Discussion Papers in Economics

FDI, Technology Transfer and Spillover:
A Case Study of India

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November, 2010

Discussion Paper 10-04

Centre for International Trade and Development

School of International Studies

Jawaharlal Nehru University

India

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August, 2010

ABSTRACT

As developing countries increasingly open their economies to foreign direct investment (FDI) one of their principal objective has been to achieve technology transfer from foreign firms to host country firms. This study for India shows that this technology transfer is more likely to be achieved by the presence of foreign firms rather than by simple purchase of foreign technology. It is also seen that technology transfer is dependent on the absorptive capacity of firms and the competitive nature of the industry. Finally, this study finds that institutional factors like the degree of competition positively impact the effects of traditional factors like absorptive capacity in determining technology transfer.

JEL Listing: F21,F23,O32,O33

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FDI, Technology Transfer and Spillover —A Case Study of India

One of the major changes in the international arena in the last two decades or so has been the increasing importance of Foreign Direct investment (FDI) in developing countries. Three main factors have accounted for this. One, the decline in Official Development Assistance as aid to developing countries and its replacement by flows of portfolio investment and FDI. Here developing countries have generally preferred FDI as this is considered more stable and related to growth considerations (Haddad and Harrison, 1992; World Investment Report, 1999). Second, developing countries have been in competition in increasingly wooing FDI. In the 1990s, for example, of all changes to bilateral investment treaties about 95 percent have been in favour of further liberalizing entry norms for FDI (World Investment Report, 1999). Third, FDI is now viewed as a major source of technology for developing countries in particular (World Investment Report,1999; Aitken and Harrison, 1999).

Among the developing countries India also indicated a preference for FDI relative to portfolio investment flows after the economic liberalization of 1991(Industrial Policy , 1993, Pant, 1995). As argued in Pant (1995), India's FDI policy started evolving after the Technology Policy statement, 1982 and in the 1980s there was a marked preference given to technology transfer in granting approvals to FDI proposals. In general, FDI proposals with only a foreign equity component tended to be rejected. However, this issue has only now gained increasing importance as the level of FDI flows have increased remarkably in the last few years.

In India it was generally felt that technical collaborations which involve transfers to, or purchase of patents and designs by, Indian companies would be the vehicle for technology transfer. However, it was seen that short term collaborations lead to limited technology transfer and mainly result in an outgo of royalty payments (see, Pant, 1995, op.cit.). Till the 1990s, India's FDI policy was enshrined in the Technology Policy statement of 1982 which was clearly in favour of FDI as a source of technology. However, as the policy evolved in the 1980s, it became evident that foreign exchange availability became the binding constraint on policy. Thus, technology transfers via purchase of drawings and designs was the preferred mode of transfer. However, the foreign exchange constraint dictated that royalties were limited to 5 percent of value of sales (later raised to 8 percent) while extension of collaboration agreements beyond 5 years was frowned upon. As shown in Pant (op.cit) this led to an outgo of payments mainly in the form of lump sum payments apart from payments of dividends and interest on intra-corporate loans. Hence, the royalty constraint turned out to be non-binding. At the same time equity investments in domestic companies was also discouraged. As Pant (1995.op.cit. Chapter III) has shown, the actual contracted lump sum payments in the 'eighties were twice the expected inflow in of FDI in the form of equity.

In general, direct technology transfer via purchase of drawings and designs etc. tend to be limited by patent laws. However, it is now increasingly seen that indirect transfers via spillover benefits may be more important. It has been argued that if transnational corporations (TNCs) introduce new products or processes in the host country, technology diffuses to the domestic firms which are competitors in production or suppliers of inputs to the foreign companies (see, for example, Aitken and Harrison, 1999; Kathuria,2000).

Much of the literature on FDI in developing countries has concentrated on direct benefits of FDI in the form of employment, exports etc.(World Investment Report,1999; Aaron and Andaya, 1998). However, particularly for developing countries, the literature on the indirect benefits of FDI to the host economy has not received sufficient attention. Studies for India are particularly few and far between. While the Indian policy on FDI has been liberalised remarkably in recent years, the focus on FDI as a source of technology transfer has now gained even political acceptance. In this paper we will look specifically at the factors that determine this transfer via spillover benefits to local firms..

