients are highly significant and suggest that over the study period for 1 percent increase in the capital input, holding the labor input constant, led on an average to about 0.10 percent increase in the output and that in the

[2] Expressing new capital goods in base year prices is tantamount to assume that new and old capital goods are same even though new and old capital goods may be different given technological improvements.

case of labor the increase in the output is 0.76 percent. In terms of overall R-square, the estimated model is quite satisfactory and as suggested by the F-value the model is highly significant.

Table-2
Estimated Cobb-Douglas Production Function
For domestic firms in Indian Pharmaceutical Industry,
An unbalanced panel data over 1989-90 to 2000-01

Dependent Variable: LogY		
Independent Variables	*Coefficients (t-statistics)*	
	Fixed Effects	*Random Effects*
LogK	0.1000406365E-02*** (8.866)	0.6392400103E-03*** (3.398)
LogL	0.7599435951*** (24.536)	0.8079263710*** (44.078)
Constant	-	-0.648914*** (-10.1344)
F-value	63.76	
Prob > F	0.00000	
Chi2		1966.84
Prob > Chi2		0.00000
R-squared	0.923171	0.74089
Observations	1565	1565
Fixed vs. Random Effects (Hausman)	14.49	14.49
Number of groups	247	247

Note: White heteroscedasticity corrected t-statistics are in parentheses; *- Significant at 10%; **- Significant at 5%; ***- Significant at 1%.

After obtaining the output elasticity of capital and labor, the study proceeds to obtain residuals from the fixed effect estimation and then derive firm level productive efficiency growth for domestic firms as discussed previously. Finally, the productive efficiency growth relation as specified by the model (1) has been estimated. The results from the fixed effects estimation of the model (1) for domestic firms have been presented in the Table-3. Apart from correcting heteroscedasticity in the variance matrix, the study has also checked for problems of multicollinearity that can inflate standard errors of the estimates. Tests such as variance inflating factor (VIF) and condition index (CI) reveal that a moderate level of colinearity exists among independent variables not serious enough to mislead the estimated standard errors (see Appendix Table-1 for results).

Equations 1.1 and 1.2 correspond to the use of two different measures of FDI spillovers. Respectively these are the share of foreign firms in total industry sales and the

share of foreign firms in total industry R&D expenditure. These estimated equations are highly significant by F-test suggesting that the various determinants of productive efficiency taken together contribute significantly to the explanation of firm-specific efficiency growth. The explanatory power of these estimated equations is about 43 percent. It is noteworthy that the inferences drawn on independent variables other than spillover variables are remarkably similar from both these estimations.

Table-3
Fixed-effects estimation of the Productive Efficiency Growth relation
For domestic firms in Indian Pharmaceutical Industry,
An unbalanced panel data over 1989-90 to 2000-01

Dependent Variable: EFF_{it}		
Independent Variables	*Coefficients (t-statistics)*	
	Equation 1.1	Equation1.2
AGE_{it}	-0.0067511** (-2.01448)	-0.00810458*** (-4.02958)
$RDINT_{it-1}$	0.0015476** (2.20738)	0.00174279*** (2.47771)
$TECHIM_{it-1}$	0.00115992*** (3.05746)	0.000848666** (2.02452)
$EMTECH_{it-1}$	-0.000185934** (-2.17521)	-0.000180961** (-2.04248)
$KINT_{it}$	-0.0247206*** (-2.75738)	-0.0243159*** (-2.70867)
$IMINT_{it}$	0.000198335 (0.37563)	0.000109562 (0.205921)
$EXPOINT_{it-1}$	-0.00103818** (-2.36782)	-0.000930976** (-2.18626)
$SPIL1_t$	0.000292494 (0.177209)	
$SPIL1_t*SIZE_{it}$	2.0405e-006# (1.56366)	
$SPIL2_t$		-0.000324711 (-1.03079)
$SPIL2_t*RDINT_{it}$		0.000115951* (1.71981)
F-value	3.53	3.54
Prob > F	0.00000	0.00000
R-squared	0.425762	.426765
Observations	1296	1296
Fixed vs. Random Effects (Hausman)	27.80	37.08
Number of groups	217	217

Note: White heteroscedasticity corrected t-statistics are in parentheses;
*- Significant at 10%; **- Significant at 5%; ***- Significant at 1%; #-significant at 12 percent.

Following inferences can be drawn from the results summarized in Table-3:

AGE_{it} has a predicted negative and significant coefficient for both the estimations. This tends to suggest that younger firms in Indian pharmaceutical industry experience higher efficiency growth than their older counterparts. The relatively higher productivity growth of younger firms can be explained by their advantages of possessing new equipments and highly flexible organizational setup to be able to benefit more from the learning process.

Among the three measures of firm's technological capabilities, while two variables namely $RDINT_{it-1}$ and $TECHIM_{it-1}$ came out with a significant positive effect, the import of capital goods represented by $EMTECH_{it-1}$ has consistently got a significantly negative coefficient in the efficiency growth regression. This seems to corroborate our hypothesis that efficiency growth crucially depends upon firm's own technological efforts and imports of foreign disembodied technologies like know-how, design, specification etc. However, the fact that $EMTECH_{it-1}$ is associated with statistically lower levels of efficiency indicates that Indian firms are not being able to efficiently absorb and utilize the imported capital goods into their production process.