This paper is organized as follows. The next section presents a brief overview of the literature on technology transfer. This is followed in Section III by a discussion of the methodology used in our analysis, definitions of variables and data sources. The main results of our estimation are presented in Section IV while some concluding observations are given in Section V.

II. Literature Review.

In the literature, technology transfer is viewed as taking place either by reverse engineering via purchase of imported products/inputs, by training of local workers who move out of the TNC to domestic firms or start their own units (see, Fosturi, Motta, Ronde, 2001) or by the creation of vertical linkages with local suppliers of inputs (see, Marcin, 2007; Smeets, 2008). It is also argued that competition from the foreign firms forces rival domestic firms to improve their production technique to keep their market share. However, direct measurement of technology transfer is not easy. When the technology and knowledge is transferred from the parent firm to their local affiliates, it leaks to the host country firms (Sjoholm, 1999) and thus enhances their productivity. Hence, the normal practice is to view changes in a firm's factor productivity as a proxy for technology transfer(Haddad and Harrison, 1992).

In terms of host country characteristics which facilitate technology transfer, three channels are stressed involving institutional issues, firm or industry specific issues and policy issues. Among institutional issues it is often argued that a competitive environment facilitates technology transfer via reduction of the X-inefficiency of domestic firms leading to faster adoption of the new technology.(Gorg and Greenway,2002; Smeets,2008). On the other hand, excessive competition may drive out domestic firms via the "market stealing effect" (see, Aitken and Harrison, 1999). While the impact of competition could thus go either way, the existence of a competitive environment is considered an important institutional factor in determining the extent of technology spillover.

In firm and industry specific issues the focus is on the absorptive capacity and technology base of a firm. It is argued that the pace of technology transfer is a function of the "technology gap" between domestic and foreign firms. Thus Findlay (1978) argued that the greater the technology gap the greater the technology transfer, a sort of "catch up" effect. However, the "catch up" hypothesis has not been substantiated empirically. Moreover, the ability of the domestic firm to absorb new technology depends on the quality of human capital available in the firms (see, for example, Girma, 2005). In particular, extreme deficiency in the host country firms' human capital or distribution network may prevent learning so that a "technology gap" may imply that only lower quality technology can be supplied to host country firms (see, Glass and Saggi, 1998). A large gap also makes the cost of learning prohibitively high for domestic firms (Girma, 2005). Finally, in institutional factors some authors have talked about the trade policy regime. Thus, an outwardly oriented trade regime creates more competition but also improves access to better technology (Kohpaiboon,06).

Technology spillovers can also be distinguished depending on whether they apply across or within industries. Thus intra-industry spillovers depend on demonstration effects (Saggi, 2002) and/or the extent of labour turnover (Fosturi, Motta and Ronde, 2001). However, these demonstration effects may not exist in the presence of strong patents. Similarly, labour immobility limits spillover effects (see, Gorg and Greenaway, 2002). Intra-industry spillovers can also occur via horizontal linkages in an industry though evidence on this is limited (see, for example, Mercin, 2007). On the other hand, inter-industry spillovers normally occur via vertical linkages of foreign companies with suppliers in the host country or forward linkages with domestic companies producing the same product (see, Tong, Hu,2003; Javorcik,2004). However, in the present study we will concentrate only on intra-industry spillover.

It is clear that technology transfer can only occur in imperfectly competitive markets where no unique market structure exists (*add reference of Kindleberger,Buckley and Casson)*. It is not then surprising that the studies noted above give different answers on the determinants of technology spillover to domestic firms. Since different countries could have different market structures it is unlikely that any generalized theoretical answer on the factors determining spillover benefits of technology to local firms can be given. Only a large body of empirical literature can allow some pattern to emerge.

While there is a large body of empirical literature on the impact of foreign firms on productivity of domestic firms it is useful to bunch them into various categories. The first category of studies investigate the impact of foreign firms (FDI) on growth rate or industry wide dispersion of productivity in the host country. Most studies use panel estimation for a cross section of industries in different countries (see, for example, Aitken and Harrision, op. cit. for Venezuela; Haddad and Harrison,1992 for Morocco; Hale and long, 2007 for China and Djankov and Hoekman, 2000 for the Czech republic). None of the studies show any significant positive impact of FDI on growth or dispersion of productivity in the host country industries. However, some other studies (see for example, Kokko(1996) for Mexico, Gorg and Strobl,(2000b, 2003) for Ireland;Chuang and Lin,(2003) for Taiwan) show a positive spillover from FDI.