The capital intensity, $KINT_{it}$, has a negative sign and turns statistically significant at 1 percent level. This is contrary to our hypothesis that firms with higher capital intensities are associated with higher performance of firm-specific efficiency. One possible reason may explain this situation. Mere availability of more capital per unit of labour may not be translated into enhanced efficiency unless the available stock of capital is fully and efficiently utilized. Generally observed low utilization rate in Indian manufacturing suggest that higher capital intensity may indicate large-scale under-utilized capacity and to that extent the firms remain high cost producers and inefficient ones.

$IMINT_{it}$ has a positive sign but has not achieved the levels of statistical significance. Therefore, firm efficiency in Indian pharmaceutical industry seems to be not significantly affected by the intensity of firms to imports. $EXPOINT_{it-1}$ comes out with a negative effect on the efficiency of the firm and reaches a modest level of statistical significance. It would suggest that firms on the contrary to witness the predicted efficiency-enhancing benefits from exporting in fact tend to be less-efficient. More research is required to understand why exporting firms are not performing well on the efficiency front.

Of the two measures of FDI spillovers, none of them are observed to have any significant and independent effect on the efficiency growth of domestic pharmaceutical

enterprises. $SPIL1_t$ and $SPIL2_t$ respectively came out with positive and negative coefficient but are statistically not different from zero. However, their interaction terms namely $SPIL1t*SIZE_{it}$ and $SPIL2_t*RDINT_{it}$ came out with a predicted positive sign and turns statistically significant at 12 percent and 10 percent level correspondingly. This provides weak evidence that domestic firms with higher market power represented by sales only benefit from competitive spur to efficiency thrown by the presence of foreign firms. Further, domestic firms to benefit from the innovative activities of foreign firms depend crucially on their won R&D activities.

5. Concluding Remarks

The FDI policy concerning Indian pharmaceutical industry has been considerably liberalized during 1990s as a part of the overall macroeconomic reforms implemented since 1991. This liberal attitude to FDI seems to have based on several possible benefits that FDI brings to the host country. Apart from bringing in investible financial resources, modern technologies, technical expertise, access to export markets, foreign exchange, employment, skills and management functions, FDI may cause productivity growth in local firms when firm specific intangibles brought in by the FDI firms spillover to the domestic firms. It is in this context that the present paper investigates the spillover benefits from FDI in Indian pharmaceutical industry and looks into the important determinants of productivity growth of domestic enterprises.

The research found that the presence of foreign firms per se may not be important for productivity growth in the domestic sector. It is only when domestic firms have already grown large or have been engaged in innovative activities that the FDI spillovers work. This finding brings out that mere encouragement and openness to FDI doesn't automatically ensure that the host economy benefits from the presence of FDI firms. The most important condition for benefiting from FDI is that the domestic economy has already build sufficient domestic capabilities including technological one. However in an industry where majority of firms are small sized and where majority of firms do not engage in innovative activities (Pradhan 2002) the spillover benefits from a liberalizing FDI policy can at best be limited. Therefore, policy efforts to encourage R&D and some concentration of size of the domestic firms in the industry may be more desirable than passively liberalizing the FDI policy.

The independent and significantly favourable role of firm's own innovative activity in the productivity growth of domestic firms further underscore the significance of promoting in-house R&D capabilities among Indian pharmaceutical companies. The disembodied technology import has a favourable effect on the productivity performance. Therefore, policy incentives towards indigenous technological capability building and ensuring firm's easy access to new technology from overseas are crucial for enhancing efficiency of domestic enterprises.

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Appendix

Table-1 Test for Multicollinearity

Variable	VIF	Tolerance	Condition Index	Squared
AGE_{it}	1.15	0.8689	1.0000	0.1311
$RDINT_{it-1}$	1.36	0.7350	1.0730	0.2650
$TECHIM_{it-1}$	1.71	0.5861	1.1861	0.4139
$EMTECH_{it-1}$	1.03	0.9688	1.2320	0.0312
$KINT_{it}$	1.04	0.9620	1.3874	0.0380
$IMINT_{it}$	1.28	0.7805	1.4576	0.2195
$EXPOINT_{it-1}$	1.29	0.7743	1.4985	0.2257
$SPIL1_{t}$	3.25	0.3082	1.7874	0.6918
$SPIL1_{t}*SIZE_{it}$	1.15	0.8660	1.9303	0.1340
$SPIL2_{t}$	3.23	0.3098	2.6216	0.6902
$SPIL2_{t}*RDINT_{it}$	2.00	0.4988	3.4539	0.5012

Mean VIF-1.68, Condition Number-3.4539

Note: As a rule of thumb VIF exceeding 10 or condition index greater than 30 indicate strong collinearity. Reported R-squared is pertaining to the auxiliary regression.