Another set of studies concentrates on finding out the impact of institutional factors on technology spillover. Thus some studies show a positive impact of FDI on productivity when competition is added as an additional control variable in the estimating equation (see, Blomstrom and Persson(1983) for Mexico, Globerman (op.cit.) for Canada Li, Liu and Parker (2001) for China). Another important factor is the dependence of technology spillover on the absorptive capacity of the host country firms. Here empirical studies seem to indicate that the spillover is a function of the extent of the "technology gap" between domestic and foreign firms. Evidence of spillover seems to exist in the case when the absorptive capacity exists, that is, the technology gap between domestic and foreign firms is not too high (see, Kokko, Tansini, Zejan,1996; Sjoholm, 1999;Girma,2005). Moreover, it is also found that a free trade environment promotes higher productivity (see for example, Kokko, Tansini, Zejan, op.cit.; Kohpaiboon, 2006; Barrios and Strobl, 2002). A third category of studies test whether the mere existence of foreign firms (foreign 'presence') in any industry leads to positive external economies for the domestic firms (see, for example, Ari Kokko,1996), These positive externalities stem mainly from demonstration effects.

As the literature survey shows, there is no conclusive evidence on the spillover impact of foreign firms (FDI) on host country firms. We have noted that this is possibly due to inter country differences which a general model cannot accommodate. What is however most surprising is the complete absence of such studies for India. This is possibly because FDI in India has been largely insignificant except in recent years. In one set of studies, Kathuria (2000, 2002) found that there was little impact of foreign presence or technology imports on the efficiency of domestic firms. However, the spillover effect depends upon the industry to which the firm belongs and the R&D capability of the firm. In another study, the same author (see, Kathuria, 1996) found that foreign presence in fact increased the productivity dispersion in various industries. In more recent studies, Goldar (2004) indicates a positive impact of foreign ownership on the technical efficiency of firms. However, Sasidharan and Ramanathan (2007) find negative horizontal and vertical spillover effects of FDI. Finally, Bhattacharya et.al. (2008) find that foreign presence has positive spillovers on productivity but other channels like Research and Development (R&D) activity or export initiatives have no impact.

The limited evidence of spillover in the earlier studies may well be due to the fact that FDI resurgence in India has largely come after 2002. In addition, none of these studies considers the importance of institutional factors like the degree of competition and the interaction of foreign presence with well known control variables like R&D, concentration etc. for determining the extent of spillover in Indian manufacturing industry. In this study we have tried to remove these lacunae of earlier studies.

In the next section we outline our methodology, data sources and main estimation results.

III. Methodology and Data Description.

Following earlier studies we will use total factor productivity (TFP) as a proxy for technology. Improvements in technology will then be proxied by a decline in the dispersion of productivity in any industry. This constitutes our dependent variable. In calculating this variable we have used the procedure outlined below.

In most of the literature, labour productivity has been used as the measure of firm level productivity but this is actually a partial measure (Kathuria, 1996, 2000). Capital and labour both are considered as the main factors of production. So, total factor productivity is a better measure of firm level productivity. Following earlier studies, in calculating TFP we have used the method of calculating residuals from production function estimation (see, Bhattacharya, op.cit.). We estimate production functions for all the firms included in the sample to get the firm specific productivity level. Each firm i has a production function for gross output:

$Y_{ijt} = A_{ijt} F (L_{ijt} , K_{ijt})$; i=no. of the firm
j=no of the industries included
And, t=denotes the year.

Y is the Gross Value added[1](Kathuria, 1996; Kathuria, 2000, 2002), L denotes the labour input, K[2] denotes the capital input and A_{ijt} is the level of productivity which is assumed to

[1] **Gross Value Added (GVA) is defined as:** Total Sales turnover – (Raw material cost + Power and Fuel expenditure). The capital charges and worker's remunerations are not included in the calculation of Gross Value Added (GVA) following the same definition used by Pant and Pattanayak (2005). The Gross Value Added has not been deflated. These values are in nominal terms.

vary across firms as each firm is a distinct entity and as the past behaviour (previous production performance), efficiency (managerial and organizational skills) and the initial conditions (initial capital stock, labour quality) are different for each firm.

Assuming that *F*(.) is a Cobb Douglas production function, we can write the production function as $Y_{ijt} = A_{ijt} \times L^{\alpha}_{ijt} K^{\beta}_{ijt}$. Taking logarithm we can write this as:

$$y_{ijt} = \ln A_{ijt} + \alpha_{ijt}\, l_{ijt} + \beta_{ijt}\, k_{ijt}.$$

Where, y_{ijt}, k_{ijt}, l_{ijt} are the logarithmic values of Gross Value Added of the firm, labour input of the firm and capital input of the firm.

If the technical parameters α and β are invariant across the firms and invariant over time and TFP is varying across the firms over time and unobservable, then we can reproduce the above equation as:

$$y_{ijt} = \alpha\, l_{ijt} + \beta\, k_{ijt} + U_{ijt} \text{ where } U_{ijt} = \ln A_{ijt}.$$

Now, by estimating the above equation, we will get the relative (i.e. relative to the regression line) Total Factor Productivity (TFP) for each firm for each year where the residual measures the Total Factor Productivity (TFP) of each firm.

Measure of Relative Productivity Dispersion

It is assumed that the firm which has the highest level of productivity has achieved the best practice production frontier (is the most efficient firm). The other firms which have not yet reached the frontier are considered to be the laggard firms. Now, if the spillover takes place, the gap between the most productive firm (the most efficient firm) and the other laggard firms would decrease over time.

The level of the TFP of a firm can be examined relative to the productivity level as achieved by the most efficient firm in each industry j. For N no. of firms, there would be N estimates of productivity within each industry j, given by a_{1jt}, a_{2jt} ,………a_{Njt}. From here, we can get $a_{jt} = \max(a_{ijt})$, as the productivity of the most efficient firm in the industry j for the year t. Then, the dispersion from the most efficient firm or the relative inefficiency of each firm can be calculated as:

$$Z_{ijt} = a_{jt} - a_{ijt}.(i = 1,\ldots,N; j=1,\ldots,5; t= 2001,\ldots,2007).$$

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[2] Capital is proxied by the Gross Fixed assets of the firms (Kathuria,1996, 2000). Employment data is not available in the CMIE PROWESS database. Therefore, wages and salaries paid by a particular firm are considered as the proxy for the labour. Both of these variables are expressed in nominal terms.

A high value of Z_{ijt} in absolute terms implies that the firm i is very inefficient relative to the most efficient firm in the industry j at the time t. The relative dispersion or the deviation of the firm level productivity from the best practice frontier can be measured by $P_{ijt} = Z_{ijt} / a_{jt}$ where, P_{ijt} denotes the relative productivity dispersion of the firm from the best practice firm in the industry. This variable i.e. P_{ijt} has been used as the dependant variable for our estimation.

Data Description and Sources

The data has been retrieved from Prowess database provided by the Centre for Monitoring the Indian Economy (CMIE). The data consists of five two digit industries of the manufacturing sector which account for most of the FDI. These industries are: Electrical Goods Industry, Power and Fuel Industry, Industrial Machinery Industry, Transport Equipments Industry and Chemical Industry. Our initial sample consisted of 3779 firms. Most of the firms were dropped from the initial sample because of the discontinuity of data for several years. A total of 2611 firms were thus dropped from the initial sample. The final sample consisted of 1168 firms from the five industries: Power and Fuel (37 firms), Chemical Industry (505 firms), Industrial Machinery (231 firms), Electrical Equipment (176 firms) and Transport Equipment (219 firms). The study period covers the years from 2000-01 to 2006-07. Therefore, our sample used for the estimation constituted an unbalanced panel.

The Model.

As we have already noted, technology spillover is measured by the impact on the relative productivity of firms. Following the literature, we will also use TFP as our proxy for technology. However, since our concern is with changes in relative productivity, our dependent variable will be the dispersion of productivity across firms in an industry.

From the literature review we saw a fairly mixed evidence of spillover effect from foreign presence per se. The presumption is that FDI presence in the industry improves productivity of all firms.

Technology or knowledge cannot spillover to the firms automatically. Domestic institutional factors like competition facilitate spillover. A high market concentration level means that the industry is dominated by a few firms which have market power, better technology base and are in a more advantageous position in price setting. As a result, these firms tend to have higher productivity and the other firms stay behind the large and highly productive firms (Tong and Hu, 2003). Therefore, higher concentration would lead to higher relative productivity dispersion between the best practice firm and the laggard firms in the industry.

We have already noted that technology spillover also depends on the absorptive capacity of the firm. R&D reflects the technological capacity and awareness of the firms in adopting new technology (Wang and Blomstrom, 1992). Technology is "tacit" in nature, and it needs to be decodified. It requires significant R&D investment by the firms to decodify and exploit learning or spillovers. In fact, the more the local firms are investing in learning and R&D, the more is the potential spillover it is able to absorb from foreign presence (Kathuria, 2000, 2002). Therefore, it is obvious that the firms which are engaged in R&D activities would benefit more from foreign presence (technology and knowledge spillover) thus gaining more productivity.

However, there are other firm level features like the capital intensity of the firm, expenditures on input materials and power and fuel that influence the productivity of the firms. Hence these will be introduced as control variables in our estimating equation.

Now, for our hypothesis testing, P_{ijt} , the relative productivity dispersion between the best practice firm and the laggard firms is taken as the dependent variable. We can then represent the basic model as:

$P_{ijt} = F$ (SPILL, K/L, CONC, R&D, MAT) - - - - - - - - (1)

Where, SPILL represents the foreign presence, K/L represents the capital–labour ratio of the firm, CONC represents the concentration in the industry, R&D represents the R&D expenditure and MAT is the material expenditure of the firms.

We have used two measures of foreign presence (SPILL): the foreign firms' physical presence in the industry (denoted by SPILL1) and disembodied technology import or technical collaborations by the firms (denoted by SPILL2). Both of these induce significant learning to the local firms thereby leading to productivity improvements (Kathuria, 1996, 2000). It is argued that only large firms have the potential to import technology and take the advantage of imported technology, but there may be some "trickle down" effects of technology imports on the laggard firms in the industry.

In the above model, CONC denotes the industry concentration which is measured alternatively by the Herfindahl index, HHI and the four firm concentration ratio,CR4.

We have noted that the impact of foreign presence variables also depends on the institutional factors like the degree of competition in the market. We account for this in our estimation by considering interaction terms. The interactions considered are between the foreign presence variables (SPILL1) and the technology imports (SPILL2) and CONC and R&D. Here R&D is one measure of the absorptive capacity of firms. Hence from (1) we represent our estimation equation as

$$\mathbf{P_{ijt} = \mu + \overset{(-)}{\gamma_1\, SPILL1_{jt}} + \overset{(-)}{\gamma_2\, SPILL2_{ijt}} + \overset{(-)}{\gamma_3\, (K/L)_{ijt}} + \overset{(-)}{\gamma_4\, MAT_{ijt}} + \overset{(+)}{\gamma_5\, CONC_{jt}} + \overset{(-)}{\gamma_6\, R\&D_{ijt}}}$$

$$\mathbf{+ \overset{(-)}{\gamma_7\, (SPILL1_{jt} * R\&D_{ijt})} + \overset{(-)}{\gamma_8\, (SPILL2_{ijt} * R\&D_{ijt})} + \overset{(+)}{\gamma_9\, (SPILL1_{jt} * CONC_{jt})} +}$$

$$\mathbf{\gamma_{10}\, (SPILL2_{jt} * CONC_{jt}) + \delta_{ijt}} \qquad \text{- -} \ \mathbf{(2)}$$

Where,

$(SPILL1_{jt} * R\&D_{ijt})$ = the interaction term between the foreign presence in the jth industry at time period t and R&D of the ith firm in jth industry at time period t.

$(SPILL2_{ijt} * R\&D_{ijt})$ = the interaction term between the technology import by the ith firm in jth industry at time t and R&D of the ith firm in jth industry at time t.

$(SPILL1_{jt} * CONC_{jt})$ = the interaction term between the foreign presence in the jth industry at time period t and concentration in the jth industry at time period t.

δ_{ijt} = Normally distributed random error term which captures other Influences on P_{ijt} .

From Equation (2) it is clear that $\boldsymbol{\gamma_1}$, $\boldsymbol{\gamma_2}$, $\boldsymbol{\gamma_7}$, $\boldsymbol{\gamma_8}$, $\boldsymbol{\gamma_9}$ and $\boldsymbol{\gamma_{10}}$ are of particular importance to us. For example, $\partial P_{ijt} / \partial SPILL1_{jt} = \gamma_1 + \gamma_7 R\&D + \gamma_9 CONC_{jt}$ measures the impact of foreign presence on dispersion of productivity when the interaction between CONC, R&D and the foreign presence variable (SPILL1) is also considered. Statistically significant values of γ_7 and γ_9 would indicate that the spillover impact of foreign presence on dispersion of productivity would depend on the R&D expenditures by firms and the market concentration of the industry.

Construction of the Explanatory Variables

$(K/L)_{ijt}$: Capital–Labour Ratio of the ith firm in the jth industry at the time period t.

MAT_{ijt} : Share of ith firm's expenditure on raw material and power and fuel in total sales turnover of the ith firm in jth industry for the year t. (see, Aitken and Harrison,1999).

$R\&D_{ijt}$: R&D intensity. Measured as ratio of total Research and Development expenditure (Current and Capital) to the total sales turnover of the ith firm which belongs to jth industry for the year t.

Foreign Firm: A foreign firm has been defined as the firm where the foreign equity participation is more than or equal to 10% (see Pant and Pattanayak, 2005). This is used to define the various explanatory variables relating to foreign firms and shown below.

$SPILL1_{jt}$: This variable is measured as the share of foreign firms' sales in total sales of a particular industry for a particular year. It is a measure of the foreign presence in any industry.

$SPILL2_{ijt}$: This variable captures technology imports. It is measured as the ratio of the royalties, technical fees and licensing fees to total sales turnover of the ith firm in the jth industry for each year t (Kathuria, 1996, 2000).

$CONC_{jt}$: The HHI is measured as: $\sum^{n}_{i=1} (p_i)^2$ where $p_i = q_i / Q$ where q_i is the sales of the ith firm, Q is the total sales of the industry and n is the no. of the firms in the industry. CR4 is the share in sales of the top four firms in the industry.

IV. Estimation Results.

As we have noted, implementation of the model requires us to first generate residuals from production function estimates and then generate our dependent variable. P_{ijt} . We have used panel estimation techniques for this and our main estimating equation (2).

The results of our estimation are shown in Table 1 below. It is clear that the overall significance is fairly high. The usual tests indicated the relative efficacy of the fixed effects model results shown in the table. The explanatory variables did not exhibit any multicollinearity.

Table 1. Fixed Effects Regression Equation for Productivity Dispersion
(All firms)

Dependent Variable: P_{ijt}		
VARIABLES	EQUATION 1 (CR4)	EQUATION 2 (HHI)

(K/L)	-7.68E-06	-7.52E-06
	(-10.57)***	(-10.25)***
MAT	0.0777065	0.0735006
	(6.7)***	(6.36)***
R&D	-1.077985	-1.060866
	(-2.39)**	(-2.29)**
SPILL1	-0.5698558	-1.168603
	(-2.94)***	(-8.47)***
SPILL2	0.0185784	0.0359333
	(0.21)	(0.4)
CONC	1.411422	1.953407
	(9.59)***	(3.56)***
SPILL1*R&D	-7.432569	-7.156859
	(-2.9)***	(-2.68)***
SPILL2*R&D	-8.28612	-6.954697
	(-1.16)	(-1.02)
SPILL1*CONC	-0.2676921	9.120161
	(-0.43)	(3.13)***
CONSTANT	0.6163295	0.9510268

Note: *** indicates 1percent statistical significance. ** indicates 5 percent level of significance

Inspection of table 1 shows that our model performs fairly well. Thus high levels of R&D correlated with low dispersion which gives some credence to the usual hypothesis that R&D expenditure probably enables domestic absorption of technology and hence productivity. Similarly, our results also indicate that highly concentrated industries were those where productivity dispersion was highest. This confirms our hypothesis that lack of competition inhibits technology transfer so that productivity dispersion remains high. This holds true for both the definitions of competitiveness used, namely, CR4 and HHI. The negative coefficients for the K/L variable indicate that firms with low K/L ratio are also those with relatively low levels of productivity. This may indicate the relatively lower efficiency of labour in Indian manufacturing firms. The statistically significant coefficient for MAT is understandable given the nature of the variable. An important component of MAT is power and fuel. Our results thus show that firm productivity depends positively on the availability and use of these inputs in the production process.

Since our data mainly relates to the organized manufacturing sector the result is not surprising.

However our main focus in this paper is the spillover impact of foreign firms. We have tested two possible sources of spillover: foreign presence (SPILL1) and use of licensed foreign technology (SPILL2). Our results clearly indicate that while foreign presence has strong spillover impacts, the usual presumption that licensing of technology will induce learning by doing for Indian firms is not supported by our results. The coefficient of SPILL2 is not statistically significant. This result is important given the policy focus in the 1980s to promote technical collaborations in preference to FDI in India (see, Pant, 1995). Our results indicate that spillover seems to come more from the general presence of foreign firms rather than from purchase of imported technology.

One issue which has received no attention in the Indian context is the impact of institutional factors on the spillover from foreign firms. This has important implications for the general issue of the absorptive capacity of Indian firms. From table 1 we can see that the coefficient of SPILL1*R&D is negative and statistically significant. This indicates that while SPILL1 by itself has a positive spillover impact via reducing the productivity dispersion, this impact is larger for firms with higher R&D expenditure. This indicates that the absorptive capacity of the Indian firms is higher when they undertake more R&D expenditure.

In the same vein we see that measures that reduce market concentration (HHI) also lead to a higher impact on foreign presence on dispersion of productivity. However, this seems to be true mainly for HHI definition of concentration (see, Equation 2 in the table above). We interpret this to imply that higher competitiveness in an industry also enhances the spillover from foreign presence in that industry.

It is possible that our results are dominated by the effects on foreign firms in our sample. In other words, spillover impacts apply mainly to foreign firms and this is driving the overall results. To test this we implemented our model for the set of only domestic firms. The results are shown in Table 2 below.

Table 2. Regression equation for productivity Dispersion
(Domestic firms)

Dependent variable: P_{ijt}

VARIABLES	EQUATION 3 (CR4)	EQUATION 4 (HHI)
(K/L)	-7.47E-06	-7.49E-06
	(-11.00)***	(-10.89)***
MAT	0.0756	0.073
	(5.87)***	(5.67)***
R&D	-1.187	-1.151
	(-2.65)***	(-2.57)***
SPILL1	-0.2337	-0.7666
	(-1.85)*	(-4.85)***
SPILL2	-0.4066	-0.0269
	(-0.4)	(-0.25)
CONC	0.1597	0.8216
	(2.4)**	(1.34)
SPILL1*R&D	-7.87	-7.64
	(-3.04)***	(-2.95)***
SPILL2*R&D	-1.66	-1.96
	(-0.25)	(-0.3)
SPILL1*CONC	-0.56867	7.49
	(-1.79)	(2.27)**
CONSTANT	0.8807	0.9198

Note: *** indicates 1 percent statistical significance. ** indicates 5 percent level of significance

Inspection of Table 2 indicates that none of our earlier results are altered when the model is implemented for the set of only Indian firms. The significance of foreign presence remains the same and so does the interaction of this spillover with our variables R&D and CONC.

V. Conclusion

In this article we have argued that the concern about transfer of technology to host country firms has moved away from traditional channels to spillover impacts. In the light of strengthening patent regimes, this issue is of particular importance to developing countries which have been opening up to FDI in a big way in recent decades. It is thus imperative to see what factors determine this spillover. We have here concentrated on India for which such studies have been few and far between.

Our results support the view that foreign presence and associated demonstration effects are more likely to lead to technology transfer than attempts to buy foreign technology. It may be noted that in India the policy towards foreign collaborations in the decade of the ‘eighties was biased towards purchase of foreign technology. Our results this indicate that the abandoning of this policy in the ‘nineties was a right move. Second, as in the case of studies for other countries, our results also support the view that technology transfer and spillover is dependent on the absorptive capacity of the firms. This absorptive capacity is reflected in our model in the R&D expenditure of firms. Unfortunately, the spending on R&D by India firms has been failry low with the possible exception of the pharmaceutical sector.

One of the new results we have looked for is the impact of institutional factors on spillover. It is seen that the more competitive the industry the greater the extent of technology spillover. In addition, our study indicates that while high absorptive capacity and foreign presence do positively impact technology spillover, these impacts are heightened by a competitive environment. In other words, the government has an important enabling role in determining technology transfer to local firms.

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